SHOREBIRD CONSERVATION

IN THE

ASIA-PACIFIC REGION

Edited by Phil Straw

October 1997

Shorebird Conservation in the Asia-Pacific Region

Based on papers presented at a symposium held on 16-17 March 1996 in Brisbane, Australia

Phil Straw, Editor

Published by

The Australasian Wader Studies Group

of Birds Australia

October 1997

This publication may be obtained from
Birds Australia, Australian Bird Research Centre,
415 Riversdale Road, Hawthorn East,
VIC 3123, Australia.

Published by the Australasian Wader Studies Group of Birds Australia
(formerly Royal Australasian Ornithologists Union), with financial assistance
of the Wetlands, Waterways and Waterbirds Unit of Environment Australia

Front cover: Shorebirds congregating at Roebuck Bay, Western Australia,
during migration (photo Clive Minton).

ISBN 0 646 34429 3

Contents

Contents iii

Foreword
Bill Phillips v

Preface and Acknowledgments
Phil Straw vi

Summary Statement of The Conference on "Shorebird Conservation In The Asia-Pacific Region" vii

Part I
The Biology of Migratory Shorebirds
Theunis Piersma 2

Part II
Threats and Impacts on Shorebirds

East Asian-Australasian Flyway Overview
Brett Lane 14

Threats to waders along the East Asian-Australasian Flyway
David S. Melville 15

Habitat Loss and alteration in Japan - A History of Large-Scale Destruction
Tobai Sadayosi 35

Hunting of Shorebirds on the North Coast of West Java
Yus Rusila Noor and *Noviana Andalusi* 44

Waterfowl Disturbance in Europe: Problems and Solutions
David A. Stroud 53

Part III
Frameworks for Flyway Conservation

The Successes and Challenges of Establishing a Shorebird Conservation Program in the Americas
Ian Davidson 63

The African-Eurasian Migratory Waterbirds Agreement; a Technical Agreement under the Bonn Convention
Gerard C. Boere and *Bert Lenten* 67

The Kushiro Initiative -
Karen Weaver 72

Part IV
Asia-Pacific Shorebird Action Plan

Implementation Case Studies

Developing an Action Plan for the Conservation of Migratory Shorebirds in the Asia-Pacific
Doug Watkins and *Taej Mundkur* 76

The Distribution of Waders Along the Queensland Coastline
Peter Driscoll 80

Shorebird Research Training
Kiyoaki Ozaki 123

The use of Colour Marking in the East Asian-Australasian Flyway
Doug Watkins 125

Part V
East Asian-Australasian Shorebird Reserve Network

East Asian-Australasian Shorebird Reserve Network
Doug Watkins 132

Shorebird use of the Moroshechnaya Estuary
N.N. Gerazimov and *Yu.N. Gerasimov* 138

Observations of Migratory Waders on Lunskiy gulf, Sakhalin Island
Vladimir Zykov 141

Shorebird use of Yancheng Biosphere Reserve China
Wang Hui 149

Bangladesh: A case study on shorebird conservation network
Anisuzzaman Kahn 155

Appendix I - List of participants

Foreword

In late 1994, under the banner of the Japan-Australia Migratory Birds Agreement, Australia joined with Japan and Wetlands International to host a workshop in Kushiro, Japan. From this came the Asia-Pacific Migratory Waterbird Conservation Strategy 1996-2000, or the Kushiro Initiative as it was called, which sets out a plan for domestic and multilateral actions by the countries of the Asia Pacific. It was the result of the efforts of the many government and non-government people who share the vision of these countries and their people working together to protect the many birds which regularly cross international boundaries as part of their annual migrations in this region.

The workshop which is reported on in this volume was a part of the ever quickening pace of activities which is transforming the Asia-Pacific Migratory Waterbird Conservation Strategy from being words on paper into a major international conservation effort. The workshop was held on the days leading up to the 1996 Ramsar Convention Conference in Brisbane, Australia and provided the impetus for the launch of the East Asian Australasian Shorebird Reserve Network a few days later. On that occasion eight countries from the flyway took the significant first steps of publicly recognising 19 wetland sites as critical to the survival of these species. It is hoped the estimated 200 critical sites of the flyway will be soon gain similar recognition from their governments and the local communities that live around them.

As you will discover from the authoritative information which follows, the workshop brought together a large number of the World's experts on migratory waterbirds. The vast understanding these people have of the issues provides not just a current status report on threats and species but also sets out a way forward in terms of conservation effort.

The challenge now lies in moving ahead to see all elements of the Asia-Pacific Migratory Waterbird Conservation Strategy implemented. In the months since this workshop took place there has been further action towards this goal with a site network for cranes now in place in north-east Asia and a raft of activities being pursued by the "flyway" officers for shorebirds, cranes and ducks/geese. Technical experts from across the region are being brought together to advise the actions and we are witnessing growing interest from several further countries to join in and support this effort.

Environment Australia has worked closely with its Japanese counterpart to give this initiative direction and support and Wetlands International has been the driving force behind shaping it and mobilising support more broadly. With the pledge of support which Senator Robert Hill, Australia's Commonwealth Minister for the Environment, gave the initiative on the occasion of the Ramsar Convention's 25th anniversary celebration it is clear that governments have recognised the need for international cooperation if we are to secure the long term future of these once neglected part of the global biodiversity. But government support can only contribute towards solving the problems; at the end of the day it will require understanding and action by the people of the Asia-Pacific region to ensure our migratory waterbirds are protected in perpetuity.

Dr Bill Phillips
Director, Wetlands, Waterways and Waterbirds Unit
Environment Australia - Biodiversity Group

PREFACE

The loss of shorebirds (waders) to hunting pressure is compounded by the increasing loss of habitat at critical breeding, staging and overwintering sites throughout the East Asian-Australasian Flyway. The need for studies and research towards the conservation of these fascinating birds has been identified in many of the countries along the flyway. The recognition of the increasing urgency of these needs resulted in the committee of the Australasian Wader Studies Group initiating the 'Shorebird Conservation in the Asia Pacific Region' conference, held in Brisbane on 16-17 March 1996.

After some debate as to when the conference should be held it was felt that the most effective time would be immediately before the Ramsar Convention in Brisbane in March 1996. This would coincide with the presence in the country of key people who might attend both functions as well as providing a high profile of the objectives of the conference.

In addition to the information on the issues of conservation of critical habitat and identification of threatening processes, these proceedings provide information on shorebird populations in the Flyway published for the first time.

The conference comes at a critical time in the conservation of our wetlands and waterbirds, in particular migratory species. The Summary Statement of the Conference is presented here, at the front of the document as a measure of the success of this first international shorebird conference to be held in Australasia.

Phil Straw, Editor

ACKNOWLEDGMENTS

The Editor and AWSG Committee wish to thank the Wetlands, Waterways and Waterbirds Unit of Environment Australia for sponsoring the production of these proceedings and for giving support to the idea and initiation of the Brisbane Conference.

Members of the organising committee were Mark Barter, Peter Driscoll, Phil Straw and Doug Watkins. However, the conference 'Shorebird Conservation in the Asia-Pacific Region' and the production of these proceedings would not have been possible without the support of many dedicated volunteers from the Australasian Wader Studies Group, Queensland Wader Study Group and the Queensland Ornithological Society. These people worked very hard to ensure all went well at the conference. Many of them also made their homes available to provide billeting for speakers and overseas delegates. Thanks to Derek Griffin and his staff at the Queensland Museum for providing instant interpretation facilities and coming to our rescue when computer discs crashed, necessitating the re-typing of the entire book of abstracts, and when handouts were needed at very short notice. Thanks also to Liz Cameron for proof reading a large part of these proceedings and to Louise Allard for working so hard on the formatting and final layout of these proceedings.

Thanks should also go to the speakers who provided illuminating and stimulating presentations and discussion on shorebirds and conservation issues in the Flyway. Thanks also to participants who attended from all parts of the Flyway, and other parts of the world, who made the blood sweat and tears of organising the conference well worth while.

SUMMARY STATEMENT

OF THE CONFERENCE *ON*

"SHOREBIRD CONSERVATION IN THE ASIA-PACIFIC REGION"

A Conference entitled "Shorebird Conservation in the Asia-Pacific Region" was held on 16 and 17 March in Brisbane, Australia. The Conference was attended by 145 participants from 16 countries and territories (Australia, Bangladesh, Belgium, Canada, People's Republic of China, Hong Kong, Republic of Indonesia, Japan, Republic of Korea, Malaysia, The Netherlands, New Zealand, The Philippines, Russian Federation, Singapore and the United Kingdom).

The Conference heard presentations by 23 speakers from 15 countries and territories outlining the conservation status of shorebirds and their habitats in the Asia-Pacific Region, and describing the serious threats to migratory shorebirds, and the impacts of these threats.

Options for improving shorebird conservation, particularly the proposed Asia-Pacific Shorebird Action Plan and East Asian - Australasian Shorebird Reserve Network were discussed. Workshop sessions were held on four components of the Action Plan to obtain feedback from participants.

The Conference:

- recognizing the growing evidence of declining population numbers for many species of shorebirds in the region, due to habitat loss and degradation, disturbance, pollution and hunting, urged that immediate action be taken to reverse the situation.

- expressed particular concern at the destruction of critically important staging sites for migratory shorebirds in China, the Korean peninsular and Japan.

- welcomed the timely response to the "Kushiro Initiative", which has involved the publication of the Asia-Pacific Migratory Waterbird Conservation Strategy, and the development of the Asia-Pacific Shorebird Action Plan and East Asian-Australasian Shorebird Reserve Network.

- strongly supported the development of the Asia-Pacific Shorebird Action Plan

- endorsed the development of the East Asian-Australasian Shorebird Reserve Network

- called on countries at the Conference of Parties of the Ramsar Convention to support the "Brisbane Initiative" being proposed by the Australian Government.

- noted that successful implementation of the Strategy, Shorebird Action Plan and Shorebird Reserve Network requires the cooperation and coordination of national and local Government agencies, inter-governmental agencies, non-government organisations, academic institutions, local people and individuals, both within countries and on a Flyway-wide scale, and called for all to work together for shorebird conservation.

- stressed the need for an effective Flyway-wide communication network to allow all those involved in shorebird management, conservation and research to be well informed.

- recognizing the need for improved knowledge of migration routes, recommended that priority be given to analyzing existing data and developing cooperative migration studies involving satellite tracking, especially of the Eastern Curlew, and the use of marking, particularly leg-flagging.

- recognizing the need for improved knowledge of the abundance, distribution and population trends of shorebirds within the flyway, recommended that additional surveys and counts be undertaken and that a flyway-wide monitoring programme be established.

Part I

The Biology of Migratory Shorebirds

The Biology Of Migratory Shorebirds

Theunis Piersma

There are few avian groups that can boast of being as highly migratory as the shorebird families Charadriidae and Scolopacidae. Plovers and sandpipers travel the globe by the millions, each individual carving out a precarious existence by moving from one acceptable piece of habitat to another in the course of its annual cycle. Why are so many shorebirds continuously on the move? Most habitats show large fluctuations in quality with respect to food availability, energy expenditure (weather) and safety (e.g. presence of raptors), so it is easy to understand that organisms capable of moving have been naturally selected to track the best ecological conditions for survival and reproduction. The migratory mode would have been further enforced by evolving sensory specialisations and the correlated ecological requirements. Long-distance flights that enable shorebirds to track ecological resources in space and time not only require excellent navigational capabilities, but also necessitate a suite of physiological adjustments. The ability to rapidly store fat, the fuel-for-flight, and to remain actively airborne for several days, put high demands on the metabolic capacities of shorebirds. No shorebird species lays more than four eggs per clutch, few species breed when one year old, and many become quite old relative to their body size and rate of energy expenditure. The great variety of migratory strategies in shorebirds finds a counterpart in the great variability of mating systems. Although some aspects of migration and reproduction are clearly functionally linked, much of the covariation remains unexplained. Shorebirds breeding at arctic latitudes have short breeding seasons and little time for mate selection. Much of the courtship displays and colourful breeding plumages may be sexually selected quality traits; traits that otherwise act as handicaps. The biological features of some non-migratory, resident, shorebird species such as the Antarctic snipes of New Zealand, provide insightful contrasts to the life-history of long-distance migrants.

T. Piersma, Netherlands Institute for Sea Research (NIOZ), P.O. Box 59, 1790 AB Den Burg, Texel, The Netherlands; and Centre for Ecological and Evolutionary Studies, University of Groningen, P.O. Box 14, 9750 AA Haren, The Netherlands; E-mail: theunis@nioz.nl. Piersma, T. (1997). The biology of migratory shorebirds.

Introducing shorebird migrants

Most species of long-distance migrating shorebirds belong to two of the thirteen families within the infra-order Charadrii of the Charadriiformes (del Hoyo *et al.* 1996), the Charadriidae (plovers) and the Scolopacidae (snipes, sandpipers and phalaropes) (Piersma & Wiersma 1996, Piersma *et al.* 1996b). Even though several inland and island forms do not carry out seasonal migrations, the majority of plovers and sandpiper species do. In fact, some plovers and sandpipers belong to the most spectacular migrant birds of the world. They are suspected of not only carrying out some of the longest uninterrupted flights of the animal kingdom, physical achievements that depend on their great capacity to store fuel and then rapidly expend it, but also of unrivalled capabilities to navigate over featureless terrain, including the world's largest oceans. In this brief introduction to migrating shorebirds, I aim to review some of the biological characteristics of this spectacular group of birds. The review won't be comprehensive, but readers may follow up particular points in some of the selected references that are given below. (At this point, I must apologise for being biased towards studies with which I am most familiar, often rather recent ones in which I was personally involved.)

Before discussing several of the ecological and physiological aspects of long-distance migration of shorebirds, I would like to introduce the main players by describing the annual cycle of a typical migrant shorebird. Let's start on a tropical "wintering" (i.e. non-breeding) area, the Banc d'Arguin in the West African country Mauritania (Ens *et al.* 1990), or Roebuck Bay near Broome in north-west Australia (Tulp & de Goeij 1994), for example. Shorebirds arrive here between August and November, and then go through a complete moult of their flight and body contour feathers. Thereafter, some birds have time to do "nothing": no moult, no nutrient storage, just survival (Zwarts *et al.* 1990a). Only during this time of the year is the life of shorebirds reasonably relaxed.

But then, from early February onwards, the long-distance migrating shorebirds must start to prepare for breeding. First of all, they begin to produce a new breeding plumage, and also the storage of the fat and protein needed for the first of a series of long northward flights (Piersma & Jukema 1990, 1993, Zwarts *et al.* 1990b). Some birds cover the distance to the breeding grounds in a few very long flights; others do it in a longer series of much shorter flights, visiting many refuelling sites *en route* (Piersma 1987, 1989). Depending on latitude, northward migration may take up most of March, April and May (Piersma *et al.* 1990a). Especially for the high arctic breeders, the short summer season dictates that they arrive as early as possible, as soon as the first tundra vegetation is uncovered by the melting snow (Green *et al.* 1977, Meltofte 1985). The "early" timing implies that the northernmost staging areas, areas that can be used after breeding, are still snow- and ice-covered. Thus, shorebirds have to embark for the Arctic from refuelling areas in the temperate zone, often at a distance of 3,000 kilometres, and sometimes over 5,000 kilometres (Gudmundsson *et al.* 1991).

Having arrived in the taiga or tundra, they need to find a suitable partner, a process that may involve the establishment of a good territory and other intense behaviours, and select a nest site. Within one or two weeks after arrival, the first eggs are usually laid (Whitfield & Tomkovich 1996). In some of the species one of the partners takes the rest of the breeding season for granted and migrates southwards straight away (Myers 1981, Székely & Reynolds 1995). Reproductively successful birds spend about three weeks incubating, and then a further three weeks caring for chicks. But they also leave southwards as quickly as they can. By that time in late July most of the northern arthropod-peaks are over (Nettleship 1973), snow may start to fall in the northernmost parts of the range, and food availability is already on the decline in temperate staging areas (Schneider & Harrington 1981, Zwarts *et al.* 1992). Although at northern latitudes more of the sites are suitable for refuelling than in spring, overall southward migration is just as stressful, and many birds succumb during the trip. Those that make it to tropical wintering areas may arrive exhausted. Occasionally they can be picked up there by hand during this time of the year (W.J.A. Dick pers. comm.). Then, after a year of intense use in flight, the worn wing feathers urgently need renewal, and the birds also change their colourful breeding dress into the cryptic plumage of winter (Boere 1976). The cycle is complete.

Why continuously on the move? The imperative of sensory and correlated ecological specialisations

The question as to why so many sandpipers and plovers are long-distance migrants can be approached in many ways. As many of us know from personal experience, at any one place the environmental conditions may vary considerably in the course of the year. For animals such as birds that are capable of easily moving large distances, it would perhaps be more surprising if they did not move in response to such seasonal environmental changes, than that they did (Alerstam 1990). Added to this comes the fact that most shorebird species are restricted to clearly circumscribed habitat types, both during the breeding and the non-breeding seasons. The availability and quality of these habitats also vary enormously in the course of the year. One might argue that migration allows shorebirds to profitably track the best habitats year-round (Piersma 1994), even if this means travelling half the world.

The very strict but varying habitat requirements of the various species appears to be correlated with different sensory specialisations, each of which allows a profitable and efficient exploitation of particular kinds of food. For example, the beach-combing Sanderling (*Calidris alba*) makes a living on small sand crabs and similar crustaceans that live buried in sand in the wave-washed zone (Myers 1988). As waves wash back, sand crabs withdraw beneath the surface. At the tail end of retreating waves sand crabs are most easily captured. This explains the Sanderlings' incessant running up and down in front of the waves. To detect the small crustaceans and polychaetes buried in the sand, Sanderlings and related *Calidris*-sandpipers possess a form of "remote sense" (Gerritsen & Meijboom 1986). With the array of sensory receptors in the bill tips, Sanderlings detect the vibrations of small polychaetes moving in the sand at distances of two centimetres from the bill tip.

Red and Great Knots (*Calidris canutus* and *C. tenuirostris*) also forage on intertidal soft sediments (Piersma *et al.* 1993a), but the hard-shelled molluscs that they eat do not usually move. Even so, with equally sophisticated sensory equipment in their bill tips, these knots seem to have some sort of remote sense as well. Perhaps they detect the hard-shelled objects in soft sediments from the direction in which counter-pressure builds up as they push their bills in the substrate (Piersma *et al.* 1995, R. van Aelst & T. Piersma pers. obs.). It has been argued that such sensory specialisations (and the need for reproduction) restrict knots to particular profitable habitats that differ in location according to season (Piersma 1994). Thus, ultimately it would be the sensory specialisations and their ecological consequences that drive the long-distance migrations undertaken by Red Knots and other shorebird species.

Necessary capabilities for a migratory lifestyle: navigation & body flexibility

The seasonal appearance of Pacific Golden Plovers (*Pluvialis fulva*) on oceanic islands in the Pacific, at distances of 4,000 kilometres or more from the nearest landmass, provided the first unambiguous evidence that shorebirds migrate over thousands of kilometres of inhospitable terrain in uninterrupted flights. Such flights bear witness to the enormous navigational capacities of long-distance migrating plovers and sandpipers, but details of the orientation and navigational mechanisms remain virtually unstudied in shorebirds. Sauer (1963) made some innovative tests on hand-raised Pacific Golden Plovers to show their orientation ability in the presence of different orientational cues such as the sun and the stars. New work with small sandpipers such as Dunlins (*Calidris alpina*) in orientation funnels is now in progress (Sandberg & Gudmundsson 1996). Even though not much direct work on orientation and navigation has been undertaken, descriptive studies of departure behaviour can also be highly instructive.

During long-distance migration, shorebirds fly in flocks. Such flocks usually contain 10-60 conspecific individuals, with the larger species occurring in larger flocks (Piersma *et al.* 1990b, Marks & Redmond 1994, Tulp *et al.* 1995). A small percentage of flocks may contain more than one species, although in such cases the co-occurring species are of roughly the same size. During peak migration and at high tides, i.e. at times when conspecifics are best available, departing flocks are largest. Starting flocks usually assemble from clusters into Vee-formations or echelons, and ascend to flight heights of several hundred metres to several kilometres with climb rates of approximately half a metre per second (Piersma *et al.* 1990b, 1997). As for coastal sites, wader departures bear no uniform relationship with the timing and the height of the tides (Tulp *et al.* 1995). However, at all study sites most flocks leave just before sunset.

With such departure timing, birds can maximise the use of multiple orientational cues such as skylight polarisation patterns and the position of both the setting sun and the stars (Piersma *et al.* 1990b), and also fly under the calmer wind conditions of the night (Kerlinger & Moore 1989). For many species the night is also a better period to fly because foraging is less profitable than during the day (Lank 1989). And the flock, with its cumulative sense of direction, may prevent individuals from straying off into the wrong directions, while formation-flying may be important in reducing flight costs.

The preparations for the breeding season include a moult of part of the contour feathers into a fresh and sometimes colourful breeding plumage (Piersma & Jukema 1993). Obviously, long flights also necessitate the storage and consumption of large amounts of fuel, usually fat. Again for Pacific Golden Plovers, a study by Johnston & MacFarlane (1967) on their fat content and metabolic rate was one of the first that came up with estimates of the energy costs of long-distance flights. Recent studies have shown that long-distance migrating shorebirds do not only store fat, but also increase the size of the flight muscles (Piersma & Jukema 1990, Lindström & Piersma 1993). At intermediate stopover sites the picture is more complicated, as waders may have catabolized part of the metabolic machinery that they need for rapid refuelling (Piersma *et al.* 1993b). In Bar-tailed Godwits (*Limosa lapponica*) and Red Knots arriving at a stopover site, the birds first grow a large digestive apparatus, of which the protein appears to be turned into breast muscle during the last few days before take-off on the next flight (T. Piersma, G.A. Gudmundsson & J. Jukema in prep.). In the meantime they may have doubled their body mass, especially through fat storage.

In waders that are ready to take off on a long-distance flight, fat can make up 50% of total body mass. Subcutaneous fat envelops their bodies with a thick white layer. Until late last century, Eskimo Curlews (*Numenius borealis*) provided abundant examples of such fat migrants. Before take off on their transoceanic flights from northeast America, their skins were stretched with fat to the extent that when they were shot, the whitish fat could burst out of the skin when they struck the ground. For this reason, Eskimo Curlews were called "dough-birds" in New England (Matthiesen 1994). Jehl (1997) has documented instances where fat individuals of Wilson's Phalaropes (*Steganopus tricolor*) that weight-wise would appear ready to depart, were unable to take-off as a consequence of overloading (Hedenström & Alerstam 1992).

Demographic features: few chicks, postponed adulthood, long lives

Long-distance migrating shorebird species tend to lay clutches of four eggs. In the majority of species, birds start breeding when more than one, and sometime three or four years old (Evans & Pienkowski 1984, Pienkowski & Evans 1985, van Dijk *et al.* 1990). Not surprisingly, many long-distance migrant shorebirds live quite long (Boyd 1962, Goede 1993), easily reaching an age of ten years, in spite of the risks incurred during migration. Mortality will be particularly severe during the first year of life when the inexperienced juveniles must find suitable wintering area independently of the adults (Evans 1991). That long-distance migrating shorebirds become so much older than temperate breeding songbirds and other birds of similar size and with similarly high rates of energy expenditure (Kersten & Piersma 1987), is interpreted by Goede (1993) to be a consequence of the high levels of selenium-rich enzymes found in bodies of species belonging to this group. Such enzymes can "catch" free radicals that otherwise damage DNA, the carrier of genetic information and thus slow down the process of aging (Ricklefs & Finch 1995).

There have been few long-term studies of the demography of long-distance migrating shorebirds, so let us examine the results obtained by Oring *et al.* (1983, 1991), a team that spent 17 summer seasons following a population of polyandrous Spotted Sandpipers (*Actitis macularia*) on Little Pelican Island in Leech Lake, Minnesota, USA. Spotted Sandpipers do not undertake the longest of migrations among sandpipers, nor do they have the morphology to make very long uninterrupted flights. Yet, males as well as females live up to nine years. Females produce an average of 5.2 fledglings over an average of 3.0 reproductive seasons. Males have an average reproductive yield of 3.3 young over 2.8 seasons. The lifetime reproductive success of Spotted Sandpipers is determined by the reproductive lifespan and the proportion of chicks fledged.

The Spotted Sandpiper can be considered a pioneering species that quickly and frequently colonises new sites in response to reproductive failure at a previous breeding site, breeds first at an early age, lives a relatively short time, lays many eggs per female and has low of the species there is a change before the breeding season. The bellies may turn from light grey to dark rusty-red or black and the backs may be decorated with finely coloured scapulars whose colours match those of the breast and belly plumage. Red Knots, Curlew Sandpipers (*Calidris ferruginea*), Bar-tailed Godwits and Red Phalaropes (*Phalaropus lobatus*) develop rusty-red bellies, colours which are most outspoken in the males of the first three species, and in the females of the last. In phalaropes, the males are the choosy sex that take care of all parental duties except egg laying, and the duller plumage may provide better camouflage, as is usually the case for females in other sandpiper species.

What is the function of the often intense and sometimes variable colouration of some of the breeding plumages? Does it have the function of camouflage on the breeding grounds, just as the dull winter plumage may give cryptic protection on intertidal mudflats in winter? Is the plumage meant to be well visible, and a signal of beauty and quality? Or does the breeding plumage show adaptations to both functions (Jukema & Piersma 1987)? Let's examine Bar-tailed Godwits along the East-nesting success. The Common Sandpiper (*Actitis hypoleucos*) of Eurasia, and also the endangered Spoon-billed Sandpiper (*Eurynorhynchys pygmeus*) share most of these characteristics (Holland & Yalden 1994, Tomkovich 1994). As we have seen, in most long-distance migrant shorebirds, life is usually somewhat longer, and the importance of reproductive lifespan in determining lifetime reproductive success is therefore probably even more important. What is likely to count for a long-distance migrant is the number of seasons that it successfully migrates into the arctic, i.e. that it arrives there in time, and with a plumage that is attractive enough for a prospective high-quality mate.

Migration and sexual selection: a bouquet of quality signals

During the non-breeding season the plumage of waders tends to be dull greyish. It usually consists of a relatively light belly plumage and a darker back (Hayman *et al.* 1986). In many Atlantic Flyway where these aspects have been quite well studied (Piersma & Jukema 1990, 1993). Before their northward departure from West Africa to the Siberian breeding grounds, Bar-tailed Godwits have more or less completed the moult into a rusty-red breeding plumage. During their main stopover period in The Netherlands some of the Bar-tailed Godwits, males as well as females, nevertheless start a second contour feather moult. Moulting individuals are not only the ones with the brightest colours, but also those that are heaviest for the time of the year. Moulting individuals also carry fewer intestinal parasites and have a better blood profile, e.g. higher counts of red blood cells (Piersma *et al.* 1996a). Thus, individual Bar-tailed Godwits that can afford to upgrade their plumage during a stopover in spite of the stress of rapid fuel storage, signal their own quality as healthy, well-performing, migrants (Piersma & Jukema 1993). For long-distance migrating shorebirds, and indeed other birds (Fitzpatrick 1994), breeding plumages may represent the products of sexual selection for quality traits, rather than reflecting changing camouflage strategies in response to changing habitats.

These findings suggest that there are strong functional relationships between life-history features of the wintering, migration and breeding seasons. This does not only hold for aspects of plumage and nuptial display, but also for aspects of timing, reproductive investment and the length of migration. Shorebird species, in which the males show early abandonment of the breeding attempts, are also the ones where males migrate furthest away from the breeding grounds (Myers 1981, Reynolds & Székely 1997). Reduced care in males appears to have facilitated the evolution of greater migratory distances or vice versa.

The insightful mirror: biology of non-migratory shorebirds

One can hardly think of a greater contrast with that of long-distance migrating shorebirds than the one that is provided by the Subantarctic and Chatham Snipes (*Coenocorypha aucklandica* and *C. pusilla*), studied by Miskelly (1989, 1990). These unobtrusive and well-camouflaged species live on oceanic islands off New Zealand, which are free of predators. In such stable environments the snipe populations are limited by intense competition for food. Instead of producing a costly and colourful breeding plumage, or making costly aerobatic nuptial flights, males display their quality by bringing food to the female as part of the courtship ritual. Also in contrast to most long-distance migrating shorebirds, the Antarctic snipes lay only two relatively large eggs that take a long time to incubate and hatch, (nutritional constraints during egg formation may partially account for the two-egg clutches). Both sexes take part in incubation and care of the chicks. Chicks are fed over a period of at least forty days and take even longer to fledge. In long-distance migrating shorebird species, chicks are brooded but not fed, and grow much more quickly, fledging within twenty days.

Being confined to predator-free islands where carrying capacity is reached through food limitation, male Antarctic snipes can signal their quality by showing an ability to provision a prospective female. A food rich territory is the most precious asset in the life of an Antarctic snipe. For shorebird species that travel the world to capitalise on temporary profitable habitats, it is the proficiency of migration (incorporating effects of foraging, physiological and navigational abilities) that determines their fitness. This can be signalled by a bright breeding plumage, and an ability to engage in costly behaviours in spite of the stresses imposed by an adverse (e.g. arctic) environment.

Conservation implications

Long-distance migrating shorebirds have life-history characteristics that make them susceptible to changes in their environments. First of all, their habit of migrating long distances along chains of critical sites brings them together at particular times (Evans 1991, Ens *et al.* 1994). At such sites and times they are all at risk at once, a characteristic that violates the basic assumption of conservation biology that being common means being safe (Myers *et al.* 1987). Long-distance migration is nutritionally and behaviourally highly demanding and is time-constrained by the seasons, adding to the fragility of the system. A maximum clutch of four eggs is indicative of relatively low reproductive rates (Walters 1984, Redmond & Jenni 1986) and hence a limited capacity to recover from population declines. Finally, there is evidence of strong sexual selection pressures in many species (Myers 1982, Myers *et al.* 1982, Oring & Lank 1982, Reynolds *et al.* 1986). Sustained sexual selection may compromise adaptations with respect to other components of fitness (McLain 1993, McLain *et al.* 1995). Thus, sexually dimorphic species may allocate less energy to adaptations that reflect selection pressures arising from interspecific competition, environmental change, and coevolutionary responses to parasites and prey. Consequently, strongly sexually selected populations may be especially vulnerable to extinction, a factor that could be aggravated in long-distance migrating wader populations by the reduced levels of genetic heterogeneity resulting from past population bottlenecks (Baker & Strauch 1988, Baker *et al.* 1994).

Acknowledgments

I am grateful to Mark Barter and Phil Straw for not only talking me into the Brisbane gathering of wader people, but then also to repeatedly encourage me to come up with a written report. I also like to display my gratitude to the many friends in the international Wader Study Group for providing such an incredibly stimulating and congenial forum for shorebird studies. This is publication 3049 of NIOZ, Texel.

References

Alerstam, T. 1990. Bird migration. Cambridge University Press, Cambridge.

Baker, A.J. & Strauch, T.G., Jr. 1988. Genetic variation and differentiation in shorebirds. Proc. XIX Internat. Ornithol. Congr. (Ottawa): 1639-1645.

Baker, A.J., Piersma, T. & Rosenmeier, L. 1994. Unravelling the interspecific phylogeography of Knots *Calidris canutus*: a progress report on the search for genetic markers. J. Orn. 135: 599-608.

Boere, G.C. 1976. The significance of the Dutch Waddenzee in the annual life cycle of arctic, subarctic and boreal waders. Part 1. The function as a moulting area. Ardea 64: 210-291.

Boyd, H. 1962. Mortality and fertility of the European Charadrii. Ibis 104: 68-87.

del Hoyo, J., Elliott, A. & Sargital, J. (eds.) 1996. Handbook of the birds of the world, Vol. 3. Hoatzin to auks. Lynx Edicions, Barcelona.

Ens, B.J., Piersma, T., Wolff, W.J. & Zwarts, L. 1990. Homeward bound: problems waders face when migrating from the Banc d'Arguin, Mauritania, to their northern breeding grounds in spring. Ardea 78: 1-16.

Ens, B.J., Piersma, T. & Drent, R.H. 1994. The dependence of waders and waterfowl migrating along the East Atlantic Flyway on their coastal food supplies: what is the most profitable research programme? Ophelia Suppl. 6: 127-151.

Evans, P.R. 1991. Seasonal and annual patterns of mortality in migratory shorebirds: some conservation implications. Pp. 346-359 in Perrins, C.M., Lebreton, J.-D. & Hirons, G.J.M. (eds.). Bird population studies. Relevance to conservation and management. Oxford University Press, Oxford.

Evans, P.R. & Pienkowski, M.W. 1984. Population dynamics of shorebirds. Pp. 83-123 in Burger, J. & Olla, B.L. (eds.). Shorebirds. Breeding behaviour and populations. Plenum Press, New York.

Fitzpatrick, S. 1994. Colourful migratory birds: evidence for a mechanism other than parasite resistance for the maintenance of 'good genes' sexual selection. Proc. R. Soc. Lond. B 257: 155-160.

Gerritsen, A.F.C. & Meijboom, A. 1986. The role of touch in prey density estimation by *Calidris alba*. Neth. J. Zool. 36: 530-562.

Goede, A.A. 1993. Longevity in homeotherms, the high lifespan and lifespan energy potential in Charadriiformes. Ardea 81: 81-88.

Green, G.H., Greenwood, J.J.D. & Lloyd, C.S. 1977. The influence of snow conditions on the date of breeding in waders in north-east Greenland. J. Zool., Lond. 183: 311-328.

Gudmundsson, G.A., Lindström, Å. & Alerstam, T. 1991. Optimal fat loads and long-distance flights by migrating Knots *Calidris canutus*, Sanderlings *C. alba* and Turnstones *Arenaria interpres*. Ibis 133: 149-152.

Hayman, P., J. Marchant & T. Prater. 1986. Shorebirds. An identification guide to the waders of the world. Christopher Helm, London.

Hedenström, A. & Alerstam, T. 1992. Climbing performance of migrating birds as a basis for estimating limits for fuel-carrying capacity and muscle work. J. exp. Biol. 164: 19-38.

Holland, P.K. & Yalden, D.W. 1994. An estimate of lifetime reproductive success for the Common Sandpiper *Actitis hypoleucos*. Bird Study 41: 110-119.

Jehl, J.R., Jr. 1997. Fat loads and flightlessness in Wilson's Phalaropes. Condor 99: in press.

Johnston, D.W. & MacFarlane, R.W. 1967. Migration and bioenergetics of flight in the Pacific Golden Plover. Condor 69: 156-168.

Jukema, J. & Piersma, T. 1987. Special moult of breast and belly feathers during breeding in Golden Plovers *Pluvialis apricaria*. Ornis Scand. 18: 157-162.

Kerlinger, P. & Moore, F.R. 1989. Atmospheric structure and avian migration. Current Ornithol. 6: 109-142.

Kersten, M. & Piersma, T. 1987. High levels of energy expenditure in shorebirds; metabolic adaptations to an energetically expensive way of life. Ardea 75: 175-187.

Lank, D.B. 1989. Why fly by night? Inferences from tidally-induced migratory departures of sandpipers. J. Field Ornithol. 60: 154-161.

Lindström, Å. & Piersma, T. 1993. Mass changes in migrating birds: the evidence for fat and protein storage re-examined. Ibis 135: 70-78.

Marks, J.S. & Redmond, R.L. 1994. Migration of Bristle-thighed Curlews on Laysan Island: timing, behaviour and estimated flight range. Condor 96: 316-330.

Mathiessen, P. 1994. The wind birds. Shorebirds of North America. Chapters Publishing, Shelburne, Vermont.

McLain, D.K. 1993. Cope's rules, sexual selection, and the loss of ecological plasticity. Oikos 68: 490-500.

McLain, D.K., Boulton, M.P. & Redfearn, T.P. 1995. Sexual selection and the risk of extinction of introduced birds on oceanic islands. Oikos 74: 27-34.

Meltofte, H. (1985). Populations and breeding schedules of waders, Charadrii, in high arctic Greenland. Meddr Grønland, Biosci. 16: 1-44.

Miskelly, C.M. 1989. Flexible incubation system and prolonged incubation in New Zealand snipe. Wilson Bull. 101: 127-132.

Miskelly, C.M. 1990. Breeding systems of New Zealand Snipe *Coenocorypha aucklandica* and Chatham Island Snipe *C. pusilla*; are they food limited? Ibis 132: 366-379.

Myers, J.P. 1981. Cross-seasonal interactions in the evolution of sandpiper social systems. Behav. Ecol. Sociobiol. 8: 195-202.

Myers, J.P. 1982. The promiscuous Pectoral Sandpiper. Amer. Birds 36: 119-122.

Myers, J.P. 1988. The Sanderling. Audubon Wildlife Report 1988/1989: 651-666.

Myers, J.P., Hilden, O. & Tomkovich, P.S. 1982. Exotic *Calidris* species of the

Siberian tundra. Ornis Fenn. 59: 175-182.

Myers, J.P., Morrison, R.I.G., Antaz, P.Z., Harrington, B.A., Lovejoy, T.E., Sallaberry, M., Senner, S.E. & Tarak, A. 1987. Conservation strategies for migratory species. Amer. Sci. 75: 19-26.

Nettleship, D.N. 1973. Breeding ecology of Turnstones *Arenaria interpres* at Hazen Camp, Ellesmere Island, N.W.T. Ibis 115: 202-217.

Oring, L.W. & Lank, D.B. 1982. Sexual selection, arrival times, philopatry and site fidelity in the polyandrous Spotted Sandpiper. Behav. Ecol. Sociobiol. 10: 185-191.

Oring, L.W., Lank, D.B. & Maxson, S.J. 1983. Population studies of the polyandrous Spotted Sandpiper. Auk 100: 272-285.

Oring, L.W., Colwell, M.A. & Reed, J.M. 1991. Lifetime reproductive success in the Spotted Sandpiper (*Actitis macularia*): sex differences and variance components. Behav. Ecol. Sociobiol. 28: 425-432.

Pienkowski, M.W. & Evans, P.R. 1985. The role of migration in the population dynamics of birds. Pp. 331-352 in Sibly, R.M. & Smith, R.H. (eds.). Behavioural ecology. Ecological consequences of adaptive behaviour. Blackwell Scientific Publications, Oxford.

Piersma, T. 1987. Hink, stap of sprong? Reisbeperkingen van arctische steltlopers door voedselzoeken, vetopbouw en vliegsnelheid. Limosa 60: 185-194.

Piersma, T. 1989. Hop, skip or jump? Constraints on migration of arctic waders by feeding, fattening, and flight speed. Stilt 14: 38-40.

Piersma, T. 1994. Close to the edge: energetic bottlenecks and the evolution of migratory pathways in Knots. Uitgeverij Het Open Boek, Den Burg.

Piersma, T. & Jukema, J. 1990. Budgeting the flight of a long-distance migrant: changes in nutrient reserve levels of Bar-tailed Godwits at successive spring staging sites. Ardea 78: 315-337.

Piersma, T. & Jukema, J. 1993. Red breasts as honest signals of migratory quality in a long-distance migrant, the Bar-tailed Godwit. Condor 95: 163-177.

Piersma, T., & Wiersma, P. 1996. Family Charadriidae (plovers). Pp. 384-442 in: J. del Hoyo, A. Elliott & J. Sargital (eds.) Handbook of the birds of the world, Vol. 3. Hoatzin to auks. Lynx Edicions, Barcelona.

Piersma, T., Klaassen, M., Bruggemann, J.H., Blomert, A.-M., Gueye, A., Ntiamoa-Baidu, Y. & van Brederode, N.E. 1990a. Seasonal timing of the spring departure of waders from the Banc d'Arguin, Mauritania. Ardea 78: 123-134.

Piersma, T., Zwarts, L. & Bruggemann, J.H. 1990b. Behavioural aspects of the departure of waders before long-distance flights: flocking, vocalizations, flight paths and diurnal timing. Ardea 78: 157-184.

Piersma, T., de Goeij, P. & Tulp, I. 1993a. An evaluation of intertidal feeding habitats from a shorebird perspective: towards relevant comparisons between temperate and tropical mudflats. Neth. J. Sea Res. 31: 503-512.

Piersma, T., Koolhaas, A. & Dekinga, A. 1993b. Interactions between stomach structure and diet choice in shorebirds. Auk 110: 552-564.

Piersma, T., van Gils, J., de Goeij, P. & van der Meer, J. 1995. Holling's functional response model as a tool to link the food-finding mechanism of a probing shorebird with its spatial distribution. J. Anim. Ecol. 64: 493-504.

Piersma, T., Everaarts, J.M., & Jukema, J. 1996a. Build-up of red blood cells in refuelling Bar-tailed Godwits in relation to individual migratory quality. Condor 98: 363-370.

Piersma, T., van Gils, J., & Wiersma, P. 1996b. Family Scolopacidae (sandpipers, snipes and phalaropes). Pp. 444-533 in: J. del Hoyo, A. Elliott & J. Sargital (eds.) Handbook of the birds of the world, Vol. 3. Hoatzin to auks. Lynx Edicions, Barcelona.

Piersma, T., Hedenström, A & Bruggemann, J.H. 1997. Climb and flight speeds of shorebirds embarking on an intercontinental flight: do they achieve optimal behaviour? Ibis 139: in press.

Redmond, R.L. & Jenni, D.A. 1986. Population ecology of the Long-billed Curlew (*Numenius americanus*) in western Idaho. Auk 103: 755-767.

Reynolds, J.D., Colwell, M.A. & Oring, L.W. 1986. Sexual selection and spring arrival times of Red-necked and Wilson's Phalaropes. Behav. Ecol. Sociobiol. 18: 303-310.

Reynolds, J.D. & Székely, T. 1997. The evolution of parental care in shorebirds: life histories, ecology and sexual selection. Behav. Ecol. in press.

Ricklefs, R.E. and Finch, C.E. 1995. Aging. A natural history. Scientific American Library, New York.

Sandberg, R. & Gudmundsson, G.A. 1996. Orientation cage experiments with Dunlins during autumn migration in Iceland. J. Avian Biol. 27: 183-188.

Sauer, E.G.F. 1963. Migration habits of Golden Plovers. Proc. XIII Internat. Ornithol. Congr. (Ithaca): 454-467.

Schneider, D.C. & Harrington, B.A. 1981. Timing of shorebird migration in relation to prey depletion. Auk 98: 801-811.

Székely, T. & Reynolds, J.D. 1995. Evolutionary transitions in parental care in shorebirds. Proc. R. Soc. Lond. B. 262: 57-64.

Tomkovich, P.S. 1994. Breeding biology and breeding success of the Spoon-billed Sandpiper *Eurynorhynchus pygmeus*. Russ. J. Ornithol. 4: 77-91.

Tulp, I. & de Goeij, P. 1994. Evaluating wader habitats in Roebuck Bay (north-western Australia) as a springboard for northbound migration in waders, with a focus on Great Knots. Emu 94: 78-95.

Tulp, I., McChessney, S. & de Goeij, P. 1994. Migratory departures of waders from north-western Australia: behaviour, timing and possible migration routes. Ardea 82: 201-221.

van Dijk, A.J., de Roder, F.E., Marteijn, E.C.L. & Spiekman, H. 1990. Summering waders on the Banc d'Arguin, Mauritania: a census in June 1988. Ardea 78: 145-156.

Walters, J.R. 1984. The evolution of parental behaviour and clutch size in shorebirds. Pp. 243- 287 in Burger, J. & Olla, B.L. (eds.). Shorebirds. Breeding behaviour and populations. Plenum Press, New York.

Whitfield, D.P. & Tomkovich, P.S. 1996. Mating system and timing of breeding in Holarctic waders. Biol. J. Linn. Soc. 57: 277-290.

Zwarts, L., Blomert, A.-M. & Hupkes, R. 1990a. Increase of feeding time in waders preparing for spring migration from the Banc d'Arguin, Mauritania. Ardea 78: 237-256.

Zwarts, L., Ens, B.J., Kersten, M. & Piersma, T. 1990b. Moult, mass and flight range of waders ready to take off for long-distance migrations. Ardea 78: 339-364.

Zwarts, L., Blomert, A.-M. & Wanink, J.H. 1992. Annual and seasonal variation in the food supply harvestable by Knot *Calidris canutus* staging in the Wadden Sea in late summer. Mar. Ecol. Prog. Ser. 83: 129-139.

Part II

Threats and Impacts on Shorebirds

East Asian-Australasian Flyway - An Overview

Brett A Lane

B.A. Lane, Ecology Australia Pty Ltd., 272-276 Heidelberg Rd., Fairfield, VIC 3078

The wider community, which pays for the efforts of shorebird researchers and government officials, requires that we focus clearly on their greatest concern, namely: how to achieve the effective conservation of shorebirds. The purpose of this paper is to provide a geographical perspective on how shorebirds use the East Asian - Australian flyway and to provide some strategic directions for future research and conservation efforts to meet this requirement.

Key geographical characteristics of the flyway are described and, where possible the relationship between these and known important regions for shorebirds are highlighted. Key characteristics relate to:

- geological setting;
- climate and its impact on sea waves, hinterlands weathering and sedimentation;
- tidal characteristics; and
- wetland vegetation.

The importance of the rivers draining the central Asian uplands is highlighted. The patterns of distribution of shorebirds in the flyway reflect the relationship between geography and biology. The theme is explored using a number of example species.

East Asia represents 14 percent of the earth's land area and it is home to over 56 percent of its human population. This has enormous implications for shorebirds and other animal populations. The extent to which the relationship between geography and biology is being changed by the activities of over half the world's population will be briefly explored.

Some hypotheses and associated predictions based on this changing relationship are offered to suggest a framework to enable future research activities to focus on the mechanisms of population decline in migratory shorebirds. The sooner these mechanisms are clarified then the sooner flyway-wide shorebird management programmes (e.g. the Brisbane Initiative) can deliver on the community's expectations.

Threats to Waders Along the East Asian-Australasian Flyway

David S. Melville

Abstract

Several million waders migrate between breeding grounds in the Palaearctic and non-breeding grounds in tropical south east Asia and Australasia each year. These birds depend upon a range of habitats in their breeding and non-breeding grounds, as well as migratory "stepping stones" in between. The greatest threat facing waders is habitat loss, both direct and indirect. Immediate problems relate to reclamation of coastal habitats, which is extensive throughout much of east and south east Asia, and changes to the watersheds of major rivers including deforestation, dams and tidal barrages, which will impact coastal regions. Conversion of fresh water wetlands to agriculture and drainage projects are also destroying inland areas used by waders. Longer-term impacts on breeding, staging and non-breeding grounds will result from global warming and associated sea level rise. Pollution is a growing problem in parts of the flyway, due to both nutrient enrichment and industrial discharges, although the impacts on waders are little studied in this region. Hunting is an important threat to wader populations in some areas, but not in others, and improving socio-economic conditions appear to be reducing hunting though harvesting of benthos may be a serious problem in some areas, and associated disturbance may also adversely impact waders. Degradation and/or loss of habitats are likely to result in an increase in the density of birds in those habitats remaining, which may result in changes in patterns of deposition of body stores, due to competition for food and/or interference in feeding, and thus affect the migration systems of waders, with possible impacts on breeding success due to delayed arrival on the breeding grounds and/or reduced body reserves on arrival. Waders also may be expected to become more concentrated in the remaining areas which could increase disease impacts, although these remain to be studied.

David S. Melville, WWF Hong Kong, G P O Box 12721, Hong Kong

Introduction

Every year some four to six million waders migrate between breeding grounds in the Palaearctic and non-breeding grounds in the tropics and Australasia (Parish 1987). Of the 103 species recorded from the region 77 are migratory (Parish *et al* 1987). This paper reviews the various threats faced by migratory waders along the East Asian-Australasian Flyway.

The Rock Sandpiper *Calidris ptilocnemis* has one of the shortest migrations of any wader in East Asia, travelling only a few hundred kms (Gill *et al* 1994). In contrast, the longest journeys are over 12,000 kms for high arctic breeding species wintering in Australasia, such as the Curlew Sandpiper *Calidris ferruginea.* Some waders such as the Bar-tailed Godwit *Limosa lapponica* are thought to undertake single-flight journeys of up to 8,000 kms (Barter and Wang 1990, Minton 1993). During the course of a lifetime these birds will travel prodigious distances - one Curlew Sandpiper, for example, is estimated to have flown over 350,000 kms on migration alone - a distance nearly equivalent to that from the earth to the moon (Minton 1993).

Information on the migration of waders in the East Asia-Australasian flyway is still sketchy, but band recoveries, analysis of weight data, sightings of marked individuals and radar studies are beginning to give an indication of likely routes (McClure 1974, Tulp *et al* 1994).

There is evidence from band recoveries which indicates that some Great Knots *Calidris tenuirostris* and Bar-tailed Godwits may fly directly between north west Australia and the Yangtze (Changjiang) River estuary, China (Barter and Wang 1990). Estimated flight ranges, based on weight data, for Curlew Sandpiper and Red Knot *C. canutus* suggest that both species may be able to reach northern Australia on southward migration

Knot *C. canutus* suggest that both species may be able to reach northern Australia on southward migration from Hong Kong, whereas Curlew Sandpipers on northward migration depart Hong Kong at lower weights only permitting them to reach north east China (Barter 1992, Young and Melville 1993).

In order to successfully complete these long journeys birds require stop-over sites where they can rest and feed, usually accumulating body stores (fat and protein), before undertaking the next stage of their journey (Evans and Davidson 1990, Piersma and Jukema 1990).

Many stop-over sites are used regularly on southward and/or northward migration each year, but some other sites may only be used every few years, for example when strong headwinds reduce the flight range of birds (Piersma and Jukema 1990, Tulp *et al* 1994). Unusually high numbers of Great Knots in Hong Kong on northward migration in 1994, including colour-flagged birds from Australia, appeared to result from adverse weather conditions (Carey *et al* 1950) since these birds apparently usually fly direct to the Yangtze Estuary (Barter 1986, Barter and Wang 1990).

In such years of adverse conditions, these sites may be critical to the survival of certain populations of waders and thus require adequate protection. The identification of such sites, however, is problematic without a detailed knowledge of the biology of the species concerned since sporadic counts and surveys may fail to reveal their true, albeit occasional, importance. Assessment of the conservation importance of particular sites may be further confounded in those species, such as the Western Sandpiper *Calidris mauri*, in which individuals of the same species may have different migration strategies within the same migration system (Iverson *et al* 1996).

The Russian far east and northern China remain very little studied areas and there are no long-term data available regarding numbers of breeding waders. Similarly, there are relatively few data available for either stopover sites or the non-breeding grounds in the flyway (Mundkur 1993). As such the potential impacts on various threats on wader populations in the flyway are unknown.

Whilst the impacts of large-scale habitat loss at non-breeding and staging sites may be readily apparent at the local level, even small environmental changes, which may affect the birds at a number of different places, may affect their ability to complete their annual migrations successfully and hence increase their annual mortality. Such "low grade" changes may be particularly difficult to identify, although they may be expected to affect different species to different extents, depending on the combination of factors affecting populations passing through different areas (Morrison *et al* 1994). However, the impacts of even large-scale habitat loss at the population level are difficult to estimate, even in well studied species (Goss-Custard *et al* 1995a, 1995b, 1995c).

Scott and Poole (1989) noted that the majority of the wetlands in southern and eastern Asia were under threat:

> "Most of the threats to wetlands in Asia are a direct consequence of the need to feed and house this massive and ever increasing population of human beings."

Howes and Parish (1989) identified two major threats to shorebirds in the flyway: hunting and reclamation. Table 1 summarises currently identified threats to shorebirds in countries along the flyway.

Threats

Habitat Loss

Habitat loss is recognised as the most urgent and immediate threat to waders throughout the flyway (Table 1, Scott and Poole 1989).
Habitat loss results in higher bird densities in the remaining areas which will, in turn, intensify competition between birds as a consequence of higher rates of prey depletion and increased rates of interference (Sutherland and Goss-Custard 1991). This, in turn, will result in decreased food intake by some individuals and eventually cause increased mortality (Evans 1991, Goss-Custard *et al* 1995a, 1995b).

Table 1

Summary of threats to waders in the East Asian Australasian Flyway*

	1	2	3	4	5	6	7	8
Russian Far East								
China	*	*	*	*	*	*	*	*
Japan	*	*	*	*	*			
North Korea	?							
South Korea	*	*		*				*
Taiwan	*	*		*	*		*	
Hong Kong	*	*						
Myanmar	*	*	*		*		*	
Thailand	*		*			*	*	
Cambodia								
Vietnam								
Philippines	*	*	*	*				
Malaysia	*	*				*	*	*
Singapore	*	*						
Indonesia	*	*				*		
Papua New Guinea	*		*					
Australia	*							
New Zealand	*	*			*			
Southwest Pacific	*							

1	Habitat loss	2	Pollution
3	Changes in drainage	4	Harvesting of benthos
5	Disturbance	6	Hunting
7	Aquaculture	8	Loss of roost sites

* Information from country reports submitted to the International Workshop on the Conservation of Migratory Waterbirds and their Habitats in the East Asian-Australasian Flyway, Kushiro, 1994 (Wells and Mundkur (1996), Scott (1989) and Scott and Poole (1989).

As Evans *et al* (1991) stated:

> "Species most at risk from habitat loss [of refuelling sites] are those travelling the longest stages to reach them. These tend to be high-arctic breeding species, which have very precise time-schedules for migration, particularly in spring. . Habitat loss on staging areas could lead, through increased densities, to failure to achieve sufficiently high food intake rates to maintain correct migration timings."

Recent modelling work indicates that the impacts of habitat loss on migrants may be greatest at the last stopover area before the breeding area is reached (Wolff 1995).

Evans (1991) has suggested that the loss of traditional moulting grounds could have even more serious affects on survival than the loss of staging sites since there appear to be relatively fewer sites which provide both good food resources and the protection against predation needed by moulting birds.

Hockey (1995) has identified an increase in carrying capacity of estuaries on a north-south gradient, noting that:

> "The number of birds and the number of species that can be 'conserved', or alternatively lost, per unit area of estuary increases from north to south. . . . An important factor moulding the (distinct) tropical assemblages is the abundance of surface-active invertebrates. In many cases the persistence of these invertebrate populations is probably linked to the persistence of fringing mangrove communities, whose conservation therefore becomes a key issue."

Large areas of mangrove have been lost throughout the region. In the Philippines 70% has been cleared (Parish 1987), and in Thailand, in the period 1961-89, 50.9% of the mangrove was lost (Aksornkoae 1993). During the Vietnam war 124,000 ha of mangrove was destroyed, accounting for 36% of mangroves in southern Vietnam (Phan and Hoang 1993). However, there has been extensive rehabilitation and more than half of the affected area is now replanted with *Rhizophora* spp. There has been extensive loss of mangrove to shrimp ponds - in Minh Hai Province 98,044 ha of mangrove in November 1987 had been reduced to 75,129 has in July 1988 (23.4% reduction). Shrimp culture, although extensive, is low in production and yields decrease yearly (Phan and Hoang 1993). Robertson (1992) noted that 1% of the remaining mangrove forest area is being lost per year in many tropical nations.

Mangroves are generally considered to be beneficial since they are thought to provide a source of nutrients/detritus for offshore aquatic systems, as well as providing nursery grounds for many organisms, especially species of fish and crustaceans of commercial value. There are, however, situations where the spread of mangroves over tidal areas may reduce feeding opportunities for waders (Peking University 1995).

Habitat loss in coastal areas has received most attention with respect to impacts on shorebirds, but it should not be forgotten that large numbers of shorebirds migrate through the inland areas of East Asia, even though species distributions, numbers and migration routes are very little known (Cheng 1987, Mundkur 1993, Perennou *et al* 1994, Wang 1996).

In China, freshwater wetlands are being lost due to siltation, reclamation for agriculture, and conversion to fish ponds - between the 1950s and the 1980s the total area of lakes in China was reduced by 11% (Scott 1989). Dam and reservoir construction, and abstraction of water from rivers has contributed to the falling level of many lakes in China, and was the cause of the final drying up of Lop Nur in 1972 (Xia 1985). Drainage of marshes formerly was widely practised to control diseases such as malaria and schistosomiasis (Huang 1981, Kung and Huang 1976). Natural geological uplifting is also resulting in desiccation and wetland loss in northern China.

Skagen and Knopf (1993) highlighted the dynamic nature of fresh water wetlands in the central USA and hypothesised that:

> "because wetlands are dynamic and unpredictable during migration, shorebird movements across the plains are characterised by dispersion and opportunism rather than by concentration and predicability, as in coastal systems."

As a result they noted that conservation strategies for continental North American populations of waders required the provision of a wide range of sites so that birds would have access to alternatives. It is possible that a similar situation prevails in northern and western China, and Mongolia, where a number of wetlands are ephemeral (Davies 1989).

With so little known about the use of inland wetlands by waders in East Asia, it is difficult to assess the potential impact of habitat loss, but there can be no doubt that a number of major projects will have very significant negative impacts. Such projects include drainage for agricultural expansion in the Sanjiang Plain, north east China - the Eighth Five-year Plan proposes conversion of c.24% of the 1.1 million ha of wetlands (Anon. 1992) - and a reduction in flooding in the middle reaches of the Yangtze resulting from construction of the Three Gorges Dam (Larson 1990).

Reclamation

High human population densities in coastal areas of many Asian countries mean that there is great pressure to "win" new land through coastal reclamation, either for aquaculture and farming, or for industrial and residential development. Reclamation, however, is a not new activity. In China, coastal areas were converted to salt pans 5,000 years B.P. (Wu 1985), and salt extraction continues to this day, with the pans providing feeding and roosting sites for a variety of shorebirds (Young 1990).

Records of land reclamation in Korea date back to 1248, although initial attempts were small scale. Between 1917 and 1938 a total of 40,880 ha were land filled and almost all areas of saltmarsh were lost (Yu 1995). In South Korea, Long *et al* (1988) reported plans to reclaim 480,000 ha by the year 2001, which included all internationally important wetlands for shorebirds (Howes and Parish 1989). Extensive reclamation has taken place (Lee 1996), but in 1995 a new policy was implemented which will save some 200,000 ha (Y.J. Sunwoo pers. comm. February 1996). This change has come about due to a growing appreciation of the intrinsic value of coastal wetlands, and a realisation that the economic return from agriculture in the new land did not justify the cost of reclamation, together with an ongoing reorganisation of the government agencies involved in the environment, conservation and natural resource management so that one agency (The Ministry of Environment) now has direct responsibility for wetlands. In Japan there has been very extensive reclamation of intertidal areas and shallow waters, as well as extensive modification of the coastline - only about half of the total coastline of Japan remains unmodified by man (Suzuki 1990).

Among Japan's internationally important coastal wetlands (Scott 1989) reclamation is taking an increasing toll. Suzuki (1990) reported that 89% of Tokyo Bay had been reclaimed. She further noted that the figures for Hakata Bay and Ariake Bay were 30% and 16% respectively - both of these sites are the subject of ongoing reclamation projects. In a situation where "the worth of politicians is commonly judged in terms of how much of the national public works or other subsidy budget they can get allocated to their district", such development projects often seem to be politically motivated rather than of any practical value (Suzuki 1990).

China has extensive coastal wetlands in the Hangzhou Bay area and the Jiangsu coast, and around the estuaries of the Liao and Yalu Rivers in the northeast, and the Yellow River delta is expanding at a rate of 2,350 ha p.a. (Xiao *et al* 1995). However, China's 3.1 million ha of coastal marshes and mudflats are under intensive threat from reclamation and development with over 50% having been lost to reclamation over the past 40 years (Lu 1994).

China's State Oceanographic Administration has recently concluded that the coastal zone has been under-exploited and is drafting plans to expand shrimp and fish farming (Anon. 1992). These plans include the utilisation of much of the tidal and subtidal areas of the old Yangtze River delta, covering some 200 kms by 90 kms, off the central Jiangsu coast for mariculture and industry (Ma Zhongqian and Bao Haosheng pers. comm. May 1996). Shrimp farming, however, is having mixed results with serious disease outbreaks in northern China resulting in farms being abandoned in Liaoning (Melville unpublished).

Anon. (1992) notes that:

> "Without policy changes, it is likely that most coastal wetlands will disappear within the next 10 to 20 years, particularly in East China (Shanghai, Zhejiang, Jiangsu and Shandong) as a result of population and economic pressures.".

There has already been very extensive reclamation in the Shuangtai estuary, Liaoning with over 20,000 ha of the former tidal area being reclaimed for rice farming and shrimp ponds since 1989 (Brazil and Melville 1993). Substantial areas of the Yancheng National Nature Reserve, which extends along 582 kms of the Jiangsu coastline, is being lost to reclamation for shrimp ponds, cotton fields, reed farms and salt pans, and other developments include five new ports and a coal fired power station. The reserve management authority has no land use control over land in the "buffer" and "experimental" areas which comprise the majority of the reserve, and although they do have control in the core area this is being heavily exploited (G. Claridge, D.S. Melville and Wang Tianhou unpubl.). A similar lack of land use control is found in most Chinese nature reserves, although the Shuangtaihekou National Nature Reserve has recently acquired control of several areas.

Reclamation usually results in a loss of the upper tidal area. These areas may be of proportionately greater importance to feeding waders than areas lower on the shore since they are exposed for a longer period of time and thus provide increased feeding opportunities (Goss-Custard and Moser 1990).

The construction of salt pans, and prawn and fish ponds in mangrove areas may have provided new roosting opportunities for some waders especially those species which do not roost in mangroves (Melville 1990). It is possible that limited opening of mangrove areas could have resulted in increased use of adjacent tidal areas. For example, management of shrimp ponds at Mai Po, Hong Kong to provide a high tide roost site in autumn resulted in waders remaining in the area to moult, whereas previously birds had passed through quickly without moulting (Melville pers. obs.).

Dams

China's rivers discharge 2.0 x 10^{10} tonnes yr^{-1} of sediment, contributing one tenth of all the sediment discharged to the world's seas (Yun and Shi 1994).

Damming rivers can reduce sediment input to estuaries with consequent erosion problems, as has happened at the Luanhe, China (Yun and Shi 1994). At the Daling estuary, Liaoning, reduced sediment discharge due to upstream water abstraction has meant no growth in the coastal marsh even 20 years after the former marsh was reclaimed to salt pans (Melville pers. obs.). The Three Gorges Dam project in China will seriously reduce sediment deposition in the Yangtze estuary, sedimentation processes possibly being affected for as long as 200 years post-construction, although detailed studies are lacking (Larson 1990).

Watershed changes resulting from logging and increased erosion in some areas, and reduced sediment run off after reforestation in others will also have downstream impacts on estuaries (Huang 1990).

Major changes in sediment flux resulting from the construction of the Aswan Dam in Egypt caused an almost immediate collapse of the coastal anchovy industry, and other large scale dam projects similarly could be expected to impact on coastal productivity through changes in both sediment and fresh water flux; the latter could result in reduced areas of mangrove (Milliman 1990).

Spartina

The coastal grass *Spartina anglica (sensu lato)* was introduced to China in 1963 to promote accretion in coastal areas and thus assist in reclamation. It has now spread over 36,000 ha along the coast, ranging from 21°27'N to 40°53'N (Chung 1990a). Areas in which *Spartina* was planted were then poldered and subsequently have been planted with a wide range of crops (Chung 1988). In some areas of coastal Jiangsu *Spartina*, however, seems to be retreating and erosion is occurring (Melville unpublished).

Impacts of *Spartina* on coastal ecology in China appear to have been little studied. In Britain, Goss-Custard and Moser (1990) found that Dunlin *Calidris alpina* numbers had dropped on those estuaries with increasing *Spartina*, however they cautioned that there was not necessarily a causal link. However, since *Spartina* invades intertidal flats which are rich in invertebrates it is regarded as harmful to nature conservation interests (Doody 1990).

Spartina has also been introduced to Australia and New Zealand (Goodman 1969). Lane (1992) noted that there was no documented Australian experience of *Spartina* adversely affecting waders, but cautioned that since *Spartina* ecology in

Australia was similar to that in Europe there may be a problem in future, and urged that research into *Spartina*/wader interactions be initiated.

Hunting

Hunting of waders is a problem in certain parts of the flyway, but there appear to be considerable regional differences in hunting pressure (Scott and Poole 1989). Parish (1985b) estimated that 250,000 to 1,500,000 waders were killed annually in the flyway. More recently Wang and Wells (1996) noted that:

> "It has been guessed that the pan-Flyway take of shorebirds by hunters per year may reach 1 million".

Recreational hunting occurs in countries such as Japan, and to some extent China, whereas hunting is mostly commercial in China, Vietnam, Thailand and Indonesia. Several studies have been undertaken to assess hunting mortality.

Bamford (1992) investigated recoveries of Great Knots banded in Australia. He suggested that a conservative (high) estimate of annual mortality in the Great Knot was 30%. Based on the number of recoveries of the banded population, annual mortality due to hunting averaged 1.6%, with a maximum of 4.5%. He suggested, however, that band recoveries reported might account for only 25% of the birds taken, in which case hunting mortality could account for an average of 6.5% to 18.2% of the total population annually.

In Thailand, Starks (1987) reported up to 2,900 waders trapped by one hunter per year using mist nets and walk-in traps with decoys, and he noted one factory worker who had left his job because he could earn more money as a bird trapper. Ruttanadukul and Ardseungnern (1989) studied 14 villages around Pattani Bay and estimated that at least 8,400 waders were caught in 1986, with Redshank *Tringa totanus* accounting for 38% of the catch. This species was also commonly caught in the Gulf of Siam in 1980/81 (Melville unpublished). Tunhikorn and Round (1996) note, however, that:

> "hunting perhaps has received a disproportionate amount of attention and there is also some evidence to suggest that, as coastal fishing communities have grown more prosperous, so direct hunting of shorebirds has declined".

In north Java it was estimated that as many as 1 million waders were killed in 1979 (Rusila 1994). The average annual catch between 1984 and 1986 was 300,000 (Milton and Marhadi 1989), including 40,000 Oriental Pratincoles *Glareola maldivarum*. In 1987 Rusila (1994) estimated the catch at 200,000 birds. It is uncertain whether this apparent decline in catch is real and, if so, the underlying causes for it.

Jaensch (1990) estimated that at least 10,000 waders were caught at Shanghai in August-September 1989. Wang (1996) estimated that 61,000 to 89,000 waders were hunted in two years at shanghai, and estimated that 36,000 to 52,000 were hunted annually in the Yellow River delta. Tang and Wang (1995), using the minimum estimated catch, noted a 17.7% reduction in autumn catch and a 38.4% reduction in spring harvests in the Shanghai area between 1991 and 1992. Factors which were thought to have resulted in the reduced catch included habitat loss, less suitable weather conditions in the spring of 1992, and a reduction in hunting pressure as hunters turned to other activities. Wang (1996) found no evidence of reduced hunting pressure in the Yellow River delta, but reported that hunting pressure around Shanghai is dropping due to improved economic conditions. However, at Panjin, Liaoning, China which is economically developed, sport hunting of various waterbirds, including waders, is now fashionable (Brazil and Melville 1993).

Most hunting around Shanghai is done with clap nets and decoy birds. The Spotted Greenshank *Tringa guttifer* is a favoured decoy due to it being pale, and thus easily seen against the tidal mud, and very vocal. During the 1970s hunters estimated catching about 100 Spotted Greenshanks each year for decoys (Howes and Parish 1989), but this had dropped to about ten birds annually in the late 1980s (Wang Tianhou pers. comm.). With an estimated world population of only 1,000 (Rose and Scott 1994) such an off-take is likely to have been deleterious.

At the Red River delta, Vietnam, Howes and Parish (1989) reported one team catching 70 kg (possibly as many as 500 birds) per night, and Lane (1993) reported 2,300 kg of waterbirds being caught in the period September-December 1992. Large numbers of snipe *Gallinago* spp. are hunted in the Philippines (Alonzo-Pasicolan 1989).

Hunting of waders is not a conservation issue in Hong Kong and in Papua New Guinea there is "minimal" hunting (Burrows 1996). However, even in those countries where waders benefit from legal protection, enforcement is often inadequate (Tunhikorn and Round 1996, Tomkovich 1992).

Whilst the numbers of birds reported being hunted in the flyway are impressively large it is not know what impact such hunting is having on populations, although it is assumed to be negative. Of fundamental concern is the question as to whether hunting mortality in wader populations is additive (i.e. hunting mortality is over and above that from "natural causes") or compensatory (in which case "natural" mortality is reduced according to the mortality due to hunting), or a combination of the two (i.e. hunting mortality is compensatory until a threshold is reached, after which it is additive). At present this is unknown. Waders have high adult survival rates (Evans 1991), thus hunting mortality may be largely additive since Nichols (1991), notes that duck species

> "with high survival rates in the absence of hunting have less potential to exhibit compensation than species with lower survival rates".

Disturbance

The effects of disturbance to waterfowl have recently been summarised by Davidson and Rothwell (1993), Pfister *et al* (1992), Hockin *et al* (1992), and Dahlgren and Korschgen (1992). Potential impacts due to human disturbance include reduced food intake rates, reduced breeding output, and increased predation.

Effects of disturbance vary among waders, some species being more susceptible than others (Smit and Visser 1993). Disturbance may force waders to abandon traditional roost sites which could affect overall use of estuaries. The "carrying capacity" of a site could be reduced through disturbance, e.g. by rendering some areas unavailable to birds for feeding and thus increasing concentrations in areas with less human disturbance where interference from congeners or other species may reduce feeding intake rates, as well as lead to increased direct competition for food resources.

The implications of disturbance on energy budgets are not yet clear, but indications are that the effects can be larger than would appear from the studies described (Smit and Visser 1993). In some situations nocturnal feeding may help to compensate for reduced daytime intake rates (Swennen *et al* 1989).

Townshend and O'Connor (1993) noted that large numbers of bait-diggers greatly reduced the use of the Lindisfarne National Nature Reserve, UK, by various waterfowl, including Bar-tailed Godwit and Redshank as a direct result of disturbance, and disturbance from the large-scale harvesting of benthos along parts of the coast of China may also adversely affect waders (personal observations).

Shooting can result in disturbance and "under utilisation" of areas by ducks and geese (Madsen 1993), but impacts on waders are less clear (Owen 1993).

Food Competition

Throughout much of East Asia the intertidal area is heavily exploited by human populations for food. The harvesting of benthic invertebrates may adversely affect waders through direct competition for food and/or associated disturbance.

In China there is very extensive collection of invertebrates directly for human food, as feed for domestic ducks and for use as feed in shrimp ponds. In July 1992 in Liaoning Province some 1,070 people, together with about 400 donkey carts, were present along about 5 kms of coast collecting molluscs for shrimp food. Each person was reported to harvest 100-150 kg per day, so daily landings in this area would have been in the order of 26 tonnes per 1 km of coastline (D.S. Melville and G.J. Carey unpublished).

In Jiangsu Province thousands of people collect the small "mud snail" *Bullacta exarata*, which is a local delicacy in Shanghai and neighbouring areas. It is estimated that at least 300 tonnes are harvested from the 15 km long shoreline in the core area of the Yancheng Reserve, and similar harvest levels are reported from elsewhere in the Province (G. Claridge, D.S. Melville and Wang Tianhou unpublished).

At the Red River delta, Vietnam there is similar large-scale harvesting. Nielsen and Pedersen (1994) recorded an average of one thousand people collecting molluscs and crabs every day, and noted that in the period 1 March to 15 June 1994, 818 tonnes of molluscs were harvested from 3,000 ha of intertidal flats at this site. The harvest included 382 tonnes of small *Solen* sp. and *Glauconome chinensis*, some of which were smaller than 2mm. Such harvesting of young, small individuals would result in competition for food with shorebirds, as well as potentially adversely impacting mollusc populations.

There is a growing market for worms such as *Perinereis aibuhitensis* for use as fishing bait in Japan and Korea. In 1996 it was estimated that 1-2,000 ha of saltmarsh in the "core area" of the Yancheng Reserve, Jiangsu Province was impacted by commercial worm digging, with some 60 tonnes of worms being harvested annually (equivalent to some 18,000,000 individual worms) G. Claridge, D.S. Melville and Wang Tianhou unpublished). Such large scale digging of saltmarsh is adversely affecting the vegetation and may lead to increased erosion.

In Wales, UK exploitation of lugworms *Arenicola marina* resulted in depopulation of dug areas until subsequent larval settlement (Cryer *et al* 1987) and it is to be expected that benthos populations would be similarly depleted in China. The impacts on non-target species also need to be considered. The raking of surface sediments is likely to damage non-target species and result in increased mortality, and digging may smother species (Jackson and James 1979). The disturbance of surficial sediments may also result in increased bioavailability of heavy metals (Howell 1985).

Pollution

Oil pollution may threaten waders such as phalaropes at sea (Senner and Howe 1984), as well as interfering with feeding in coastal areas. Oil fields occur in several areas along the flyway (e.g. China, Brunei, Indonesia) and accidental spills from tankers are a universal problem - over 30,000 tonnes of oil having been spilled or leaked in Chinese coastal waters in the past decade (Lu 1994). Increasing territorial disputes over islands in the South and East China Seas could further exacerbate the problem since many of these are associated with exploitation of oil deposits.

Tomkovich (1992) noted that Spoon-billed Sandpipers *Eurynorhynchus pygmaeus* and other intertidal feeding waders were potentially threatened by oil spills along the shore of the Sea of Okhotsk in the Russian Far East, and recorded that large spills had occurred around Sakhalin in 1989 and 1991.

There is considerable leakage and spillage from the Liaohe Oil Field, Liaoning Province, China and this at times has resulted in contamination of waterbirds (Brazil and Melville 1993). With an increase in offshore drilling in this field, as well as in the Yellow River delta and off the coast of Jiangsu Province there is an increasing risk of spills affecting intertidal areas used by large numbers of waders on migration.

Phragmites Reed areas in coastal wetlands in China are being investigated with a view to their use to "clean" oil field waste water and mud (Brazil and Melville 11993, Xiao *et al* 1995). There are potential problems both with direct oil pollution and indirect contamination by other chemicals in the wastes. Research also is being conducted in China on the use of the exotic coastal grass *Spartina* for water treatment (An Shuqing pers. comm., May 1996).
There appears to have been little work conducted on the impacts of pesticides on waders in East Asia. Mundkur *et al* (1994) noted that pesticide-treated paddy fields in Selangor, Malaysia supported fewer Long-toed Stints *Calidris subminuta* than untreated fields, presumably due to there being less food available. Other waders which feed in paddy fields, such as Wood Sandpipers *Tringa glareola* could similarly be expected to avoid treated fields.

In China the widespread application of chemicals in the 1960s and 1970s to control the snail *Oncomelana* sp., the intermediate host for the fluke which causes schistosomiasis in humans, is reported to have adversely affected waterbirds in inland lakes and marshes (Melville unpublished).

Industrial pollution has been relatively little studied in waders in East Asia. Analyses of heavy metals in waders have been reported from Korea where elevated levels of Hg and Cd were recorded in birds from the Nakdong estuary (Lee *et al* 1988, 1989).

Eutrophication is an increasing water quality problem in some areas, both coastal and inland, but the impacts on shorebirds are uncertain. Limited levels of organic enrichment in estuaries may result in increased densities of some benthic organisms (Pearson and Rosenberg 1978, McClusky 1981) and, if these organisms are favoured prey, then organic enrichment may lead to improved feeding conditions for some wader species (Harrison and Grant 1976, van Impe 1985). This appears to be the situation in Deep Bay, Hong Kong, where extreme eutrophic conditions apparently favour very high densities of polychaetes which provide an important food source for many shorebirds (Piersma *et al* 1993, S. McChesney unpublished, Peking University 1995).

In some estuaries there has been a reduction in the abundance of benthic invertebrates following an improvement in water quality and there has been a reduction in waterfowl numbers and/or a change in species composition (Furness *et al* 1986, Prater 1981). Green *et al* (1992), however, note that

> "Previous studies of the effects of organic enrichment inputs on bird populations suggest that moderate levels of organic inputs may enhance the carrying capacity of intertidal areas for wintering bird populations. Studies of estuaries showing declines in organic inputs show correlated declines in wintering bird populations. Although such declines can be shown to be accompanied by decreases in food availability, no author is prepared to say that decreases in organic inputs have been responsible, because of the existence of other confounding factors in each case. It is unclear from published work whether there is a direct causal link between organic enrichment and bird populations or whether the effects of organic enrichment on birds are exerted indirectly through their impacts on invertebrates."

Plastic particle ingestion has been noted as a problem for phalaropes (Connors and Smith 1982). Lead poisoning from ingestion of spent gunshot is a serious problem for many waterfowl species in certain areas of North America and Europe. Although lead poisoning is best known from ducks, there are some instances of waders ingesting shot (Pain 1991).

Lead poisoning appears to have been little studied in East Asia/Australasia. Ochiai *et al* (1993) reported that lead poisoning may be a threat to waterfowl in Japan, where some 75 tonnes of lead shot is discharged into wetlands annually, but they did not investigate any waders. Sonter (1984) recorded lead in the stomach contents of four of six Red-necked Avocets *Recurvirostra novaehollandiae* in Victoria, Australia.

Disease

The role of disease in bird population processes has only recently attracted much attention (Loye and Zuk 1991, May 1994). Dobson and May (1991) suggest that parasites may be a significant source of mortality and that disease can be the primary regulatory factor even in situations where it is responsible for only a relatively small proportion of all deaths.

Little is known about diseases in waders globally. Table 2 summarises information on the relative occurrence of certain diseases in North America. Diseases in waders in the East Asian-Australasian region have been very little studied and even in some cases where mortality events have been investigated the causes remained unknown (Melville 1980). McClure *et al* (1978) provide details of haematozoa recovered from Asian shorebirds during the MAPS project, but the biological consequences of the presence of these organisms in waders remain uncertain.

Limited sampling of waders for influenza has revealed very low incidence in birds in Australia (Mackenzie *et al* 1984) and Hong Kong (K. Shortridge and D.S. Melville unpublished). In contrast, comparatively high incidences were found among shorebirds on the east coast of the USA in Delaware Bay (Sladen *et al* 1990).

Table 2
Relative occurrence of certain diseases affecting waders in North America. (after Friend, 1987)

Avian cholera	o	
Avian botulism	**** type C	O type E
Chlamydiosis	*	
Avian pox	o	
Aspergillosis	o	
Sarcocystis	o	
Trichostrongylid nematodes	o	

O = infrequent, rare, or not reported
* = small number of reports generally involving individual or small numbers of birds
**** = frequent

Endoparasites have been recorded in several wader species in Asia (Wong and Anderson 1984, Melville 1982), but the biology of host-parasite relationships remains largely unstudied and the significance, if any, in terms of population impacts are unclear. Redshanks with heavy endoparasite burdens appeared to be more susceptible to leg cramp; possibly indicating that the birds were stressed (Melville 1982).

Wong and Anderson (1984, 1990) noted that transmission of several nematodes apparently occurred away from the breeding grounds in coastal areas The relatively high ambient temperature in the tropics may promote rapid development of parasites in the intermediate host which would facilitate transmission to shorebirds (Wong and Anderson 1984).

McNeil *et al* (1993, 1995) suggested that there may be a relationship between trematode infection and over-summering on the "wintering" grounds, infected birds being less "fit" to migrate northwards.

Although the current impacts of parasite infections remain little studied and uncertain, it is clear that habitat loss is likely to increase the density of waders in remaining habitats and this will increase the likelihood of disease transmission (McNeil *et al* 1993, 1995, Wong and Anderson 1990). Scott (1988) summarises the situation thus:

> "As animals are forced to exist at higher densities, virtually every aspect of the life and health of animals will be affected. Their parasite fauna is no exception. . . . . . The higher the host density, the higher the net transmission and the higher the average parasitic burden per host. Higher parasite burdens translate into more severe effects of the parasites on the survival and reproduction of the host."

It is possible that degradation of habitat quality may also adversely affect waders indirectly through disease impacts since Spalding *et al* (1993) noted that epizootics of the nematode infestation Eustrongylidosis, which affects ardeids in the USA, seemed to be linked to nutrient pollution. Potential relationships between water quality and parasite infestations of waders apparently remain unstudied.

There is a need to further study disease in waders.

Climate Change

Global mean temperature is predicted to increase by 0.3^{O}C per decade during the 21st century and there will be complex regional variations in both temperature and precipitation (Huntley 1995). These changes will result in vegetation changes on land, while coasts will be affected by a rise in global sea level resulting from thermal expansion of the oceans, as well as melting of glaciers and ice sheets.

A detailed study of impacts on China has shown that over the last 100 years different regions of the coastline have experienced quite different rates of sea level change. Sea levels along the South China Sea coast have increased during this century by about 20 cms, while in the Yellow Sea they have actually fallen by some 2 cms (the global-mean change over this period has been a rise of between 10 and 20 cms). These local differences can be accounted for by natural land movements - rising due to isostatic rebound, or sinking due to geological activity.

Natural land movements along the coast of southern China are likely to exacerbate sea level rise due to greenhouse warming, but the effect will be relatively small (10 cms vs 44 cms due to climate change). A sea level rise of just 0.5 m would inundate an area of about 40,000 km^2 in China, including some of the most densely populated parts of the country (Hulme *et al* 1992). The likely response to sea level rise will be an increase in dyke building, thus preventing the landward movement of intertidal habitats, and resulting in serious loss of wader habitat. Chung (1990b) also has suggested increased planting of *Spartina* to counter rising sea levels in China.

A rise in sea level is expected to result in direct habitat loss for waders - in Britain it has been estimated that some 1.2% of the wintering wader population could be impacted (Norris and Buisson 1994). However, rise in sea level does not necessarily mean a loss of tidal areas in simple proportion to the increased water depth since impacts will vary at different localities depending on sediment flux. The Dutch Wadden Sea tidal flats, for example, are expected to restructure with only a very limited reduction in total area (Wolff 1995). Thus Ens and Goss-Custard (1995), who modelled Oystercatcher *Haematopus ostralegus* populations in the Wadden Sea, Europe, found that, even under extreme scenarios of sea level rise, the effects on the population were small since the surface area of the tidal flats was unlikely to change significantly.

They cautioned, however, that the model had not included temperature effects on benthos and noted that higher temperatures were likely to adversely affect at least some bivalves, recruitment being lower after warmer winters than colder ones (Wolff 1995).

Boorman *et al* (1989) suggested that the intertidal benthos will become poorer and less diverse, and the productivity of surviving species will be reduced if levels of suspended sediments in inshore waters increase, and this would be expected to result in a reduction of wader populations.

Global warming is predicted to be at its greatest in the higher latitudes of the northern hemisphere, where it is expected to result in a reduction in the areas of both tundra and boreal forest (Huntley 1995, Markham *et al* 1993), which would result in a reduction of breeding habitat for many wader species. Warmer winters could result in increased snow cover in winter but the onset of winter freezing will be later and spring snow melt earlier, thus the snow-free season in expected to be longer than at present (Markham *et al* 1993). The implications of such a change for breeding waders are uncertain, but annual changes in the timing of snowmelt can affect the timing of breeding and subsequent production of young (Green *et al* 1977).

Some countries are now giving serious consideration to the likely impacts on sea level rise on biodiversity (Reid and Trexler 1992, Boorman *et al* 1989, Davidson *et al* 1991) and are considering management strategies to mitigate the impacts (Pye and French 1993, Norris and Buisson 1994), but similar studies appear to be lacking in the Far East.

The Future

In view of the various threats facing shorebirds throughout the East Asian-Australasian Flyway there is a need for urgent action on several fronts.

The East Asian-Australasian Shorebird Reserve Network, inaugurated at the Brisbane Ramsar Conference in March 1996, is an essential first step towards safeguarding major sites.

This action, however, will be of limited impact unless there is also an improvement in national land use management policies, fully recognising the value of wetlands and their "wise use" in accordance with the Ramsar Convention guidelines.

In many, if not all, countries along the flyway, responsibility for wetland and coastal zone management rests with a large number of government agencies, often with competing agendas. In New Zealand there are 42 Acts of Parliament which have jurisdiction over land and seas boundaries. Williams (1995) notes that

> "This encourages administrative fragmentation, duplication, political competition and gamesmanship between authorities with differing responsibilities for the same coastal sections and occasionally uncertainties of jurisdiction".

This situation is undoubtedly reflected elsewhere. Thus, in the Philippines 16 government agencies have responsibilities affecting wetlands, and in China there are more than 14.

In recent years there has been considerable progress in developing models to assess the potential impacts of habitat loss on waders (Dolman and Sutherland 1994, Goss-Custard *et al* 1994, 1995a, 1995b, Sutherland and Goss-Custard 1991) but these are still far from coming up with unequivocal results. Detailed studies of waders and their food supplies are essential if one is to have the necessary information to build such models but, as Ens *et al* (1994), note

> "it took Goss-Custard and his team 15 years of intensive field studies before they felt sufficiently confident to estimate the carrying capacity of the mussel beds in the Exe estuary for Oystercatchers".

In East Asia we do not have the time to wait.

I am unaware of any wader/food studies in the region of similar detail to those conducted in Europe on the Exe, or at Teesmouth, or on the Wadden Sea. Whilst not wishing to discourage the initiation of such studies, the rate of habitat loss in East Asia is such that we cannot afford to wait for detailed results.

We must build on the more detailed knowledge of population processes available from elsewhere and push ahead with regional strategies which promote the sustainable management of wetlands, both through safeguarding particular sites and the implementation of national "wise use" policies. Such actions will ensure that our waders have a future well beyond the 21st century.

Acknowledgements

I am very grateful to Mark Barter, Geoff Carey, Steve McChesney, Clive Minton, Taej Mundkur, Theunis Piersma, Wang Tianhou, and Lew Young for commenting on a draft of this paper and/or providing information.

References

Anon. 1992 *China environmental strategy paper.* Report No.9669-CHA. World Bank Washington.

Aksornkoae, S. 1993. *Ecology and management of mangroves.* IUCN, Bangkok.

Alonzo-Pasicolan, S.N. 1989. *Study of hunting pressures on waterfowl in Luzon.* Asian Wetland Bureau, Kuala Lumpur and Cebu.

Bamford, M. 1992. The impact of predation by humans upon waders in the Asia/Australasian flyway: evidence from the recovery of bands. *Stilt 20*: 38-40.

Barter, M. 1986. Great Knots partly undone. *Stilt 9*: 5-20.

Barter, M. 1992. Distribution, abundance, migration and moult of the Red Knot *Calidris canutus rogersi*. pp.645-70 in Piersma, T. and Davidson, N. (eds.). *The migration of knots.* Wader Study Group Bull. 64, Suppl.

Barter, M. and Wang, T.H. 1990. Can waders fly non-stop from Australia to China? *Stilt 17*: 36-39.

Boorman, L.A., Goss-Custard, J.F. and McGrorty, S. 1989. *Climatic change, rising sea level and the British coast.* HMSO, London.

Brazil, M.S. and Melville, D.S. 1993. *Draft management plan for Shuangtaizihekou National Nature Reserve, Liaoning Province, People's Republic of China.* WWF Project: CN0032. MS.

Burrows, I. 1996. Conservation of migratory waterbirds and their wetland habitats in Papua New Guinea. pp.189-202 in Wells, D.R. and Mundkur, T. (eds.). *Conservation of Migratory Waterbirds and Their Wetland Habitats in the East*

Asia-Australasian Flyway. Wetlands International - Asia Pacific, Kuala Lumpur.

Carey, G.J., Diskin, D.A., Picken, V.B and Leader, P.J. 1995. Systematic list. *Hong Kong Bird Report* 1994: 16-91.

Cheng, T.H. 1987. *A synopsis of the avifauna of China*. Science Press, Beijing.

Chung, C.H. 1988. Spartina anglica *C.E. Hubbard as an important economic marsh grass in China*. Paper presented at the International Symposium on Botanical Gardens, Nanjing.

Chung, C.H. 1990a. Twenty-five years of introduced *Spartina anglica* in China. pp.72-76 in Gray, A.J. and Benham, P.E.M. (eds.). *Spartina anglica* - a research review. ITE Research Publication No.2. HMSO, London.

Chung, C.H. 1990b. Sea level rise and measures to meet it. *Proceedings of Fifth MICE Symposium for Asia and the Pacific: ecosystem and environment of tidal flat coast effected by human being's activities*, August 1988, Nanjing. Nanjing University Press, Nanjing. pp.184-188.

Connors, P.G. and Smith, K.G. 1982. Oceanic plastic particle pollution: suspected effect on fat deposition in Red Phalaropes. *Mar. Pollut. Bull.* 13: 18-20.

Cryer, M., Whittle, G.N. and Williams, R. 1987. The impact of bait collection by anglers on marine intertidal invertebrates. *Biological Conservation* 42: 83-93.

Dahlgren, R.B. and Korschgen, C.E. 1992. *Human disturbances of waterfowl: an annotated bibliography*. U.S. Dept. Interior Fish and Wildl. Serv. Res. Publ. 188.

Davidson, N.C., Laffoley, D.d'A, Doody, J.P., Way, L.S., Gordon, J., Key, R., Drake, C.M., Pienkowski, M.W., Mitchell, R. and Duff, K.L. 1991. *Nature conservation and estuaries in Great Britain*. Nature Conservancy Council, Peterborough.

Davidson, N. and Rothwell, P. (eds.) 11993. *Disturbance to waterfowl on estuaries. Wader Study Group Bill.* 68 Special Issue.

Davies, J. 1989. Mongolian People's Republic. pp.1-30 in Scott, D.A., *A directory of Asian wetlands*. IUCN, Gland.

Dobson, A.P. and May, R.M. 1991. Parasites, cuckoos, and avian population dynamics. pp.391-412 in Perrins, C.M., Lebreton, J.D. and Hirons, G.J.M. (eds.). 1991 *Bird population studies: relevance to conservation and management*. Oxford University Press, Oxford.

Dolman, P.M. and Sutherland, W.J. 1994. The response of bird populations to habitat loss. *Ibis* 137: S38-S46.

Doody, J.P. 1990. *Spartina* - friend or foe? A conservation viewpoint. pp.77-79 in Gray, A.J. and Benham, P.E.M. (eds.). Spartina anglica - *a research review*. ITE Research Publication No.2. HMSO, London.

Ens, B.J and Goss-Custard, J.D. 1995. The effect of sea level rise on a migratory wader. pp.827-830 in Zwerver, S., van Rompaey, R.S.A.R., Kok, M.T.J. and Berk, M.M. (eds.). *Climate change research: evaluation and policy implications*. Elsevier, Amsterdam.

Ens, B.J., Piersma, T. and Drent, R.H. 1994. The dependence of waders and waterfowl migrating along the East Atlantic Flyway on their coastal food supplies: what is the most profitable research programme? *Ophelia suppl.* 6: 127-151.

Evans, P.R. 1991. Seasonal and annual patterns of mortality in migratory shorebirds: some conservation implications. pp.346-359 in Perrins, C.M., Lebreton, J.D. and Hirons, G.J.M. (eds.). *Bird population studies: relevance to conservation and management*. Oxford University Press, Oxford.

Evans, P.R. and Davidson, N.C. 1990. Migration strategies and tactics of waders breeding in arctic and north temperate latitudes. pp.387-398 in Gwinner, E. (ed.). *Bird* *migration: physiology and ecophysiology.* Springer-Verlag, Berlin Heidelberg.

Evans, P.R., Davidson, M.C. Piersma, T. and Pienkowski, M.W. 1991. Implications of habitat loss at migration staging posts for shorebird populations. *Acta XX Congressus Internationalis Ornithologici*: 2228-2235.

Friend, M. (ed.). 1987. *Field guide to wildlife diseases. Vol.1. General field procedures and diseases of migratory birds.* U.S. Dept. Interior Fish and Wildl. Serv. Resource Publ. 167.

Furness, R.W., Galbraith, H., Gibson, I.P. and Metcalfe, N.B. 1986. Recent changes in numbers of waders on the Clyde Estuary, and their significance for conservation. *Proc. Roy. Soc. Edinburgh* 90B: 171-184.

Gill, R.E., Butler, R.W., Tomkovich, P.D., Mundkur, T. and Handel, C.M. 1994. Conservation of North Pacific shorebirds. *Trans. 59th. No. Am. Wildl. & Natur. Resour, Conf* 63-78.

Goodman, P.J. 1969 Biological flora of the British Isles. *Spartina* Schreb. *J. Ecol.* 57:285-313.

Goss-Custard, J.D. and Moser, M. 1990. Changes in the numbers of Dunlin (*Calidris alpina*) in British estuaries in relation to changes in the abundance of *Spartina.* pp.69-71 in Gray, A.J. and Benhamn, P.E.M. (eds.). Spartina anglica - a research review. ITE Publication No.2. HMSO. London.

Goss-Custard, J.D., Caldow, R.W.G., Clarke, R.T., Durell, S.E.A. le V. dit, Urfi, J. and West, A.D. 1995a. Consequences of habitat loss and change to populations of wintering migratory birds: predicting the local and global effects from studies of individuals. *Ibis* 137: S56-S66.

Goss-Custard, J.D., Clarke, R.T., Briggs, K.B., Ens, B.J., Exo, K.-m., Smit, C., Beintema, A.J., Caldow, R.W.G., Catt, D.C., Clark, N.A., Durell, S.E.A. le V. dit, Harris, M.P., Hulscher, J.B., Meininger, P.L., Picozzi, N., Prys-Jones, R., Safriel, U. and West, A.D. 1995b. Population consequences of winter habitat loss in a migratory shorebird. I. Estimating model parameters. *J. appl. Ecol.* 32: 320-336.

Goss-Custard, J.D., Clarke, R.T., Durell, S.E.A. le V. dit, Caldow, R.W.G. and Ens, B.J. 1995c. Population consequences of winter habitat loss in a migratory shorebird. II. Model predictions. *J. appl. Ecol.* 32: 337-351.

Green, G.H., Greenwood, J.J.D., and Lloyd, C.S. 1977. The influence of snow conditions on the date of breeding of wading birds in north-east Greenland. *J. Zool.* 183: 311-328.

Green, P.T., Hill, D.A., and Clark, N.A. 1992. *The effects of organic inputs to estuaries on overwintering bird populations and communities.* BTO Research Report No.59, Department of Energy, UK.

Harrison, J. and Grant, P. 1976. *The Thames transformed.* Deutsch, London.

Hockey, P.A.R. 1995. Coastal wetlands and shorebirds: latitude-link implications of habitat loss. *Asian Wetland News* 8(1): 30.

Hockin, D., Ounsted, M., Gorman, M., Hill, D., Keller, V. and Barker, M.A. 1992. Examination of the effects of disturbance on birds with reference to its importance in ecological assessments. *J. Env. Manage.* 36: 253-286.

Howell, R. 1985. The effect of bait-digging on the bio-availability of heavy metals from surficial intertidal marine sediments. *Marine Pollution Bull.* 16: 292-295.

Howes, J. and Parish, D. 1989. *New information on Asian shorebirds: a preliminary review of the INTERWADER Programme 1983-89 and priorities for the future.* Asian Wetland Bureau, Kuala Lumpur.

Huang, H.C. 1981. An outline of China's marshes. in Ma, L.L. and Noble, A.G. (eds.). *The* *environment: Chinese and American views*. Methuen, New York.

Huang, J.S. 1990. The impacts of human activities on Chinese coasts. *Proceedings of Fifth MICE Symposium for Asia and the Pacific: Ecosystem and environment of tidal flat coast effected (sic) by human beings' activities, August 1988, Nanjing*. Nanjing University Press, Nanjing, pp.28-35.

Hulme, M. Wigley, T., Tao, J., Zhao, Z., Wang, F., Ding, Y., Leemans, R. and Markham, A. 1992. *Climate change due to the greenhouse effect and its implications for China*. WWF, Gland.

Huntley, B. 1995. Plant species' response to climate change: implications for the conservation of European birds. *Ibis* 137: S127-S138.

van Impe, J. 1985. Estuarine pollution as a probable cause of increase of estuarine birds. *Marine Pollution Bull.* 16: 271-276.

Iverson, G.C., Warnock, S.E., Butler, R.W., Bishop, M.A. and Warnock, N. 1996. Spring migration of Western Sandpipers along the Pacific Coast of North America: a telemetry study. *Condor* 98: 10-21.

Jackson, M.J. and James, R. 1979. The influence of bait digging on cockle *Cerastoderma edule*, populations in north Norfolk. *J. appl. Ecol.* 16: 671-679

Jaensch, R. 1990. Assessment of waderbird hunting, 1990-91. *Asian Wetland News* 3: 17-18.

Kung C.C.and Huang, S.C. 1976. Malaria control in China with special reference to bioenvironmental methods of control. *Chinese Medical Journal* 2: 195-202.

Lane, B. 1992. The impact of *Spartina* on intertidal migratory waders *Stilt* 21: 17-19.

Lane, B. 1993. Waterbird hunting on the Red River Delta, northern Vietnam. *Stilt* 22: 51.

Larson, J.S. 1990. Downstream environmental impacts. pp.67-78 in Ryder, G. (ed.). *Damming the Three Gorges: what dam-builders don't want you to know*. Probe International, Toronto.

Lee, D.P., Honda, K., Tatsukawa, R. and Won, P.O. 1988. Heavy metal accumulation in the livers of waders in the Naktong estuary. *Bull. Inst. Ornith. Kyung Hee Univ.* 2: 17-21.

Lee, D.P., Honda, K., Tatsukawa, R. and Won, P.O. 1989. Distribution and residue level of mercury, cadmium and lead in Korean birds. *Bull. Environ. Contam. Toxicol.* 43: 550-555.

Lee, W.S. 1996. Protection and status of shorebirds in the Republic of Korea. pp.97-102 in Wells, D.R. and Mundkur, T. (eds.). *Conservation of Migratory Waterbirds and Their Wetland Habitats in the East Asian-Australasian Flyway*, Wetlands International - Asia Pacific, Kuala Lumpur.

Long, A.J., Poole, C.M. Eldridge, M.I., Won, P.O. and Lee, K.S. 1988. *A survey of coastal wetlands and shorebirds in South Korea, Spring 1988*. Asian Wetland Bureau, Kuala Lumpur.

Loye, J.E. and Zuk, M. (eds.). 1991. *Bird-parasite interactions: ecology, evolution and behaviour*. Oxford University Press, Oxford.

Lu, S.N. 1994. *Development, management and protection of coastal wetland in China*. Paper presented at the China Wetland Protection Workshop, Yueyang, China, 13-17 December 1994.

Mackenzie, J.S., Edwards, E.C., Holmes, R.M. and Hinshaw, V.S. 1984. Isolation of ortho and paramyxoviruses from wild birds in Western Australia and the characterisation of novel influenza A viruses. *Aust. J. Biol. Med Sci.* 62: 89-99.

Madsen, J. 1993. Experimental wildlife reserves in Denmark: a summary of results. *Wader Study Group Bull.* 68: 23-28.

Markham, A., Dudley, N. and Stolton, S. 1993. *Some like it hot.* WWF International, Gland.

May, R.M. 1994. Disease and the abundance and distribution of bird populations: a summary, *Ibis* 137: S85-S86

McClure, H.E. 1974. *Migration and survival of the birds of Asia.* SEATO Medical Research laboratory, Bangkok.

McClure, H.E., Poonswad, P., Greiner, E.C. and Laird, M. 1978. *Haematozoa in the birds of eastern and southern Asia.* Memorial University of Newfoundland, St. John's.

McClusky, D.S. 1981. *The estuarine ecosystem.* Blackie, Glasgow.

McNeil, R., Diaz, M.T. and Villeneuve, A. 1993. The mystery of shorebird over-summering: a new hypothesis. *Ardea* 82: 143-152.

McNeil, R., Diaz, M.T. and Villeneuve, A. 1995. *New hypothesis concerning why palaearctic waders oversummer in the tropics.* Paper presented at 10th International Waterfowl Ecology Symposium and Wader Study Group Conference, Aveiro, Portugal.

Melville, D. 1980. *Unexplained shorebird mortality - San Tin, May 1979.* Occasional Paper M11. Agriculture and Fisheries Department, Hong Kong.

Melville, D.S. 1982. Leg "cramp" and endoparasites. *Wader Study Group Bull.* 35: 11.

Melville, D.S. 1990. Waders roosting in mangroves. *British Birds* 83: 289.

Milliman, J.D. 1990. Fluvial sediment in coastal seas: flux and fate. *Nature and Resources* 27(4): 12-22.

Milton, R. and Marhadi, A, 1989. *An investigation into market hunting of birds in West Java, Indonesia.* WWF/PHP/AWB, Bogor.

Minton, C. 1993. Summary of VWSG activities. *Victorian Wader Study Group Bulletin* 17: 1-4.

Morrison, R.I.G., Bourget, A., Butler, R., Dickson, H.L., Gratto-Trevor, C., Hicklin, P., Hyslop, C. and Ross, R.K. 1994. *A preliminary assessment of the status of shorebird populations in Canada.* Canadian Wildlife Service Progress Note 208.

Mundkur, T. 1993. *A status overview of shorebirds in the East Asian-Australasian flyway.* Asian Wetland Bureau, Kuala Lumpur.

Nichols, J.D. 1991. Responses of North American duck populations to exploitation. pp.498-525 in Perrins, C.M., Lebreton, J.-D. and Hirons, G.J.M. (eds.). *Bird population studies: relevance to conservation and management.* Oxford University Press, Oxford.

Nielsen, S.S. and Pedersen, A. 1994. *Red River Project, Nghia Hung, Vietnam*, 1994. University of Copenhagen, Copenhagen.

Norris, K. and Buisson, R. 1994. Sea-level rise and its impact upon coastal birds in the UK. *RSPB Conservation Review.* 8: 63-77.

Ochiai, K., Hoshiko, K., Jin, K., Tsuzuki, T. and Itakura, C. 1993. A survey of lead poisoning in wild waterfowl in Japan. *J. Wildl. Dis.* 29: 349-352.

Owen, M. 1993. The UK shooting disturbance project. *Wader Study Group Bull.* 68: 35-46.

Pain, D.J. 1991. Lead poisoning in birds: an international perspective. *Acta XX Congressus Internationalis Ornithologici*: 2343-2352.

Parish, D. 1985a. Overview. pp.3-11 in Parish, D. and Wells, D.R. (eds). *Interwader Annual Report 1984.* Interwader, Kuala Lumpur.

Parish, D. 1985b. Threats to wader populations in East Asia. pp.211-214 in: *Proc. Third East Asian Bird Protection Conference, Tokyo, Japan, 29-31 May 1985*. Wild Bird Society of Japan, Tokyo.

Parish, D. 1987. Conservation of wader habitats in East Asia. pp.132-134 in Davidson, N.C. and Pienkowski, M.W. (eds.). The Conservation of International Flyway Populations of Waders. *Wader Study Group Bull.* 49, *IWRB Special Publ.* 7.

Parish, D., Lane, B., Sagar, P. and Tomkovich, P. 1987. Wader migration systems in East Asia and Australasia. pp.4-14 in Davidson, N.C. and Pienkowski, M.W. (eds.). The Conservation of International Flyway Populations of Waders. *Wader Study Group Bull.* 49, *Suppl./IWRB Special Publ.* 7.

Pearson, T.H. and Rosenburg, R. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. *Oceanogr. Mar. Biol. An. Rev.* 16: 229-311.

Peking University. 1995. *Environmental impact assessment study on Shenzhen River Regulation Project. Final EIA Study.* Shenzhen River Regulation Office of Municipal Government, Shenzhen.

Perennou, C., Mundkur, T., Scott, D.A., Follestad, A. and Kvenild. L. 1994. *The Asian Waterfowl Census 1987-91: distribution and status of Asian waterfowl.* AWB Publication No.86. IWRB Publication No.24. AWB, Kuala Lumpur Malaysia and IWRB, Slimbridge, U.K.

Pfister, C., Harrington, B.A. and Lavine, M. 1992. The impact of human disturbance on shorebirds at a migration staging area. *Biol. Conserv.* 60: 115-126.

Phan, N.H. and Hoang, T.S. 1993. *Mangroves of Vietnam*. IUCN, Bangkok.

Piersma, T., de Goeij, P. and Tulp, I. 1993. An evaluation of intertidal feeding habitats from a shorebird perspective: towards relevant comparisons between temperate and tropical mudflats. *Netherlands J. Sea Res.* 31: 503-512.

Piersma, T. and Jukema, J. 1990. Budgeting the flight of a long-distance migrant: changes in nutrient reserve levels of Bar-tailed Godwits at successive spring staging sites. *Ardea* 78: 315-337.

Pye, K. and French, P.W. 1993. *Targets for coastal habitat recreation*. English Nature Research Report No.35. English Nature, Peterborough.

Reid, W.V. and Trexler, M.C. 1992. Responding to potential impacts of climate change on U.S. coastal biodiversity. *Coastal Management* 20: 117-142.

Robertson, A.I. 1992. Concluding remarks: research and mangrove conservation. pp.327-329 in Robertson, A.I. and Alongi, D.M. (eds.). *Tropical mangrove ecosystems.* American Geophysical Union, Washington.

Rose, P.M. and Scott, D.A. 1994. *Waterfowl population estimates*. IWRB Publication 29. IWRB, Slimbridge.

Rusila, Y. 1996. A status overview of shorebirds in Indonesia. pp.173-188 in Wells, D.R. and Mundkur, T. (eds.). *Conservation of migratory waterbirds and their wetland habitats in the East Asian-Australasian Flyway.* Wetland International - Asia Pacific, Kuala Lumpur, Publication No.116.

Ruttanadakul,N. and Ardseungnern. 1989. Evaluation of shorebird hunting in villages around Pattani Bay, Thailand. pp.152-159. in Parish, D. and Prentice, R.C. (eds.). *Wetland and Waterfowl Conservation in Asia* Asian Wetland Bureau/IWRB, Kuala Lumpur.

Scott, D.A., (ed.). 1989 *A directory of Asian wetlands*. IUCN, Gland.

Scott, D.A. and Poole, C.M. 1989 *A status overview of Asian wetlands.* Asian Wetland Bureau, Kuala Lumpur.

Scott, M.E. 1988. The impact of infection and disease on animal populations: implications for conservation biology. *Conservation Biology* 2: 40-56.

Senner, S.E. and Howe, M.A. 1984. Conservation of Nearctic shorebirds. pp.379-421 in Burger, J. and Olla, B.L. (eds.). *Shorebirds: breeding behaviour and populations*. Plenum, New York.

Skagen, S.K. and Knopf, F.L. 1993. Toward conservation of midcontinental shorebird migrations. *Conservation Biology* 7: 533-541.

Sladen, W.J.L., Webster, R.G. and Kawaoka, Y. 1990. *Ecology of avian influenza in gulls and shorebirds.* Paper presented at XXth Congressus Internationalis Ornithologici, Christchurch, December 1990.

Smit, C.J. and Visser, J.M. 1993. Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area. *Wader Study Group Bull.* 68: 6-19.

Song, D., Li, Y. and Luo, Z. 1995. [Coastal belt seaside wetland study around Bohai Bay]. pp.275-279 in Chen, Y. (ed.). [*Study of wetlands in China*] Jilin Sciences Technology Press, Changchun (in Chinese).

Sonter, C. 1984. Red-necked Avocets and lead shot. *Stilt* 5: 20.

Spalding, M.G., Bancroft, G.T., and Forrester, D.J. 1993. The epizootiology of eustyrongylidosis in wading birds (Ciconiiformes) in Florida. *J. Wildl. Dis.* 239: 237-249.

Starks, J. 1987. Report on *INTERWADER shorebird surveys in Thailand*. Interwader Publication No.25, Kuala Lumpur.

Sutherland, W.J. and Goss-Custard, J.D. 1991. Predicting the consequences of habitat loss on shorebird populations. *Acta XX Congressus Internationalis Ornithologici:* 2199-2207.

Suzuki, M. 1990. *Wetland conservation in Japan: a grass roots perspective*. Friends of the Earth Japan/WWF Japan, Tokyo.

Swennen, C., Leopold, M.F. and Bruijin, L.L.M 1989. Time-stressed Oystercatchers, *Haematopus ostralegus*, can increase their intake rate. *Anim. Behav.* 38: 8-22

Tang, S.X. and Wang, T.H. 1995. *Waterbird hunting in East China*. Asian Wetland Bureau Publication No.114. Kuala Lumpur.

Tomkovich, P.S. 1992. Migration of the Spoon-billed Sandpiper *Eurynorhynchus pygmaeus* in the Far East of the Russian Federation. *Stilt* 21: 29-33.

Townshend, D.J. and O'Connor, D.A. 1993. Some effects of disturbance to waterfowl from bait-digging and wildfowling at Lindisfarne National Nature Reserve, north-east England. *Wader Study Group Bull.* 68: 47-52.

Tulp, I. McChesney, S. and de Goeij, P. 1994. Migratory departures of waders from north-western Australia: behaviour, timing and possible migration route. *Ardea* 82: 201-221.

Tunhikorn, S. and Round, P.D. 1996. The status and conservation needs of migratory shorebirds in Thailand. pp.119-132 in Wells, D.R. and Mundkur, T. (eds.). *Conservation of Migratory Waterbirds and their Wetland Habitats in the East Asian-Australasian Flyway*. Wetlands International - Asia Pacific, Kuala Lumpur.

Wang, T.H. 1996. Conservation of migratory shorebirds and their wetland habitats in People's Republic of China. pp.69-83 in Wells, D.R. and Mundkur, T. (eds.). *Conservation of Migratory Waterbirds and their Wetland Habitats in the East Asian-Australasian Flyway*. Wetlands International-Asia Pacific, Kuala Lumpur.

Wang, T.H. and Wells, D.R. 1996. Direct exploitation of migratory shorebirds and other waterbirds. pp.281-282 in Wells, D.R. and Mundkur, T. (eds.). *Conservation of Migratory Waterbirds and their Wetland Habitats in the East Asian-Australasian Flyway*. Wetlands International - Asia Pacific, Publication No.116, Kuala Lumpur.

Williams, A.T. 1995. Coastal planning policies: some conservation aspects in Australia and New Zealand. pp.429-435 in Healy, M.G. and Doody, J.P. (eds.). *Directions in European coastal management*. Samara, Carigan.

Wolff, W.J. 1995. Assessment report on NRP Subtheme "Impact of climate change on the Wadden Sea", pp.781-818 in Zwerver, S., van Rompaey, R.S.A.R., Kok, M.T.J. and Berk, M.M. (eds.). *Climate change research: evaluation and policy implications*. Elsevier, Amsterdam.

Wong, P.L. and Anderson, R.C. 1984. Acuarioids (Nematoda: Acuarioidea) from waders and terms (Aves) in Sabah, East Malaysia: evidence for transmission on the wintering ground. *Can. J. Zool*: 63: 1706-1710.

Wong, P.L. and Anderson, R.C. 1990. Host and geographic distribution of *Skryjasbinoclasva* spp. (Nematoda: Acuarioidea) in Nearctic shorebirds (Aves: Charadriiformes), and evidence for transmission in marine habitats in staging and wintering areas. *Can. J. Zool*. 68: 2539-2552.

Wu, B.L. 1985. Traditional management of coastal systems in China pp.181-189 in Ruddle, K. and Johannes, R.E. (eds.). *The traditional knowledge and management of coastal systems in Asia and the Pacific*. UNESCO, Jakarta.

Xia, X.C. 1985. (ed.). *The mysterious Lop Lake*. Science Press, Beijing.

Xiao, D., Hu, Y., Wang, X. and Li, X. 1995. [The ecological and environmental characteristic and protection of the littoral wetland in northern China.] pp.262-268 in Chen, Y. (ed.). [*Study of wetlands in China*.] Jilin Sciences Technology Press, Changchun (in Chinese).

Young, L. 1990. *Introduction to the land-use at Sheyang salt works and implications for waterbird habitat use*. WWF Hong Kong, MS

Young, L. and Melville, D.S. 1993. Conservation of the Deep Bay environment. pp.211-231 in Morton, B. (ed.). *The Marine Biology of the South China Sea*. Hong Kong University Press, Hong Kong.

Yu, K.B. 1995. Korea's disappearing wetlands. *Green Korea Reports* 2 92): 33-35.

Yun C.X. and Shi, Z. 1994. *Ecological and environmental monitoring and management of coastal wetlands in China: an outline*. Paper presented at Joint Ministry of Forestry/WWF Workshop on Chinese Wetlands, Yueyang.

Habitat Loss and Alteration in Japan - A History Of Large-Scale Destruction

Sadayosi Tobai
Wetland Officer, WWF Japan, Shiba 3-1-14, Minato-Ku, Tokyo, Japan

Introduction

In the East Asia-Australasia Flyway, Japan lies in its centre and acts as a crucial stepping stone in the migration of shorebirds (Fig.1) . This has been demonstrated by banding studies and more recently leg-flag studies (Kashiwagi, 1995).

Seventy-six species of shorebirds have been recorded in Japan but of these, 67 species (88%) are migrant against 9 resident species (12%) (Shigeta, 1995). Of these migrant species, 21 species (31%) are those which only stage in Japan along with 13 breeding species (19%), 25 wintering species (37%), 26 vagrant species (39%) (Fig. 2). This large proportion of species only staging in Japan shows a particular function of Japan as a major staging area and presents difficulty in assessing quantitatively the importance of sites along Japan.

Tidal flats are the most important feeding habitat followed by rivers, lakes, rice fields, mangroves, coral reefs, and rocky coasts (Thompson et. al, 1993).

Habitat loss

High concentration of human population in the lowlands along the coasts created demands for conversion of tidal flats, flood plains into mainly rice paddies historically, but traditional methods of reclamation or drainage allowed gradual regeneration of new tidal flats and floodplains.

Since 1945, rapid and large-scale destruction of wetland habitats has taken place. On a national scale, 33% of tidal flats have been lost between 1945 and 1978 and a further 7.3% lost between 1978 and 1992 (Fig.3-1). On a regional scale at important sites, the loss of tidal flats between 1945 and 1978 ranged from 16% for the Sea of Ariake up to 86% for the Tokyo Bay (Fig.3-2) (Environment Agency of Japan, 1993).

Similar trends are observed for shorelines of lakes and coasts (Fig. 4). For the coastlines, 59% of coastlines were in a natural state in 1978 and they were reduced by 3.8% to 55.2% in 1993. A survey in 1991 of all lakes larger than 1 ha revealed that 60.3% of the total lengths of all the lake shores were in a natural state in 1979 and the figure dropped down to 56.6% by 1991 (Environment Agency of Japan, 1993).

Sources of threats

The largest source of threats to the major habitat, tidal flats, have been reclamation and drainage for agriculture such as rice paddies, and industrial use such as port facilities, housing development and landfill for refuse, more recently. Other types of threats were construction of river mouth barrages and embankment of riverbanks. Habitats are not only lost but also degraded in other cases through pollution from domestic sewage, livestock farms, pesticides and deforestation in the catchment area.

Impacts on shorebirds

National scale

Impacts of these threats are felt on populations of shorebirds. The total numbers of spring and autumn counts have been declining since 1981 (Fig. 5) (Wild Bird Society of Japan, 1985). The Kentish Plover, in particular, shows a steady decline.

Broad-billed Sandpiper, Red-necked Stint, Great Knot, Eurasian Curlew and Eastern Curlew were other species in decline. This is thought to be due to losses and changes in ecological characters of tidal flats. Broad-billed Sandpipers were in decline in autumn counts as well.

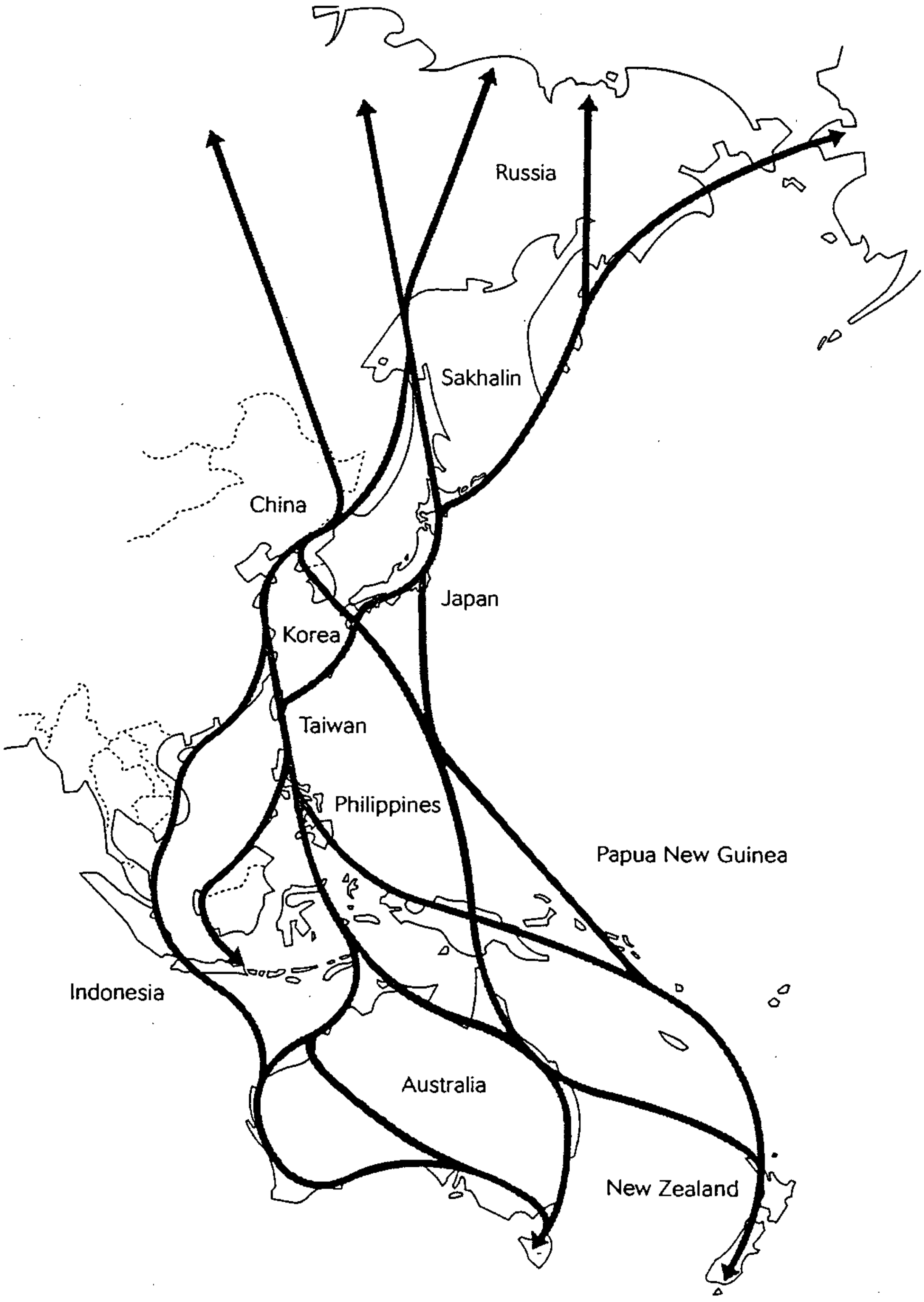


Fig.1 Location of Japan in East Asia/Australasia Flyway

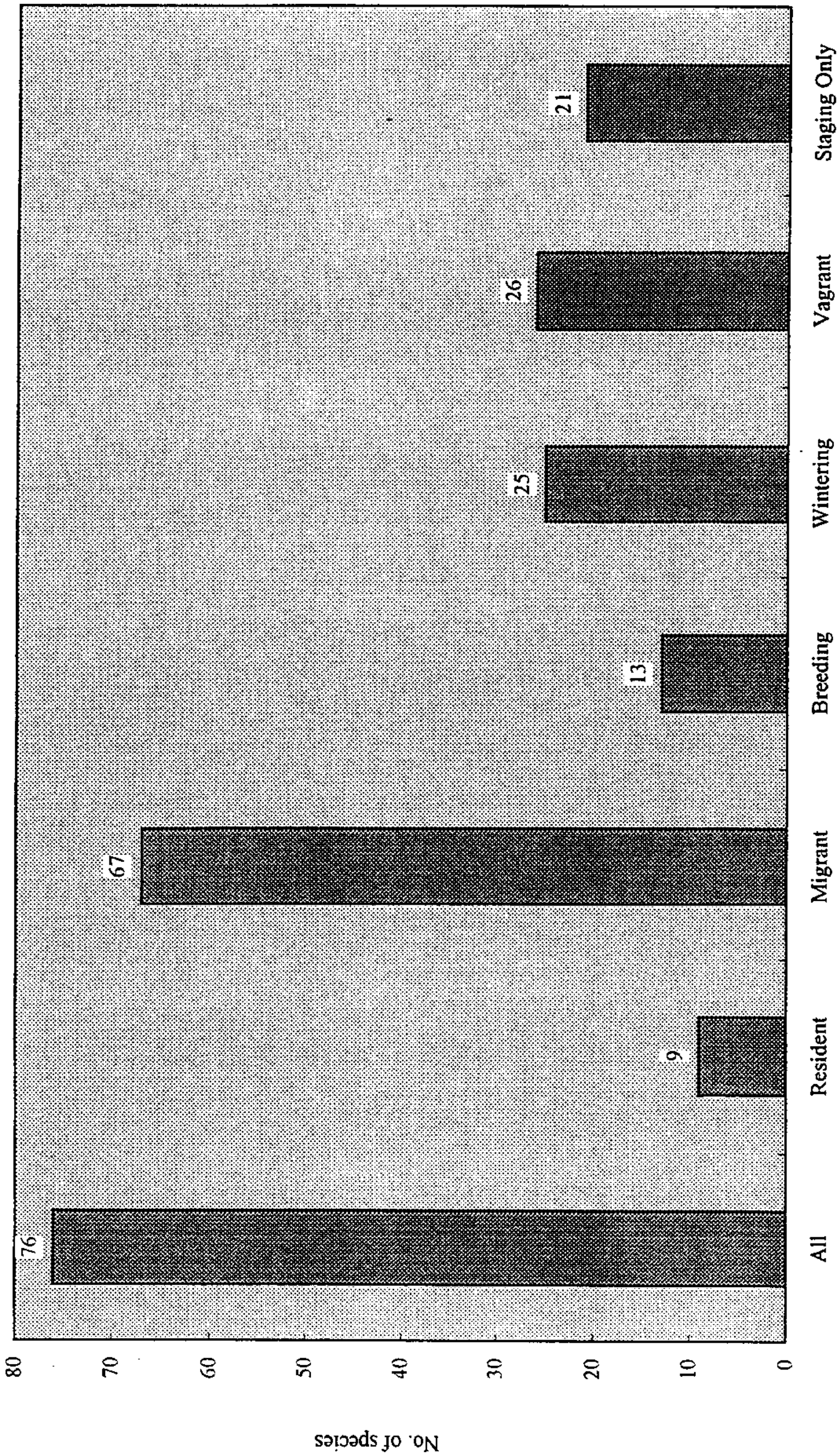


Fig.2 Shorebirds of Japan

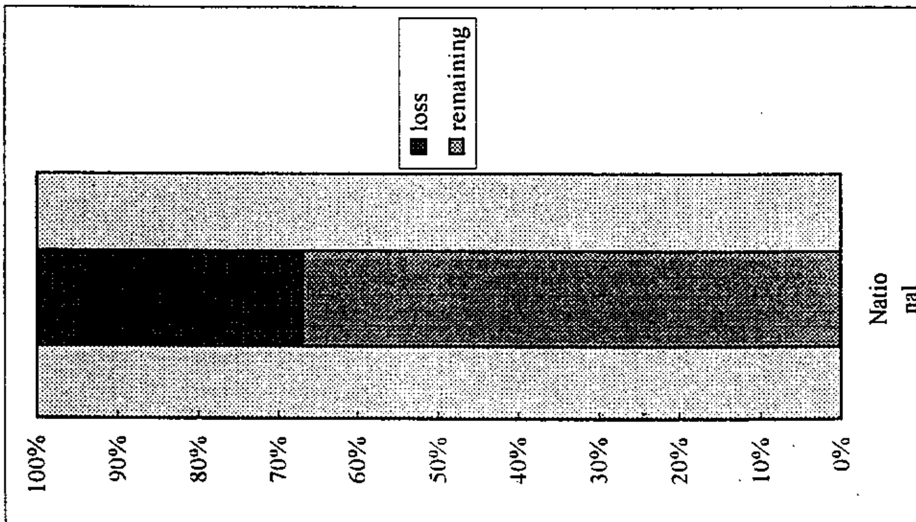


Fig.3-1 Loss of tidal flats in Japan between 1945 and 1978

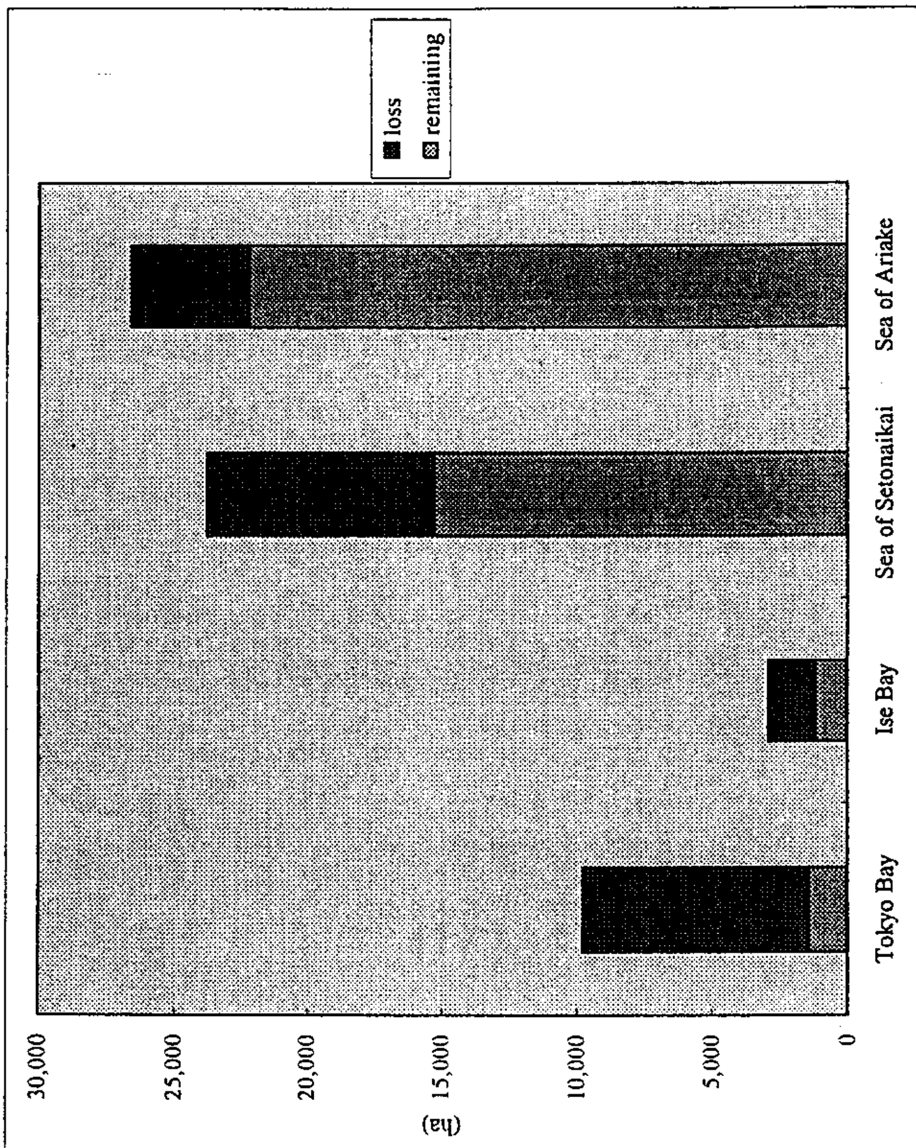


Fig.3-2 Loss of major tidal flats in Japna between 1945-1978

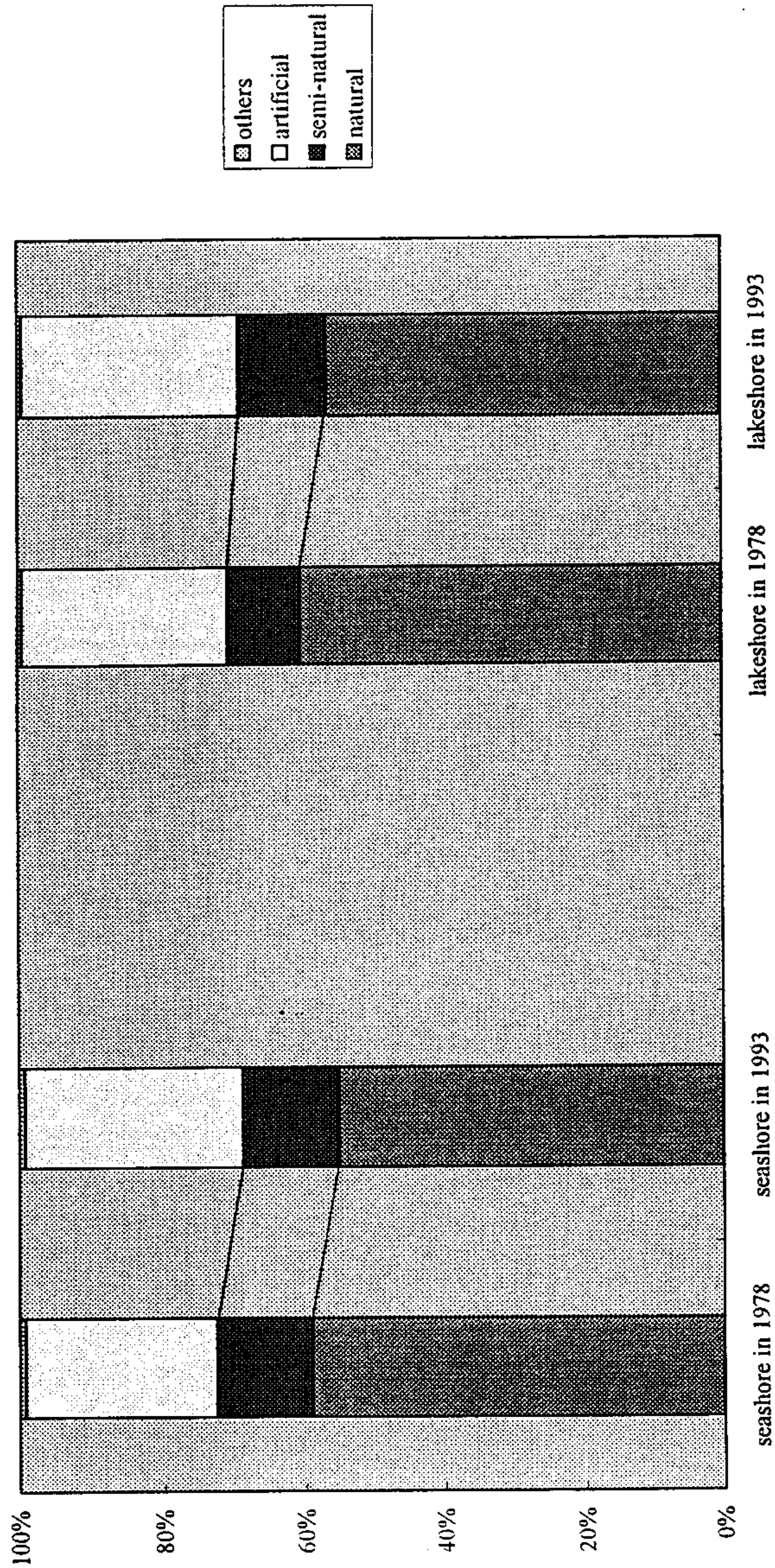
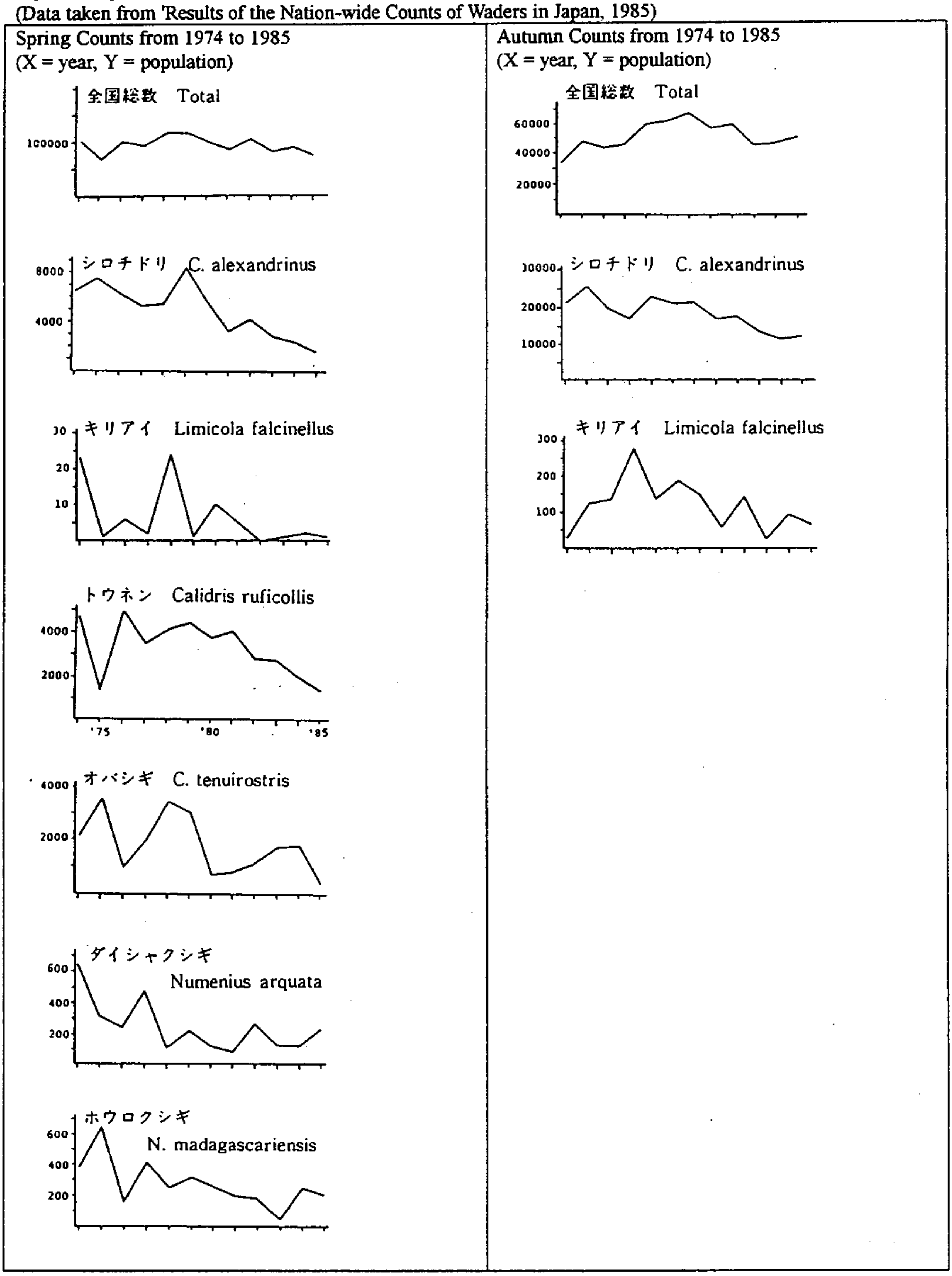


Fig.4 Alteration of seashore and lakeshore in Japan between 1978 and 1993

Fig.5 Changes in the Spring and Autumn counts of shorebirds in Japan between 1974 and 1985
(Data taken from 'Results of the Nation-wide Counts of Waders in Japan, 1985)



Regional scale

Impacts have also been recorded at individual important sites. At Yoshino River Estuary the two most dominant species, Kentish Plover and Dunlin, declined almost by half from the period of 1980-84 to 90-94 (Shibaori, 1995). This is thought to be due to the changes of substrates caused by reclamation in nearby. At Wajiro Tidal Flat, since the construction of an artificial island was begun in 1994, algal blooms have occurred and the number of bird species and populations have declined (Yamamoto, 1994)

Projected Loss

Most of remaining important sites are under threat from ongoing or imminent development projects.

Sanbanze Tidal Flat will lose 740 of 1,200ha if a proposed project of new port facilities, rubbish tip and a residential area are approved (Fig. 6-1). Fujimae Tidal Flat will lose 52 of 120ha to the project for a rubbish dump and Isahaya Bay with 3,000ha of the largest tidal flat will be completely lost when current construction of a barrage wall closes nearly all of the bay to draining.

Furthermore, the loss is greater if it is examined in proportion; 60% will be lost at Sanbanze Tidal Flat, 45% for Fujimae Tidal Flat, 100% for Isahaya Bay (Fig. 6-2). Simple calculation of proportion by area itself is misleading as it has been pointed out that the projected area to be lost accounts for 70-80% of area used for feeding in the case of Fujimae Tidal Flat (Tsuji 1994).

On top of these three sites, there are other important sites similarly under imminent threats (Table 1). At Wajiro Tidal Flat and Sone Tidal Flat, offshore reclamations are already under construction and Yoshino Tidal Flat and Sone Tidal Flat face threats from proposed development projects.

Conclusion

In conclusion, large-scale destruction and degradation of major habitats, especially tidal flats, has happened and is expected to continue. Urgent actions for conservation are called for and a new initiative to recognise and protect important sites on a flyway scale is hoped to reverse this trend. It is also hoped this framework will prevent the losses that Japan has undergone in the past 50 years, being repeated in other countries in the flyway.

Acknowledgments

I would like to express my gratitude to Mr Hanawa for allowing me to use his analysis of the shorebird national census and for his comments.

References

Nature Conservation Bureau of the Environment Agency of Japan, (Ed.) 1993, National Green Census -An Outline of Natural Environment Conservation Baseline Survey-, 69pp., Japan Wildlife Research Centre (In Japanese)

Kashiwagi, M., 1995, Shorebird Banding in Japan (tables), East Asia Flyway Tour Report - 1995,pp.35-43, WWF Japan

Research Division of Wild Bird Society of Japan, 1985, Results of the Nation-wide Counts of Waders in Japan 1. Annual Changes in the Species and Numbers of Waders (1973-1985), Strix4, pp76-87, Wild Bird Society of Japan (In Japanese with English abstract)

Shibaori, S., 1995, Yoshino River Estuary, East Asia Flyway Tour Report - 1995, pp21-22, WWF Japan

Shigeta, Y., 1995, Bird Banding Surveys of Shorebirds and Little Tern in Japan, East Asia Flyway Tour Report - 1995, pp.32-34, WWF Japan

Thompson, J. et. al, 1993, 8. Shorebirds in Japan, pp.119-130, A Status overview of Shorebirds in the East Asian - Australasian Flyway, Asian Wetland Bureau

Tsuji, A., 1995, Daishakushigi No. 40, Save Fujimae Association (In Japanese)

Yamamoto, H., 1994, News from Wajiro Tidal Flat, Daishakushigi No. 37, Save Fujimae Association (In Japanese).

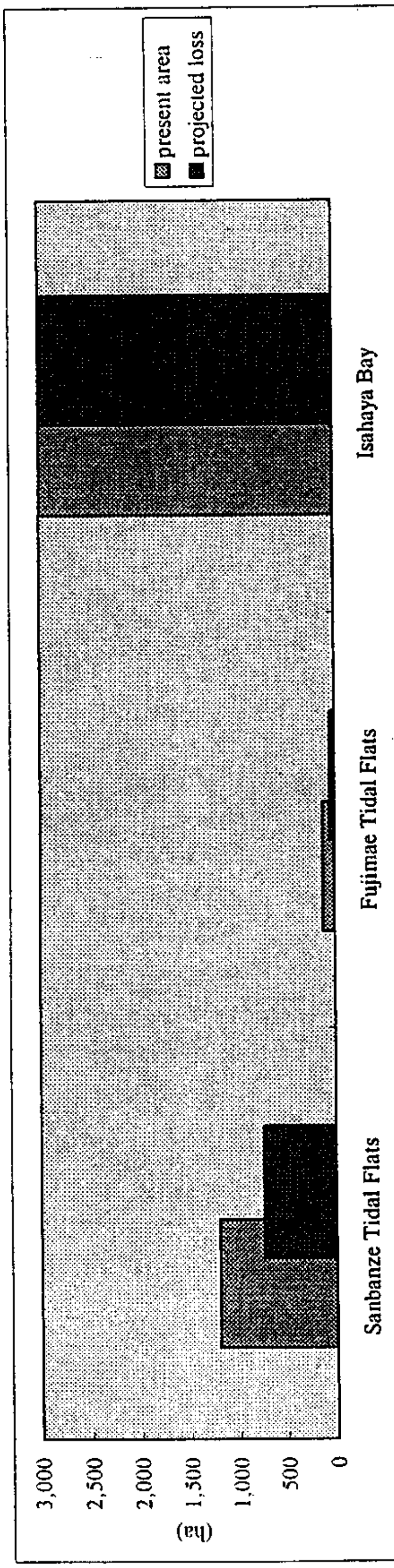


Fig.6-1 Projected loss of major tidal flats in Japan

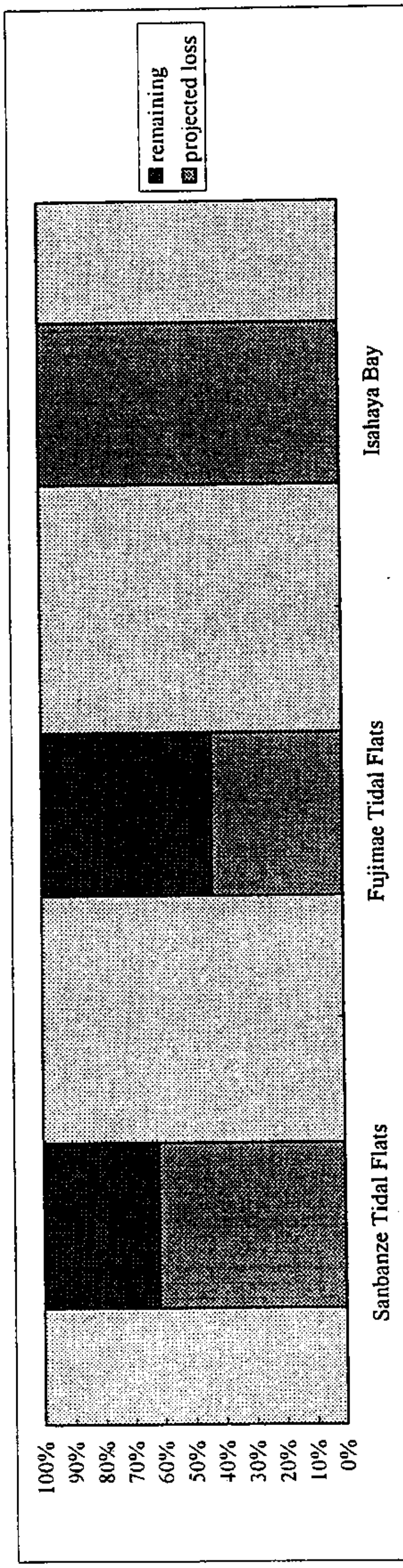


Fig.6-2 Projected loss of major tidal flats in Japan by proportion

Table 1
Imminent threats to important shorebird sites in Japan

	Site (area in ha)	Importance to shorebirds	Threats and present status of development project	Loss and/or alteration
1	Sanbanze Tidal Flat (1,200ha)	• Main feeding area for shorebirds which use Yatsu Tidal Flat, a Ramsar site	• Reclamation for port facilities, rubbish tip, residential area. • Under additional EIA process for 1996	Loss: 740 out of 1,200ha. Most of shallower feeding area will be lost.
2	Fujimae Tidal Flat (120ha)	• Regularly supports more than 10,000 shorebirds	• Reclamation for rubbish tip • Under EIA process	Loss: 52 out of 120ha. This loss will account for 70-80% of feeding area.
3	Wajiro Tidal Flat (80ha)	• Holds 4-5,000 shorebirds in winter	• Construction of an artificial island (401ha) and dredging for port facilities off the shore of the Wajiro Tidal Flat • Under construction	Alteration: Eutrophication became exacerbated by alteration of tidal flow by the artificial island combined with influx of nutrients from domestic sewage.
4	Sone Tidal Flat (500ha)	• More than 1,000 shorebirds in winter • 150 Far Eastern Curlew wintering	• Construction of an artificial island (153ha) for airport and dredging • Under construction	Alteration: changes in tidal flow caused by the artificial island may lead to alteration of benthos.
		•	• Reclamation of the Sone Tidal Flat • At conceptual stage	Loss: Scale not revealed
5	Yoshino Tidal Flat (36+18ha)	• Holds more than 0.25% of Dunlin population	• Construction of an artificial island • First stage completed (60ha), second stage being planned	Alteration: Artificial island may have caused changes in substrate - from mud to sand - and shorebird counts dropped by 47% from 5,377 in 1978-'87 to 2,553 in '90-'92
		•	• Construction of barrage 13km upstream • Under review	
		•	• Construction of two bridges • Plans	
6	Isahaya Tidal Flat (3,000ha)	• 11,000 observed in spring • 7,000 wintering	• Reclamation for agriculture • Dike for drainage near completion, drainage to start in 1997	Loss: All of 3,000ha

Hunting of Shorebirds on the North Coast of West Java

Yus Rusila Noor **and** ***Noviana Andalusi***

Abstract

During the last seven years, AWB-Indonesia, under its cooperative wetland management programme with the Directorate General of Forest Protection and Nature Conservation (PHPA), has carried out surveys of waterbird hunting activities along the north coast of West Java. In addition, ecological, conservation and socio-economic surveys in combination with an awareness programme have been conducted in the main hunting areas. The Indramayu and Cirebon regions have been known as a centre of waterbird hunting activities in Java since 1940. A total of possibly one million birds were caught in 1979, decreasing to 300,000 birds in 1984-1986 and 150,000 in 1991/92.

Local people's awareness regarding the status of the bird species hunted (many of them migratory species, some of which are protected under Indonesian law) has gradually increased since AWB/PHPA started the monitoring programme. This has contributed to the decrease in birds taken.

The research conducted during earlier phases of the project showed that local people who hunt waterbirds in Indramayu depend on hunting for their livelihood. Experience in the area showed clearly that the project needs to have the active support of the bird hunters. Yet, simply prohibiting bird hunting was likely to alienate the bird hunters and deter them from cooperating with efforts to reduce the hunting of protected birds. Moreover, such an approach would ensure that the costs of conserving the birds would be borne by those least able to pay: the poor villagers of Indramayu-Cirebon. Local people hunt birds for a living because there are few economic alternatives. Therefore to overcome the problem in the long term, hunters have to find other ways to maintain their families. To do so the community needs support from outside the area.

Future activities under the programme will focus on developing and implementing these alternatives in combination with continued awareness activities; in addition, the monitoring activities will continue. Plans for the establishment of a migratory waterbird research/banding station are being studied.

Y.R. Noor, Wetlands International, Indonesia, Jl Arzimar III No. 17, Bogor 16152, Indonesia
N. Andalusi, Directorate General of Forest Protection and Nature Conservation, Ministry of Forestry, Republic of Indonesia.

Summary of project history

The Indonesian Directorate General of Forest Protection and Nature Conservation (PHPA), World Wildlife Fund (later known as World Wide Fund for Nature) and Asian Wetland Bureau (later WETLANDS INTERNATIONAL) began studying the bird trade in Indramayu - Cirebon in 1986. As many birds head for Australia, the Australian International Development Assistance Bureau, AIDAB (later AusAid) subsequently agreed to fund a follow-up project in the area.

Under the PHPA/AWB cooperative programme, a joint Indonesian - Australian team carried out a detailed study in Indramayu - Cirebon in 1990 (Phase I of the project). The team found that hunting pressure on many species is unsustainable. Hunting in this area accounted for about 20% of the total world population of Oriental Pratincole (*Glareola maldivarum*) yearly. Over 1.5 months, marketplace surveys revealed 12,000 waterbirds of 30 species, including 90 Milky Storks (*Mycteria cinerea*), which constituted almost 20% of the Javan population of this species. This resident waterbird is a threatened species with a world population of about 5,000 birds.

In 1991 and 1992 (phase II) PHPA and AWB started developing a system to manage the hunting. Law enforcement backed up by an education campaign drew attention to the plight of the Milky Stork. This work scored an early success: villagers no longer hunt this species.

In 1992 follow up surveys found that, compared with four years before (1988), the number of birds caught had fallen by one-third. It is unclear whether this is because of falling numbers, or because falling profit margins have driven bird hunters out of Indramayu - Cirebon (which is happening) or because of PHPA/AWB activities in the area. It could be due to falling populations of migratory waterbirds along the East Asian - Australasian Flyway.

In phase III, executed simultaneously with phase IV in 1993 - 1994, a team of Indonesian community development consultants from the Indonesian NGO *Bina Desa* started a socio-economic process in the area. The team has been able to help the community to identify methods, means, resources, and potential problems before starting new community enterprises.

In phase IV, PHPA/AWB and the Science Teacher Up-grading Centre (P3G - IPA) helped local primary school teachers develop their own teaching materials and posters focusing on the ecology of migratory birds and threats to their survival.

Introduction

Indonesia is known as a country with a high level of biodiversity, as exemplified by its avifauna. Indonesia has the fourth highest number of bird species in the world. At present, a total of 1539 bird species has been recorded throughout Indonesia, including more than 380 endemic species (Andrew, 1992).

Indonesia has also been identified as an important wintering area for waterbirds that migrate between their breeding and non-breeding areas. Every year hundreds of thousands of migratory waterbirds depend on the mudflats, mangroves, lakes and other wetlands in Indonesia for food or shelter. Unfortunately, these areas are also important places for the daily activities of the human population. This overlap of use has generated significant conservation problems, since many migratory waterbird species are hunted by local people for e.g. for food or to keep as domestic pets.

In Java, where more than 60% of Indonesians live, waterbird hunting has been identified since at least 1936 as a traditional harvest for human consumption. The heaviest harvest pressure is believed to occur on the north coast of West Java.

Over the past ten years, WETLANDS INTERNATIONAL - Indonesia Programme, in its cooperation with PHPA, has carried out several projects that address these problem.

This paper presents a brief description and overview of the results of these projects.

II. General Description Of Waterbird Hunting In North Coast Of West Java

2.1 Study area

The study areas are situated in the Cirebon and Indramayu regencies, where the large coastal plain is used extensively for rice and fish production (Fig. 1). The rice fields close to the coast are irrigated by small, man-made, rivers that have their catchment in the nearby hinterland. The coast is accreting rapidly. Between the rice fields and the coast there is a strip 1 to 1.5 km. in width in which brackish-water fishponds have been constructed. These fishponds are built as rapidly as new land emerges from the sea. Very little natural vegetation remains within the fishponds, thus, most waterbird habitat is now man-made.

2.2 Hunting periods and sites

The survey data show that waterbird hunting continues year-round, with the peak season from November to February, when the migratory waterbirds stop over in this area. Depending on the techniques used, hunting is carried out by day or by night.

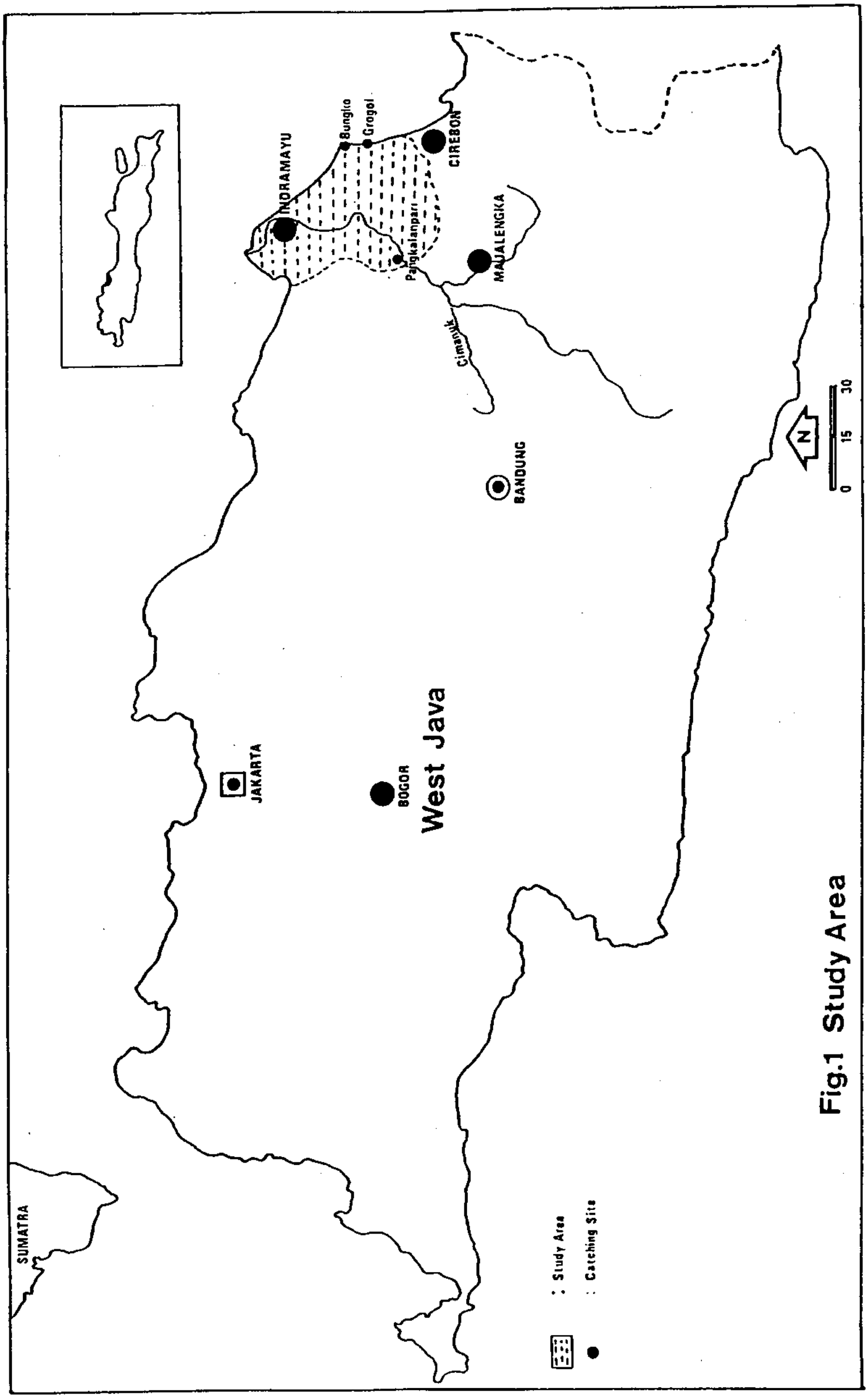


Fig.1 Study Area

In the peak migration period, most hunters operate in the areas adjacent to their houses. In the last ten years, because the birds' habitats have been reclaimed so rapidly, the remaining areas have become too small for the hunters, many of whom have expanded their hunting operations to areas as far away as Lampung, Jambi and Riau in Sumatra. The hunters spend a week catching waterbirds in these areas. Captured birds are skinned, and taken back to Cirebon/Indramayu. The expansion of the hunting areas has encouraged the local people in these new areas also to hunt waterbirds as a cheap source of income that requires no capital outlay. As a result, the conservation problem is spreading.

2.3 Hunters and wholesalers

The total numbers of hunters and wholesalers are not known precisely: the number of hunters varies from time to time, even within one season. This variation is mostly affected by the fluctuation in waterbird abundance and the availability of other income sources. With no stable population of hunters, it is difficult to estimate their numbers, therefore only very rough estimates can be made. For instance there were 135 - 170 hunters working in the area in 1985/86, but around 300 in 1990 and 1994.

Bird hunters usually begin their career at the age of 11, but the average age is 35 and the oldest hunter recorded was 60 years old (Aminah, 1993).

The total number of wholesalers is, fortunately, better documented. Reflecting the increase of hunter numbers, the number of wholesalers increased from 15 in 1985/1986 to 30 in 1990 and 29 in 1994.

The number of hunters supplying each wholesaler varies. Hunters sell birds to wholesalers while the birds are still alive. Almost 93% of hunters sell their birds to wholesalers who have previously lent money to them or provided transport and cigarettes.

Table 1. Number of hunters in the Krangkeng area

YEAR	RESEARCHER	NUMBER OF HUNTERS
1985/86	Milton & Marhadi	135 - 170
1990	Johnson *et al*	around 300
1994	Local informant	around 300

Table 2. Number of Wholesalers

YEAR	RESEARCHER	NUMBER OF WHOLESALERS
1985/86	Milton & Marhadi	15
1990	Johnson *et al*	30
1994	Local informant	29

2.4 Hunting techniques

There are three main hunting techniques: mist netting, clap netting, and dazzling. Of these, mist netting is the most popular technique for catching shorebirds.

Nets are erected in the coastal fishponds, harvested ricefields or dykes at about 1600 hrs. A team of hunters (1 - 3 men) may use up to three nets. Each net consists of panels made of nylon monofilament, 10 - 15 m. long. Seven to twenty panels are used to form a single net suspended about 1 m. above the ground. Often two nets are erected end to end, with another net set oblique to the first in order to catch birds moving in different directions.

When many hunters are using one area, the lines of nets, which may each be up to 300 m. long, present a formidable obstacle for feeding birds. The height at which the nets are set probably keeps them below the skyline for most birds, making them difficult to avoid.

2.5 Annual waterbird harvests

There were no data available for the annual harvest before 1979. A survey estimated that 1,000,000 birds were killed during 1979. This number decreased rapidly to 300,000 birds per year during the period 1984 - 1986, the estimate being based on data collected from 14 wholesalers. In 1988, a total of 12,750 birds were recorded from two wholesalers within peak-months period. By multiplying the average number of birds taken per wholesaler by the total number of wholesalers working in the area, it was estimated that 200,000 birds were killed in 1988. Data from 1990 show that 13,000 birds were killed during the period of 30 days in the peak-months (from 15 wholesalers), while in 1991/1992 a total of 47,000 birds were recorded from 15 wholesalers during 4 peak-months period . Using the same extrapolation and comparison as applied to the year 1988, the estimated numbers for 1990 and 1991/1992 are 160,000 and 150,000 birds respectively.

It should be noted that the figures may contain considerable errors. As the 1984 - 1986 and later surveys worked in different ways, comparison between the two could lead to some inaccuracy. The records kept by the wholesalers are also of uncertain reliability. For instance, once the concept of protected birds become known, protected species disappeared from the records kept by the wholesalers, as they realised what punishments faced those caught handling such birds.

Table 3. Estimated annual bird harvests in the Indramayu/Cirebon area: 1979 - 1992

YEAR	RESEARCHER	NUMBER OF BIRDS CAUGHT YEARLY (ESTIMATE)
1979	Alikodra	1,000,000
1985/86	Milton & Marhadi	280,000 - 300,000
1988	Rusila	200,000
1990	Johnson *et al*	160,000
1992	Rusila	150,000

2.6 Shorebird species hunted

It was recorded in 1984 that a total of 63 species (22 families) were collected by wholesalers. This number remained constant until 1992.

The data from 1992 show that around 36% of these hunted birds are shorebirds species from four families, namely Scolopacidae 26%, Glareolidae 8%, and Charadriidae 1%. Of these, *Gallinago spp.* are the most heavily harvested, followed by *Glareola maldivarum*.

III. The Economics Of Waterbird Hunting

In Indramayu-Cirebon, waterbird hunting is an occupation passed down from one generation to the next. Bird hunting has become a way of life for the community living in this area. On average, bird hunters have five children and sometimes three members of the family work in the bird trade. This depends on the number of male family members above 11 years of age still living under the same roof (Aminah, 1993).

3.1 Marketing system

Although it was previously stated that the catching of birds on the north coast of Java is possibly a traditional subsistence harvest, later survey data have indicated that marketing systems have been established which involve three major groups: hunters, wholesalers and consumers.

Wholesalers can have several roles in the bird trade. Some only collect the birds (collectors) from hunters. Others collect and process the birds (processors). Some collect the birds, then process, fry and sell them (vendors).

There are four ways in which the birds pass from hunter to consumer:

1.	Hunter	Collector	Processor/vendor	Consumer	
2.	Hunter	Collector	Processor	Vendor	Consumer
3.	Hunter	Collector/Processor	Vendor	Consumer	
4.	Hunter	Vendor	Consumer		

The processors kill and clean all birds collected from the hunters, and sell them to the vendors. The vendors, who sell the birds at stalls in Cirebon and Indramayu, partly cook the birds to prevent spoilage and then complete the cooking as consumers order food.

Bird prices vary with the season and species concerned. The price of the birds depends on the price of a few standard species : e.g. Common Moorhen and Watercock. Prices change with fluctuation in the catch - especially the number of standard birds caught.

3.2 Contribution of hunting to the income of local families

Most of the hunters claimed that hunting provides a secondary source of income and is only carried out when they have no other source of income. However, using the 1992 data, it can be seen that the net profit accrued by hunters, on average, is 42% of their total income. This indicates that hunting contributes a significant amount to the hunters' income (Aminah and Rachmina, 1993).

IV. Problems And Options

4.1 The problem of conservation and the need for research

The majority of hunters and non-hunters questioned (>90%) believed that the waterbird population had decreased significantly over the previous ten years. Most of the non-hunters attributed this change to the increase in bird hunting over this period, while most hunters (>80%), by contrast, believed that the waterbirds would not become extinct because of hunting. Hunters believed that bird numbers were decreasing because the birds had fewer places to feed in the area. They believed that the birds "stop over" in other areas (Aminah and Rachmina, 1993).

There are insufficient data and evidence to determine a sustainable hunting level for every species being harvested. However, hunting pressure is at an unsustainable level for at least two species, Milky Stork and Oriental Pratincole.

It has been recognised that the hunting of Milky Stork is at unsustainable level for the Javan population, while for Oriental Pratincole it has been suggested that 21% of the Pratincoles migrating through the region are captured. This species is known to spend its non-breeding period in Northern Australia. A total of about 45,000 birds was hunted in 1984 - 1986 and 1,933 birds in October 1990, indicating that harvesting of this species is also occurring at an unsustainable level. It was estimated that the adult population required to support this hunting level on a sustainable basis would be more than 300,000, however the Australian population is probably smaller than this number (Johnson, *et al,* 1990).

Whilst these estimates are subject to inaccuracies, it is clear that a substantial proportion of the migrating population is harvested.

Acknowledging that insufficient biological data are available, research should be continued and shoul focus on :

a. Population trends.

At the moment, most of the data related to the composition and abundance of species hunted are compiled from information provided by wholesalers. Little is known about the wild populations. More surveys are needed to obtain up-to-date information on species composition and population trends in the hunting areas.

b. Species ecology

Except for Oriental Pratincole and Milky Stork, nothing is known about the ecology of the species hunted. In addition to population trend, information is urgently required on habitat requirement/relationship, sex composition and age, recruitment and local and regional movements. These data are needed, especially to determine the sustainable level of hunting.

c. Bird banding schemes

Experience has taught that bird-banding programmes are extremely helpful in obtaining data on species ecology as well as population trends. For example, a banding programme provided new morphometric and moult data and confirmation of aging criteria for Oriental Pratincole, a hitherto poorly described species (Johnson, 1991). A banding programme in the study area provided evidence that a number of birds remain in Indonesia during the non-breeding period. It is strongly recommended that the banding programme be continued in this area. More broadly, it is recommended that more continuous bird banding schemes be established in Indonesia as a means to coordinate and store banding data.

4.2 Socio-economic development

It has been clearly recognised by the surveys that the major motive for bird hunting is purely economic. Bird hunting is a very difficult and unreliable way to earn a living. Hunters have to stay by their nets all night in rice fields and fishponds, and are often soaked by rain. Sometimes they return home without catching a bird. However, the area where they live provides meagre resources, and the hunters have few assets or skills. Local people hunt birds for a living because there are few economic alternatives (MacCarthy & Rusila, 1996). Therefore, in the long term, the empowerment of local people through a community-based development programme is essential. The major objective of such a programme should be to help hunters find other ways to support their families. To do so the community needs support from outside the area.

4.3 Environmental education

Environmental education is considered to be an important tool to achieve sustainable development. This is true for the study area, where most local people are poorly educated (Nirarita, 1996). The survey found that the average child had only primary education: less than 20% of respondents had children at junior high school and less than 5% had children at senior high school. The low level of education is a result of the lack of money available for school costs (primary school is free of charge) (Aminah, 1993). This situation has led to the low level of knowledge about migratory waterbirds among local people.

To support the long-term management and community development programme, the project carried out an education programme through local schools. There were several reasons for working with primary school children (AWB, 1994):

a. An awareness programme that works through local schools will address the bird hunters directly: young boys usually learn to hunt from their fathers at the age of eleven.

b. School children are in a learning environment suitable for the exchange of information. As it is easier to establish a certain opinion than change an existing one, it is important to work with school children. The attitudes that children develop towards waterbirds at an early age are important for the long-term management of hunting.

c. Children may also pass on what they have learned to their parents, particularly if they bring home useful information and teaching materials.

To ensure the sustainability of the programme, the project staff trained teachers stationed in the area. Nirarita (1996) pointed out that, to ensure the long-term success of such an environmental education programme, it is very important to maintain momentum and the interest of the people/institution involved. Unfortunately, at the time of writing, the overall project has been suspended because of lack of funding.

4.4 Policy and law enforcement

All the shorebirds harvested in the area are migratory species covered by international agreement(s). At a national level, only six of the 56 shorebird species that occur in Indonesia are protected by wildlife regulation, two of which, *Numenius arquata* and *Numenius phaeopus*, are found in the study area. Although there is legislation that regulates the trade in non-protected species, because of the experience gained from this project and for effective law enforcement, it is recommended that all shorebird species be protected in Indonesia. From a local perspective, apart from *Gallinago spp.*, species of the families Charadriidae and Scolopacidae contribute less than 5% to the total wholesale value of the trade in the study area (Milton and Marhadi, 1989).

The concept of waterbird protection was not fully understood by local villagers. Only about 10% of respondents knew that some birds are protected; 67% of respondents said that they only knew about these laws after a recent visit by government officials, while a further 22% were not aware of bird protection (Aminah, 1993). This means that much more effort must be put into the awareness programme.

V. Conclusions

5.1 Bird hunting constitutes a significant economic component of local income. As it has become clear that economic motivation is now the major reason for hunting, the identification and implementation of alternative economic activities should receive increased emphasis.

5.2 The number of birds harvested by hunters is decreasing. This is possibly caused by the reduction of suitable habitat by conversion to fishponds and/or other man-made habitat. This will affect the activity of both birds and hunters using the areas. The decrease in numbers of birds harvested is also likely to be an effect of the more active approach that has been taken by the relevant government agencies and/or conservation organisations.

5.3 Although bird numbers have decreased, it does not mean that harvesting has decreased and become a sustainable activity, since large numbers of significant species are still being harvested, hunting areas have been expanded, and many new young hunters have entered the waterbird hunting profession.

Reference

Aminah, I. M. and I.D Rachmina. 1993. *A socio-economic study of the hunting of waterbirds in the Indramayu and Cirebon area.* Asian Wetland Bureau, Bogor.

AWB. 1994. *Inception report: Sustainable harvesting of waterbirds in the East Asian - Australasian Flyway, Indonesia Sub-project - Phase IV.* Bogor.

Johnson, R; W.G. Lawler; Yus Rusila Noor and M.A Barter. 1990. *Migratory waterbird survey and bird banding project in the Indramayu - Cirebon region, West Java: the Oriental Pratincole* Glareola maldivarum *as a case study.* PHPA/AWB/AWSG, Bogor.

MacCarthy, J. and Yus Rusila Noor. 1996. *Bird hunting in Krangkeng, West Java: Linking Conservation and Development.* Journal of Environment & Development, Vol. 5, No. 1, March 1996, California, USA. pp. 87 - 100.

Milton, R.A. and Agus Marhadi. 1989. *An investigation into the market netting of birds in West Java, Indonesia.* PHPA/WWF/AWB, Bogor.

Nirarita, Ch. E. 1996. *A community approach to reduce waterbird hunting pressures in West Java. A case toward sustainable harvesting of waterbirds in the East Asian - Australasian Flyway.* WETLANDS INTERNATIONAL - Indonesia programme.

Rusila Noor, Y. 1988. *A study on waterbird population and its conservation in the Indramayu - Cirebon coastal areas.* Thesis report. Department of Biology, Padjadjaran University, Bandung.

Waterfowl disturbance in Europe: problems and solutions

David A. Stroud

European waterfowl experience many forms of disturbance (defined as activities that prevent the full use of available habitats). Most fundamental of these factors are the effects of habitat loss through land claim and the conversion of wetlands to other land-uses (*e.g.* agriculture). Habitat degradation also occurs for a wide variety of reasons. With high human population densities along much of Europe's coastline, direct disturbance occurs as a consequence of highly varied human activity. Commercial activities such as the extraction of Cockle *Cardium* spp. from mudflats, or the commercial digging of mudflats for fishing bait, can greatly restrict waterfowl habitat usage. Disturbance from military activities such as low-flying jet aircraft and shooting, and from recreational activities such as horse-riding, walking, dog-exercising, fishing, sailing, jet skiing, sand-yachting *etc.* can also have particularly disturbing effects. Locally these activities can greatly reduce the carrying capacity of otherwise suitable habitats. Some of the various ways in which these effects and impacts have been reduced and mitigated against in Europe are summarised, together with an assessment of those approaches which have been found to be helpful in addressing the issues.

D.A. Stroud, Joint Nature Conservation Committee, Monkstone House, City Road, Peterborough PE1 1JY, United Kingdom.

Introduction

The European continent is densely populated by humans. For example, some 1.1 million people live within 15 km of the Solent Estuary, England - an estuary which has 32,000 yacht berths and moorings. The waterfowl which occur here accordingly experience many forms of disturbance as an almost inevitable consequence of the great variety and intensity of human activity in the coastal zone.

Disturbance is here defined very broadly as those factors which prevent natural distribution of birds in their wetland habitats, and which consequently may ultimately have impacts on population dynamic processes (Madsen & Fox 1995).

This brief review summarises some of those activities that have greatest effect on waterfowl in Europe (although concentrating especially on the UK). Studies reported here include many on ducks, geese and swans as well as on waders. This is because the economic and recreational importance (especially for sport hunting) of these former groups has given a rationale for many applied ecological studies.

The paper summarises some of those approaches which have been found useful in reducing or eliminating sources of disturbance and which may be valuable to consider in other contexts.

Causes of Disturbance

Disturbance from land claim

The broadest definition of 'disturbance' would include the effects of land-claim or habitat modification as factors which ultimately result in waterfowl being unable to exploit wetland habitats either in part (some habitat modifications) or at all (habitat transformation from land claim). In Britain, Davidson et al. (1991) summarised information on the loss of estuarine habitats. There has been long historical loss of wetland habitats, especially inter-tidal areas, throughout Europe (*e.g.* Rackham 1986; Finlayson & Moser 1992). Until the mid nineteenth century the driving force for this land claim was the desire to acquire new land for agriculture; more recently industrial and other economic needs have driven these processes (Davidson *et al.* 1991).

These losses continue, albeit generally at a reduced level owing to increasingly restrictive habitat conservation measures in many European countries. Both the EC Birds Directive in 1979 and more recently, the European Communities Habitats and Species Directive have been important in strengthening provision for the protection some types of internationally important wetland (Stroud *et al.* 1990; Julien 1996; Davidson & Stroud in press).

In the short-term, habitat loss and degradation can result in the displacement of waders, whilst in the long-term ecological theory suggests that population reductions will ensue. Owing to their migratory nature and scale effects, it has rarely been possible to demonstrate the consequences of the loss or degradation of sites at the level of biological populations (Davidson & Rothwell 1993b). There are sound theoretical reasons, however, to suppose that such impacts can be manifest (Goss-Custard & Yates 1992; Goss-Custard *et al.* 1995).

Major modifications of the estuarine environment have ensued consequent upon the creation of barrages across many of Europe's major estuaries. In particular, the later phases of the creation of barrages across the Dutch Delta area have been the subject of detailed study and assessment (Meire 1993; Meire & Meininger 1993; Shekkerman *et al.* 1993). These studies have greatly enhanced the scientific understanding of the complex consequences of the modification of inter-tidal habitats. Likewise Hötker (1994) reviewed three cases of monitored inter-tidal land claim in the Wadden Sea, and the success or otherwise of planned attempts to mitigate the losses.

More recently there have been some attempts to redress the scale of inter-tidal habitat losses through a move to 'soft' coastal engineering. Progressively rising sea levels have forced a reassessment of the type and form of coastal defence in many areas.

There has been a growing realisation that the most effective coastal defences are broad areas of barrier natural habitats such as saltmarshes, rather than concrete sea walls or other engineered structures. Such thinking has been encouraged by nature conservation organisations (*e.g.* Norris & Buisson 1994) with the potential benefits to wildlife, especially for coastal birds, firmly in mind. To date, whilst demonstration projects in the UK, Belgium, Denmark, Germany and elsewhere have been small, they have clearly shown the potential of the approach (Burd 1995). Wide-scale adoption of this 'managed retreat' and the consequent setting-back of coastlines has major potential to increase the extent of wader feeding and breeding habitats and thus offset historical habitat losses.

Disturbance from extractive and other commercial activity

The effects of shell-fisheries have been highly disruptive (disturbing) to the distributions of waterfowl in many European coastal areas. In particular, recent attention has focussed on the severe over-exploitation of Cockles *Cardium* spp. and other bivalve molluscs in the Dutch Wadden Sea, which has led to population impacts on Oystercatchers *Haematopus ostralegus* and Eider *Somateria mollissima.* These impacts are currently being addressed through revised national shell-fishing policies in The Netherlands, but the area is politically highly sensitive.

Disturbance of waterbirds from military activities

Many European coastal areas are used for military training. Some of these activities can be highly disturbing. Some of the disturbance effects on waders of shooting and low-flying in the Dutch Wadden Sea and Delta areas have been reviewed by Smit & Visser (1993) and Koolhaas *et al.* (1993).

Wind turbines

Wind turbines have the potential to be disturbing to waterfowl, especially if situated close to or in traditionally used flight paths. Crockford (1992) reviewed literature on wind turbine impacts and possible means of reducing these. As with other disturbing factors, the assessment of the potential effects caused by wind turbines is hindered by a general lack of well-designed studies. Such studies that have been undertaken emphasise the importance of turbine design and siting in a local context in order to minimise environmental impacts.

Shooting disturbance

The disturbing effects of shooting activity has been the subject of much recent study in Europe, albeit mostly directed at assessing effects and impact on wildfowl rather than wader populations (Owen 1993). There are clearly both direct effects, through mortality of target species, and indirect effects, such as changes to behaviour (increased escape flight distances) and site selection leading to distribution effects at the scale of the population (Owen 1993). Madsen & Fox (1995) have recently published an exhaustive review of the various causes and consequences of hunting disturbance on waterbirds, especially exploring the evidence for impacts on population dynamics, so this area will not be considered in detail here.

Recent Danish experimental studies have also demonstrated how the effects of shooting disturbance can be reduced or mitigated through the creation of adequate refuge areas (Madsen 1993, 1995). Madsen's studies have shown that by the creation of just two no-shooting refuges, two of the most important sites for coastal waterfowl in Denmark have been created with a consequent doubling of national autumn staging numbers of both Wigeon *Anas penelope* and Shoveler *A. clypeata*. Indeed, not only has the refuge creation increased the number of target species, but there have also been increases in numbers of non-target species, together with an increase in overall waterfowl species diversity.

Other recreational disturbance

There is a wide variety of types of and extent of disturbance to European waterfowl from human recreational activity, including wildfowling. These activities include horse riding in coastal areas, walking and dog-walking (e.g. Kirby *et al.* 1993), bait-digging (Townshend & O'Connor 1993), sand yachting, jet skiing and the effects of inshore sailing boats. Keller (1995) published an extensive review of the literature (between 1965-1994) concerning the effects of disturbance on birds.

Towards some possible solutions

There have been about as many approaches to the mitigation of disturbance as there are types of disturbing activity. Conceptually these approaches can be summarised considering the scales of response in the light of responses that target either species or habitats (Figure 1).

International treaties and legislation place a variety of relevant obligations on signatory governments. In the context of disturbance, the most obvious is the obligation accepted by Contracting Parties to the Ramsar Convention (which includes all coastal European States) to promote the "wise-use" of wetlands within their territories. (Note that this obligation to use wetlands wisely (or sustainably) extends beyond listed Ramsar sites to *all* wetlands, whether or not they are individually of international importance). Some of the many examples of wise-use, and guidance to Ramsar Contracting Parties are given by Davis (1993).

Other habitat based measures to reduce disturbance to waterfowl include those requirements under the EC Birds Directive (EC/409/79) to establish national (and thus international) networks of 'Special Protection Areas' (Stroud *et al.* 1990; Davidson & Stroud in press). Similar site-protection provisions exist under other treaties also (Figure 1).

International legislation is also directed at species conservation and in particular the EC Birds Directive provides for close regulation of target species, hunting season (e.g. forbidding hunting of birds on spring migration), and modes of hunting (*e.g.* forbidding hunting from mobile boats and other vehicles).

Additional to international legislation, there are also national legislative requirements which are relevant. For European Union countries, much national legislation enacts requirements established by international treaty. Thus in the UK, the 1981 Wildlife and Countryside Act (the principle legislation relating to the conservation of sites and species) was enacted to establish the requirements of the 1979 EC Birds Directive in national law. There may be further relevant provisions at a national level relevant to the restriction or management of waterfowl disturbance.

In the UK, for example, the Wildlife & Countryside Act enables temporary suspension of shooting during 'emergency periods'. This provision has been used to establish a system to suspend wildfowling in periods of prolonged severe winter weather, when waterfowl are energetically highly stressed and thus especially susceptible to the consequences of hunting and other disturbance (Stroud 1992).

Many European states with provincial governments (*e.g.* Germany and Spain) may have further regional (*i.e.* sub-national) legislation relevant to both species and habitats.

Much of the effective management of disturbance takes place at a local or site-level, and here different countries have a wide variety of potential mechanisms. In the UK, bylaws (local laws) can be passed to restrict the location, timing or extent of disturbing activities such as bait-digging (*e.g.* Townshend & O'Connor 1993). Likewise many protected areas will have more restricted areas managed as refuges or with restricted access. Finally, there is a great variety of non-statutory measures, from the establishment of nature reserves by non-governmental organisations through to the agreement of code of conduct with interest groups whose activities may be disturbing to waterfowl (see below).

Thus there is a general 'cascade' of complementary actions. At the international scale, treaties and conventions establish principles and set obligations for their state parties. These generalities are progressively worked through in greater detail down to local levels (where of course the birds are!).

Conclusions

European approaches to managing waterfowl disturbance have highlighted several key areas that may be of wider applicability.

Environmental impact assessments

All major activities which have the potential to be disturbing (e.g. land claim proposals, barrages, wind turbines, and creation of new recreational infrastructure such as marinas) should be the subject of sound Environmental Impact Assessments. Practise has shown that it is easier to avoid or mitigate disturbing impacts on waterfowl at the earliest, planning stages of a project (when there is still flexibility in project design or activity) rather than in later stages of implementation when scope for project modification may be especially constrained. Environmental Impact Assessments should conform to high standards of scientific quality and independence. Some major problems in this regard have recently been reviewed by Treweek (1996).

Well-documented case studies

Disturbance is frequently addressed within conservation casework, yet only rarely is the knowledge gained published so that lessons about successful (and unsuccessful!) solutions can be disseminated. Given the ever restricted funding for applied ecology, it is particulary important that all opportunities are taken to benefit from lessons arising from conservation casework. In this regard it is important that projects which have the potential to be disturbing are well monitored and reported so that others can draw conclusions from attempted mitigation approaches (e.g. Davidson & Evans 1987). The studies of Hötker *et al.* (1994) and Hötker (1994) are especially good examples of how broad conclusions concerning the effectiveness of attempted mitigation can be derived from well monitored conservation case studies.

In 1993 the International Wader Study Group published papers deriving from a seminar attended by nature conservation practitioners with an interest in waterfowl disturbance issues. The pooling of expertise at the seminar and the resultant publication (Davidson & Rothwell 1993a) have been extremely valuable in stimulating more consideration of these issues. Indeed, the studies presented have been widely cited in relevant conservation casework since 1993. There would be great advantages in promoting such an approach elsewhere.

International best practise guidelines

Following from the need to review and report knowledge are the benefits of publishing 'best practise' guidance for those dealing with disturbance issues. Indeed, one of the requirements of the Action Plan of the African-Eurasian Waterbird Agreement is the production of "Conservation Guidelines" which address many of the issues summarised in the first part of this

Figure 1

Conceptual framework indicating different scales of intervention in managing or reducing disturbance to waterfowl populations in Europe. Generally the different approaches are complementary.

International legislation	**Habitat based**	**Species based**
EC Birds Directive	Special Protection Areas	Regulation of: Quarry species, time of hunting, modes of hunting
African-Eurasian Waterbird Agreement	National/international protected site network	Regulation of: Quarry species, time of hunting, modes of hunting
Ramsar Convention	Wise-use requirements International co-operation in wetland management	Wise-use requirements International co-operation in species management
Berne Convention [1]	National/international protected site network	Regulation of: Quarry species, time of hunting, modes of hunting
Biosphere Reserves [2]	Zoning of land-use activity	
National legislation	Nationally protected sites and nature reserves	National hunting/taking laws: may further restrict time/mode of hunting or quarry spp. (*e.g.* enabling cold weather shooting bans)
Regional (sub-national) regulations and laws	Regionally protected sites	Further restrictions possible within international/national frameworks
Local regulations	Bylaws - restrictions on certain activities e.g. sand-yachting, cockling, bait-digging, low-flying avoidance areas, etc. Refuge areas Local planning to avoid key habitats/areas.	
Non-statutory measures	Other local nature reserves	Codes of conduct: Jet-skis, Hunters, Birdwatchers

[1] **Convention on the conservation of European wildlife and natural habitats; 1979**

[2] **Reserves designated under the UNESCO Man and Biosphere programme.**

paper. These will give guidance on best practice which will be of value not only to the state parties to the Agreement, but also to many other wetland managers and users.

In April 1996, the British Ornithologist's Union and Wildfowl & Wetlands Trust held a seminar on waterfowl disturbance issues. It is intended to distil the information presented at that meeting and from other studies into a manual of principles and practise concerning waterfowl disturbance from recreation (Davidson *et al.* in prep.; *c.f.* Merritt 1994).

Strategic guidance to mitigate disturbing activity

One specific aspect of best practise guidance is that relating to strategic guidance in situations where damaging or disturbing activities have to be undertaken, but where there is flexibility as to when and/or where these activities take place. A good example from the marine environment is the series of atlases of sensitive areas produced by JNCC's Seabirds and Sea Team and others (Tasker et al. 1990; Carter *et al.* 1993; Webb *et al.* 1995). These reports summarise extensive offshore ornithological surveys. Results are presented as a series of monthly maps highlighting those areas that are most and least sensitive for marine and coastal birds at that time of year. This allows those operating at sea, especially the offshore oil industry, to plan to undertake high risk activities at times of year or in locations where there is least risk to vulnerable marine or coastal birds.

The examples above relate especially to the marine environment. However, the approach has been taken further in the UK with the publication of a series of regional directories of data and information relating to all aspects of the coastal environment (*e.g.* Barne *et al.* 1996). These summarise sources of information (including those related to breeding and wintering waterfowl) in a way that may be easily used by those making planning or policy decisions concerning specific areas of coastline. The approach has been widely commended and is suitable for adoption elsewhere.

Partnerships to limit disturbance

It is the experience at many places in Europe that it is easier (and in the long-term, more effective) to seek voluntary co-operation with those undertaking disturbing activities, than it is to coerce or attempt formally to restrict such activity. Many interest groups which undertake disturbing activity are often willing to modify their activities in ways to reduce disturbance if the problems are explained. Such voluntary restriction of disturbing activity can be formalised into codes of guidance prepared by, and with, representative groups. These codes seek to limit unintended consequences of disturbing recreational activities. For example, in the UK there are codes of guidance drawn up by the representative bodies of wildfowlers and jet skiers which aim to educate participants in these sports and promote good behaviour that will limit unnecessary disturbance.

The promotion of this voluntary principle can be highly successful, especially in engaging those undertaking potentially disturbing activities to think more widely about the consequences of their actions for other aspects of the environment (Kirby *et al.* 1993; Nicolle 1995). This is not always possible, however, where major economic interests are involved.

Refuge areas

The importance of disturbance free refuge areas has been highlighted above. To be effective, there is a need to address all relevant forms of disturbance and not just target certain activities. For example, there is little point in establishing a refuge from hunting disturbance if the same site is highly disturbed by walkers or horse-riders. Fox (in press) has recently reviewed waterfowl refuge design considerations from a theoretical view and thus has highlighted elements of best practise in refuge creation.

Summary

Solutions to the problem of waterfowl disturbance have been sought at a number of scales: countries of the European Union are bound by the EC Birds Directive, which requires, *inter alia,* the designation of Special Protection Areas for migratory birds. The Directive also regulates, at

European level, those species which may be hunted, the time of year at which hunting may take place, and modes of hunting which are forbidden. Other international Conventions such as Ramsar and Bonn (especially the African-Eurasian Waterbird Agreement - AEWA) also contain relevant obligations.

Whilst these international treaties give broad frameworks and overall management goals (*e.g.* Ramsar's requirement for the wise-use of wetland and waterfowl resources), all European countries have additional legal measures at national, sub-national (regional), and local levels. These add more specific legal requirements, usually going beyond the controls specified by international treaties. The final tier of this hierarchy are non-statutory measures such as the creation of voluntary nature reserves or the development of codes of conduct with other wetland user groups.

In all of the above, however, practical application may differ widely from legal aspirations!

References

Barne, J.H., Robson, C.F., Kaznowska, S.S., Doody, J.P., Davidson, N.C. & Buck, A.L. eds. 1996. *Coasts and seas of the United Kingdom. Region 10 South-west England: Seaton to the Roseland Peninsula.* Peterborough, Joint Nature Conservation Committee. (Coastal Directory Series).

Burd, F. 1995. *Managed retreat: a practical guide.* English Nature, Peterborough, UK.

Carter, I.C., Williams, J.M., Webb, A. & Tasker, M.L. 1993. *Seabird concentrations in the North Sea: an Atlas of vulnerability to surface pollutants.* JNCC, Aberdeen. 39 pp.

Crockford, N.J. 1992. *A review of the possible impacts of wind farms on birds and other wildlife.* JNCC Report No. 27. Joint Nature Conservation Committee, Peterborough.

Davidson, N.C. & Evans, P.R. 1987. Habitat restoration and creation: its role and potential in the conservation of waders. *Wader Study Group Bull.* 49, *Suppl./IWRB Special Publ.* 7: 139-145.

Davidson, N.C. & Rothwell, P.I. 1993a. Disturbance to waterfowl on estuaries. *Wader Study Group Bull.* 68, *Special Issue.* 106 pp.

Davidson, N.C. & Rothwell, P.I. 1993b. Human disturbance to waterfowl on estuaries: conservation and coastal management implications of current knowledge. *Wader Study Group Bull.* 68: 97-105.

Davidson, N.C. & Stroud, D.A. in press. Conserving international coastal habitat networks on migratory waterfowl flyways. *J. Coastal Conservation.*

Davidson, N.C., Laffoley, D. d'A., Doody, J.P., Way, L.S., Gordon, J., Key, R., Drake, C.M., Pienkowski, M.W., Mitchell, R., & Duff, K.L. 1991. *Nature conservation and estuaries in Great Britain.* Nature Conservancy Council, Peterborough. 422 pp.

Davis, T.J. (ed.) 1993. *Towards the wise use of wetlands.* Ramsar Convention Bureau. 180 pp.

Finlayson, M. & Moser, M. 1992. *Wetlands.* Facts on File, Oxford. 224 pp.

Fox, A.D. in press. [Refuge design] *J. Applied Ecology*

Goss-Custard, J.D. & Yates, M.G. 1992. Towards predicting the effects of saltmarsh reclamation on feeding bird numbers on the Wash. *J. Applied Ecology* 29: 330-340.

Goss-Custard, J.D., Clarke, R.T., Durell, S.E.A. le V. Dit, Caldow, R.W.G. & Ens, B.J. 1995. Population consequences of winter habitat loss in a migratory shorebird. II. Model predictions. *J. Applied Ecology* 32: 337-351.

Hötker, H. 1994. Wadden Sea birds and embankments - can artificial wetlands compensate for losses due to land claims? *Ophelia Suppl.* 6: 279-295.

Hötker, H. Bruns, H.A. & Kölsch, G. 1994. Die Nordstrander Bucht nach der Eindeichung - Naturschutz, Habitat Management und Entwicklung der Vogelbestände. [The Nordstrand Bay after the land claim - nature conservation, habitat management and development of bird populations.] *Berichte zum Vogelschutz* 32: 84-96. (In German).

Julien, B. 1996. Integrated management of the European coastal zone. Pp. 5-22. *In*: *Studies in European Coastal Management.* P.S. Jones, M.G. Healy & A.T. Williams (eds). Samara Publishing, Cardigan, UK.

Keller, V. 1995. Auswirkungen menschlicher Störungen auf Vögel - eine Literaturübersicht. *Der Ornithologische Beobachter* 92: 3-38.

Kirby, J.S., Clee, C. & Seager, V. 1993. Impact and extent of recreational disturbance to wader roosts on the Dee estuary: some preliminary results. *Wader Study Group Bull.* 68: 53-58.

Koolhaas, A., Dekinga, A. & Piersma, T. 1993. Disturbance of foraging Knots by aircraft in the Dutch Wadden Sea in August-October 1992. *Wader Study Group Bull.* 68: 20-22.

Madsen, J. 1993. Experimental wildlife reserves in Denmark: a summary of results. *Wader Study Group Bull.* 68: 23-28.

Madsen, J. 1995. Impacts of disturbance on migratory waterfowl. *Ibis* 137: S67-S74.

Madsen, J. & Fox, A.D. 1995. Impacts of hunting disturbance on waterbirds - a review. *Wildlife Biology* 1: 193-207.

Meire, P.M. 1993. *Wader populations and macrozoobenthos in a changing estuary: the Oosterschelde (The Netherlands).* PhD thesis, University of Gent; Institute of Nature Conservation, Hasselt, Report no. 93.05. 31 pp.

Meire, P.M. & Meininger, P. 1993. Changes in wader populations at the Slikken van Vianen (Oosterschelde NL.) after major environmental changes (1976-1990). Pp. 115-139. *In*: Meire (1993).

Merritt, A. 1994. *Wetlands, industry & wildlife, a manual of principles and practise.* Wildfowl & Wetlands Trust, Slimbridge, UK. 182 pp.

Nicolle, P. 1995. Shooting ahead with coastal initiatives in the UK. Pp. 91-96. *In*: *Directions in European Coastal Management.* M.G. Healy & J.P. Doody (eds). Samara Publishing, Cardigan, UK.

Norris, K. & Buisson, R. 1994. Sea-level rise and its impact upon coastal birds in the UK. *RSPB Conservation Review* 8:63-71.

Owen, M. 1993. The UK shooting disturbance project. *Wader Study Group Bull.* 68: 35-46.

Rackham, O. 1986. *The history of the countryside.* Dent, London. 445 pp.

Schekkerman, H., Meininger, P.L. & Meire, P.M. 1993. Changes in the waterbird populations of the Oosterschelde, S.W. Netherlands, as a result of large scale coastal engineering works. *Hydrobiologia*

Smit, C. & Visser, G.J.M. 1993. Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Seas and Delta area. *Wader Study Group Bull.* 68: 6-19.

Stroud, J.M. 1992. *Statutory suspension of wildfowl in severe weather: review of past winter weather and actions.* JNCC Report No. 75. Joint Nature Conservation Committee, Peterborough.

Stroud, D.A., Pienkowski, M.W. & Mudge, G.P. 1990. *Protecting internationally important bird sites: a review of the* *network of EC Special Protection Areas in Great Britain.* Nature Conservancy Council, Peterborough.

Tasker, M.L., Webb, A., Harrison, N.M. & Pienkowski, M.W. 1990. *Vulnerable concentrations of marine birds west of Britain.* Nature Conservancy Council, Peterborough. 45 pp.

Townshend, D.J. & O'Connor, D.A. 1993. Some effects of disturbance to waterfowl from bait-digging at Lindisfarne National Nature Reserve, north-east England. *Wader Study Group Bull.* 68: 47-52.

Treweek, J. 1996. Ecology and environmental impact assessment. *J. Appl. Ecol.* 33: 191-199.

Webb, A., Stronach, A., Tasker, M.L. & Stone, C.J. 1995. *Vulnerable concentrations of seabirds south and west of Britain.* JNCC, Peternborough. 47 pp.

Part III

Frameworks for Flyway Conservation

The Successes and Challenges of Establishing a Shorebird Conservation Program in the Americas

Ian Davidson

An Overview

The Western Hemisphere Shorebird Reserve Network (WHSRN) is a voluntary collaboration of government and private organizations that are committed to shorebird conservation. WHSRN gives international recognition to critically important shorebird sites and promotes cooperative management and protection of these sites as part of an international reserve network.

WHSRN was launched in 1985 by the World Wildlife Fund, the International Association of Fish and Wildlife Agencies, and the Academy of Natural Sciences of Philadelphia, in response to research which indicated significant declines in shorebird populations.

During migration, shorebirds depend on a chain of critical wetland sites strategically located along their flyways extending from the Canadian high arctic to Tierra del Fuego in southern Argentina. The diminished ecological function of just one of these critical sites could have disastrous affects on specific shorebird populations or even entire species. WHSRN identifies these areas and seeks to work together with wildlife agencies, land owners, private conservation groups and others to help ensure the conservation of shorebirds and shorebird habitats.

As of 1994, WHSRN has designated 25 internationally important reserves throughout the Western Hemisphere, offering protection for approximately 30 million shorebirds and over 4 million acres of wetlands. WHSRN uses shorebirds as a symbol of the intense conservation challenge facing wetlands and of the need for international cooperation in the protection of these areas.

Ian Davidson, Wetlands International, Americas, 7 Hinton Ave., N. Suite 200, Ottawa, Ontario, Canada

Introduction

The Western Hemisphere Shorebird Reserve Network (WHSRN) links wetland and grassland sites essential to migratory shorebirds in a voluntary, collaborative effort for habitat management and protection. Shorebirds migrate across the hemisphere, some from the Arctic to Tierra del Fuego. Their movements carry them through wetlands with immense natural value to wildlife and to humans alike. The Network uses shorebirds as symbols of the intense conservation challenge that wetlands face and of the need for international cooperation in the protection of these areas.

Launched in 1985 through the efforts of the World Wildlife Fund (WWF), the International Association of Fish & Wildlife Agencies (IAFWA), and the Academy of Natural Sciences of Philadelphia (ANSP), the Network brings together wildlife agencies, private conservation groups, and other organizations to solve conservation challenges faced by migratory shorebirds and, fundamentally, the habitats in which they live.

The Conservation Need

Shorebirds depend upon the continuing viability of critical habitats along their annual migratory route for breeding, stopover, and wintering sites. They concentrate in great numbers in a few essential and irreplaceable locations along these pathways. At times, large percentages of entire populations gather at a single place. These concentrations place enormous numbers of birds, even whole populations, at risk from environmental threats and habitat loss. Research conducted over the last eighteen years by the Manomet Bird Observatory (MBO), the U.S. Fish and Wildlife Service (USFWS), the Canadian Wildlife Service (CWS), the Point Reyes Bird Observatory (PRBO) and other organizations, has established these facts of shorebird biology and revealed alarming declines in their populations.

Many of the wetlands and grasslands essential for shorebirds have been diverted from their natural state for construction, commerce, agriculture, and recreation. Studies from the USFWS show that 50 percent of the original U.S. wetlands have been destroyed or reclaimed. In many parts of southern Canada, destruction of wetlands is approaching 30 percent.

Losses in many specific regions within the United States have been much greater. For example, by 1938 mosquito-control programs had affected almost 90 percent of wetlands between Maine and Virginia, over two-thirds of California's coastal wetlands have been developed, and the system of barrier islands along the coasts of New Jersey and Delaware has largely been given over to densely populated beach resorts. Wetland habitats in Texas and Florida now follow similar paths.

While comparable data from Central and South America on wetland habitat loss are unavailable, the same general trends prevail. Agriculture encroaches upon coastal saline marshes and grasslands. Human populations expand rapidly into the wetland oases of desert Peru, Chile, and Argentina. Widespread, unregulated pesticide applications enter soils and waters. New demands for enhanced transportation lead to dredging, filling, and other types of wetland destruction. Human encroachment, such as industrial complexes, airports built on filled mud flats, prawn and shellfish aquiculture, impinge increasingly on critical habitats. These developments all threaten wetland habitats of immense natural value, not only for wildlife but for the human environment as well for their roles in watersheds, as nurseries for fisheries, and as a place for enjoyment and recreation.

Why A Network?

For many shorebird populations, critical sites extend in a chain from arctic breeding grounds to wintering sites in South America. As with any chain, the system as a whole is only as strong as its weakest link. The Network highlights the key roles that particular sites throughout the hemisphere play in maintaining that chain. By joining the Network, a site gains explicit acknowledgement of its participation in a hemisphere-wide effort. The Network offers support to local wetland conservation initiatives by providing recognition for the importance of member sites in international shorebird migration.

Membership in the Network and participation in its projects are wholly voluntary; management authority and priorities remain the prerogative of the land administrator. The Network's success depends upon the involvement of those in wildlife agencies, park systems, governments, and private groups that own and manage wetlands. These are the key individuals and organizations whose decisions control the future of wetland habitats.

At the same time, the Network enlists the participation of the scientists and conservation groups who are carrying out research on shorebird migration and habitat. Their involvement addresses two essential needs: (1) to examine the roles that different sites play in shorebird migration and thereby identify sites for network participation, and (2) to evaluate management options that can maintain and enhance the value of local wetlands for shorebird migration.

Network Goals

The Network works to achieve five main goals:

I. Protect sites critical to the Western Hemisphere's migratory shorebirds;
II. Promote and support the development of strong conservation organizations and their efforts to protect shorebirds and shorebird habitats;
III. Build strong public support for wetlands and shorebird conservation through education and public awareness;
IV. Develop and support international, national, and local policies to help ensure the long term protection and management of the hemisphere's migratory shorebirds and critical wetlands;
V. Compile, improve, and disseminate information on shorebird distribution, migration, habitat, and biology in the Western Hemisphere.

Becoming A Reserve

Participation in the network is wholly voluntary both in nomination and in management. To be recognized as a network reserve, the area must meet biological criteria establishing its importance to shorebirds and then it must be nominated by the individuals, organizations, or agencies responsible for management of the area.

Reserve membership in the Network is not incompatible with participation in other national or international conservation programs. On the contrary, it is encouraged. For example, the USFWS has nominated a long list of National Wildlife Refuges, as has the Instituto Forestal y de Fauna of Peru for several of its National Reserves. Similarly, National Audubon and The Nature Conservancy (TNC) have both nominated sanctuaries in their systems as Network members. Many of the designated and potential WHSRN sites in the Americas correspond with Important Bird Areas: a program that is growing throughout much of the region.

Biological Criteria For Reserve Membership

WHSRN member reserves are voluntarily designated by their owners or managers for participation in the Network. Sites fall into four categories: Hemispheric, International, Regional, and Endangered Species Reserves:

Hemispheric Reserves host at least 500,000 shorebirds annually or 30% of a species' flyway population.

International Reserves host 100,000 shorebirds annually or 15% of a species' flyway population.

Regional Reserves host 20,000 shorebirds annually or 5% of a species' flyway population.

Endangered Species Reserves are critical to the survival of endangered species and no minimum number of birds is required.

In cases where shorebird species are spread out over a vast space and do not concentrate in high densities in localized areas, WHSRN works with land owner(s) under the Stewardship Program.

The Network Council

The Network Council is in place to stimulate development of the network and to oversee functions related to the network on behalf of the established system. The Council provides guidance to WHSRN staff in working with relevant government agencies and land management authorities responsible for important shorebird habitats, reviews nominated sites, and ratifies their nomination. It also provides a focal point for disseminating information on shorebirds and their habitats. The Council meets biannually or more frequently as needed and shall remain manageably small in the interests of efficiency. Participants in the Council represent a mix of biological and administrative knowledge.

WHSRN: On The Ground

In 1980, the United Nations Education, Scientific and Cultural Organization (UNESCO) and the Ramsar Convention identified wetlands as "the most endangered ecosystem globally". Yet wetland conservation in Central and South America is generally still overlooked today. Shortages of trained personnel, lack of primary information, and inadequate international support for addressing this issue contribute to this situation.

It's very clear that the future of Neotropical conservation lies in the hands of those living on or near the area. For this reason, WHSRN has co-developed workshops and training programs in the Neotropics. Two types of workshops are offered in each country: one for biologists and one for policy makers.

Training has two tangible benefits. First, scientists and students develop the biological skills necessary to gather data essential for guiding the Network programs and growth. Second, managers and policy makers are provided information and mechanisms addressing the problem of wetlands conservation in each country. For all, education establishes and reinforces commitment by building networks for grassroots support. WHSRN works in close cooperation with governmental and non-governmental organizations in each country to organize workshops. Through workshops, the preparation of action plans, the provision of small grants for needed studies and the designation of national coordinators, are all accomplished with primary involvement of people from participating countries.

Land stewardship, including management practices are critical to the effectiveness of WHSRN as a tool for promoting shorebird conservation. In Canada for example, the Network has worked to secure Dorchester Cape (Bay of Fundy), an Internationally recognized coastal wetland vital to the survival of several species, including the Semipalmated Sandpiper. Here, in July and August, on a small stretch of beach at the head of the Bay of Fundy, close to a million Semipalmated Sandpipers and other shorebirds congregate to feed on huge quantities of small invertebrates to fuel a remarkable non-stop migration to their wintering areas in Surinam - located 4,000 kilometres to the south. The loss of these critical feeding grounds would be devastating to migrating populations. Funds for promoting land stewardship and acquisition of key properties within target areas have been obtained through the support of governments and NGOs. Although some lands have been purchased, many other properties are not available. It is here that WHSRN and its partners work to ensure land owners are cognizant of the property's biological significance and the need to ensure long-term conservation of these sites. Community involvement is strongly encouraged and promoted through local meetings and the delivery of information targeted to landowners.

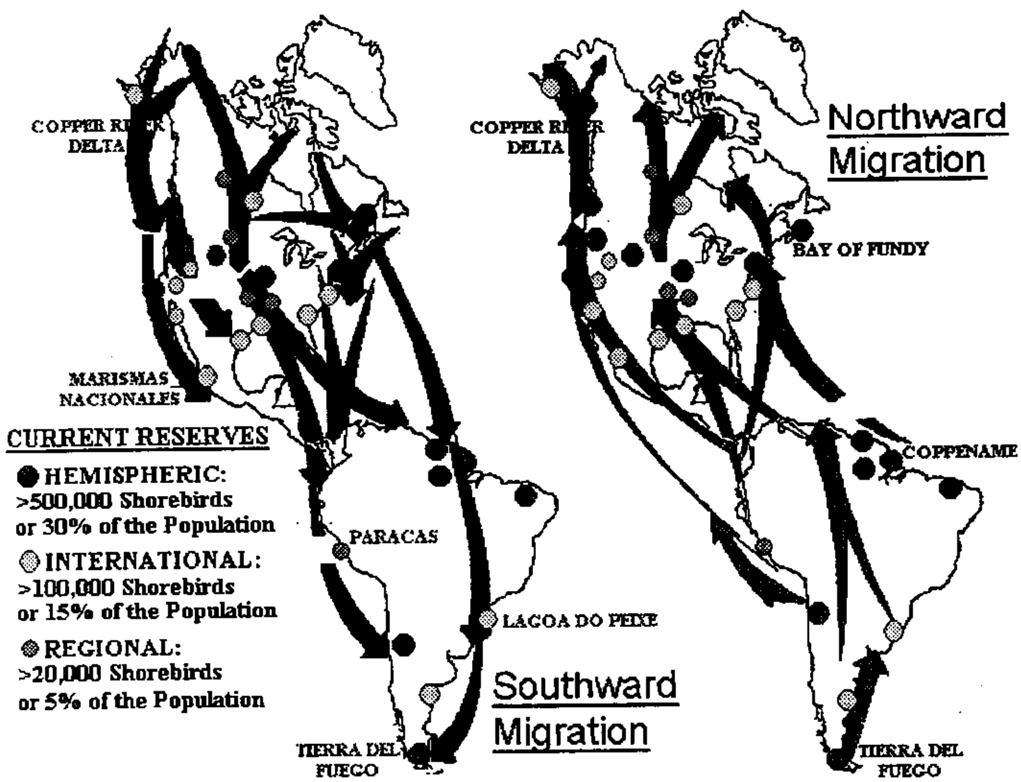
WHSRN As A Model

WHSRN is the first program to successfully link wetland habitats throughout the Americas by drawing attention to the collective importance of a variety of sites to individual species migrating the length and breadth of the Americas.

The key to this success has been the voluntary basis for the program. Conservation activities at each site depend on the interest of the stakeholders who promoted a site's nomination to the network. This successful approach places the owness on the landowners and land managers to initiate conservation activities. WHSRN provides follow-up by providing expertise, facilitating linkages, developing and seeking support for funding, and promoting the issues regionally, nationally and internationally.

As WHSRN enters the next millennium, it must continue to build upon and establish new partnerships within and between countries to ensure that a cooperative approach is ensured. Development of a similar initiative in Asia bode well for the eventual establishment of a Global Shorebird Network that will help to bridge the continents and truly provide conservation coverage for these remarkable "wind birds".

Ultimately, the true test of initiatives like WHSRN will be the viable and indeed healthy existence of shorebird populations worldwide.



The African-Eurasian Migratory Waterbird Agreement; a Technical Agreement under the Bonn Convention

Gerard C. Boere and Bert Lenten
AEWA interim secretariat, c/o Department of Nature Management, P O Box 20401, 2500 EK The Hague, The Netherlands

1. Introduction And Perspective

Throughout history animals have been migrating. Many animals migrate in response to biological requirements, such as the need to find a suitable location for breeding and raising their young, and to be in favourable areas for feeding, in which to feed at other times of the year. In some cases, these specific requirements are fulfilled in locations separated by distances of thousand of kilometres.

During their migration these animals cross political boundaries between nations; boundaries that have no inherent meaning for animals, but which have a dramatic influence on their annual life-cycles and their individual survival chances due to the great differences that exist between countries in conservation policy. Migratory species are dependent on the specific sites they find at the end of their journey and along the way. Increasingly these sites are threatened by man-made disturbances and habitat degradation. Migratory animals may also fall victim to adverse natural phenomena such as unfavourable climatic conditions.

The above-mentioned influences are aggravated by the fact that it has long been held that migratory species legally do not fall within the jurisdiction of one particular country which could be held responsible for any harm occurring to them.

In 1972 the United Nations Conference on the Human Environment recognised the need for countries to co-operate in the conservation of animals that migrate across national boundaries or between areas of national jurisdiction and the high seas. This recommendation resulted in the Convention on the Conservation of Migratory Species of Wild Animals, commonly referred to the Bonn Convention (after the German city where it was concluded in 1979). It came into force in 1983. The goal of the Convention is to provide conservation for migratory terrestrial, marine and avian species over the whole of their range. This is very important, because failure to conserve these species at any particular stage of their life cycle could adversely affect any conservation efforts elsewhere. The fundamental principle of the Bonn Convention therefore is that the Parties of the Bonn Convention acknowledge the importance of migratory species being conserved and of Range States agreeing to take action to this end whenever possible and appropriate, paying special attention to migratory species the conservation status of which is unfavourable, and taking individually or in co-operation appropriate and necessary steps to conserve such species and their habitat. Parties acknowledge the need to take action to avoid any migratory species becoming endangered. In particular, the Parties:

- shall endeavour to provide immediate protection for migratory species included in Appendix I;
- shall endeavour to conclude Agreements covering the conservation and management of migratory species included in Appendix II.

Agreements are the primary tools for the implementation of the main goal of the Bonn Convention. They are more specific than the Convention itself, involve more deliberately the Range States of the species to be conserved and are easier to put into practice than the whole Bonn Convention.

- 1902 Convention for the Protection of Birds Useful to Agriculture referred to the Paris Convention: ** This Convention did not mention migratory birds specifically.*
- 1960 Convention for the Protection of Birds, substituting the 1902 Convention of Paris;
- 1970 Benelux Convention on Hunting and Protection of Birds;
- 1979 The Directive of the Council of the European Economic Community on the Conservation of Wild Birds.
- Convention on the Conservation of Migratory Species of Wild Animals

Box 1: Short Historical Overview of treaties involving migratory birds.

2. A Brief Historical Overview

The African-Eurasian Waterbird Agreement under the Bonn Convention is not the first or only international agreement aiming at the conservation of migratory birds. An overview of historical and existing instruments has been published by S. Lyster in "International Wildlife Law" (1985). Besides the above mentioned Conventions, a number of bilateral conventions for example between Japan and U.S.A., the former U.S.S.R., Japan and Australia, etc. were concluded.

Fig 1. Map of the Agreement Area

After the first Conference of Parties of the Bonn Convention where it was decided to prepare an Agreement for the Western Palaearctic Anatidae in 1988 the Dutch Government began developing a draft Western Palaearctic Waterfowl Agreement as part of its Wester Palaearctic Flyway conservation programme. In 1991 a draft, including an Action Plan for ducks, swans and geese and a general Management Plan for all Waterfowl, was sent to the European Commission which offered to sponsor the Agreement. However, little progress could be made within the European Commission. In early 1993, the Bonn Convention secretariat, in close co-operation with the Dutch Government, again took the initiative. The text of the Agreement and related documents was updated, a stronger African component was incorporated and the name was changed into the African-Eurasian Waterbird Agreement (AEWA).

The first consultative meeting of Range States of AEWA was held in Nairobi in June 1994. The meeting strongly supported the concluding of AEWA, and consensus could be achieved on almost all matters of substance. In June 1995 the final negotiation meeting was held in The Hague. At this meeting sixty-four Range States and the European Union were represented. Several Inter Governmental and Non Governmental Organisations attended the negotiation meeting as observers.

The Meeting adopted by consensus the Agreement and accepted with appreciation the offer of the Government of the Kingdom of the Netherlands to act as Depositary and to provide, at its own expense until 1 January 1999, an Interim Secretariat and to host the first session of the Meeting of the Parties.

The Dutch Government, Ministry of Agriculture, Nature Management and Fisheries established per 1 January 1996.

The procedure for signing and ratifying the Agreement has been delayed because of problems with the Russian and Arabic translation of the Agreement text. In March 1996 these problems were solved including some minor linguistic problems with the English and French versions. Therefore it is now possible to open the Agreement for signature.

3. The African-Eurasian Waterbird Agreement

3.1 Structure of the Agreement

The African-Eurasian Waterbird Agreement has two parts, both of which are legally binding:

- Firstly the Agreement text, which describes the philosophy, legal framework and provisions;
- Secondly an Action Plan which describes the conservation actions that are to be taken. The Action Plan is at present restricted to geese, swans, ducks, spoonbills, ibises and storks.

The African-Eurasian Waterbird Agreement is the first regional Agreement of a vast area of 60 million square kilometres. It covers the entire continent of Africa and Europe, as well as parts of Asia and a few Arctic islands of north eastern Canada encompassing about 120 Range States (see Box 2 and Fig. 1) AEWA covers 170 species (see Box 3).

In implementing the Agreement, two Fundamental Principles have been agreed on:

1. Parties shall take co-ordinated measures to maintain migratory waterbird species in a favourable conservation status or to restore them to such a status;
2. In implementing the measures of paragraph 1, Parties should take into account the precautionary principle.

3.2 Conservation Measures to be taken

Based on the Fundamental Principles, Parties shall take General Conservation Measures. These measures include:

I. Parties shall take measures to conserve migratory waterbirds giving special attention to endangered species as well as to those with an unfavourable status;
II. To this end, the Parties shall:
   - Protect endangered migratory waterbird species in the Agreement Area by Strict Legal Protection;
   - ensure that any use of migratory waterbirds is based on sustainable use;
   - identify sites and habitats and encourage their protection, management, rehabilitation and restoration;
   - develop and maintain programmes to raise awareness and understanding of migratory waterbird conservation issues;
   - etc., etc.

3.3 Technical Committee

In the Agreement the establishment of a technical committee is foreseen. This technical committee shall comprise:

a) nine experts representing different regions of the Agreement Area;
b) one representative of the International Union for Conservation of Nature and Natural Resources (IUCN), one of Wetland International and one of the International Council for Game and Wildlife Conservation (CIC); and
c) one expert of each of the following fields: rural economics, game management, and environmental law.

The task of this committee is to provide scientific and technical advice and information, to make recommendations concerning the Action Plan and Agreement, etc., for the Meeting of the Parties.

3.4 Action Plan

The second Part of the Agreement is the Action Plan. This Action Plan specifies actions which Parties shall undertake in relation to priority species and issues, under the following headings, consistent with the general conservation measures:

a. species conservation;
b. habitat conservation;
c. management of human activities;
d. research and monitoring;
e. education and information; and
f. implementation.

3.4.1 Species conservation

The first group of actions is directed towards the conservation of species. It provides for legislation and law enforcement measures to be undertaken by Parties, development of programmes for emergency situation, both natural and caused by human activities, and the development of International Species Conservation plans for all threatened and vulnerable species of populations of waterbirds.

3.4.2 Habitat conservation

The second group of activities concerns the conservation of habitats and important sites. Parties shall endeavour to continue establishing protected areas and shall give special protection to wetlands of international importance. Furthermore, they will endeavour to make wise and sustainable use of all wetland, to avoid degradation or to restore or rehabilitate areas that are important to populations.

3.4.3 Management of human activities

The third group of activities is the management of human activities. One of the human activities is hunting. Parties shall cooperate to ensure that their hunting legislation implements the principle of sustainable use. In order to assess the annual harvest of populations, Parties shall cooperate with a view to developing a reliable and harmonised system for the collection of harvest data. Eco-tourism is another kind of human activity that may affect waterbird populations. Therefore Parties shall encourage eco-tourism, where appropriate, but not in core zones or protected areas.

3.4.4 Research, monitoring, education, information and implementation

Besides the above-mentioned groups of activities, research and monitoring is very important. Scientific research and monitoring of the migratory waterbird population can reveal population trends, point out priorities for protection activities and discover the reasons for unfavourable developments.

Algeria	Greece	Republic of Moldova
Andorra	Guinea	Romania
Angola	Guinea-Bissau	Russian Federation
Armenia	Hungary	Rwanda
Austria	Iceland	Sao Tome and Principe
Azerbaijan	Iran	San Marino
Bahrain	Iraq	Saudi Arabia
Belarus	Ireland	Senegal
Belgium	Israel	Seychelles
Benin	Italy	Sierra Leone
Bosnia-Herzegovina	Jordan	Slovakia
Botswana	Kazakhstan	Slovenia
Bulgaria	Kenya	Somalia
Burkina Faso	Kuwait	South Africa
Burundi	Latvia	Spain
Cameroon	Lebanon	Sudan
Canada	Lesotho	Swaziland
Cape Verde	Liberia	Sweden
Central African Republic	Libyan Arab Jamahiriya	Switzerland
Chad	Liechtenstein	Syrian Arab Republic
Comoros	Lithuania	The former Yugoslav
Congo	Luxembourg	Republic of Macedonia
Cote d'Ivoire	Madagascar	Tanzania
Croatia	Malawi	Togo
Cyprus	Mali	Tunisia
Czech Republic	Malta	Turkey
Denmark	Mauritania	Turkmenistan
Djibouti	Mauritius	Uganda
Egypt	Monaco	Ukraine
Equatorial Guinea	Morocco	United Arab Emirates
Eritrea	Mozambique	United Kingdom of
Estonia	Namibia	Great Britain and
Ethiopia	Netherlands	Norther Ireland
Finland	Niger	Uzbekistan
France	Nigeria	Yemen
Gabon	Norway	Yugoslavia
Gambia	Oman	Zaire
Georgia	Poland	Zambia
Germany	Portugal	Zimbabwe
Ghana	Qatar	European Commission

Box 2: List of Range States

Education and information is also a must. Without this kind of activities there will not be public awareness of the importance of conservation of migratory birds. In the long run this will negatively influence the acceptance of all the activities mentioned in the AEWA.

The Action Plan shall be reviewed at each ordinary session of the Meeting of the Parties. The first session will take place not later than one year after the date of the entry into force of this Agreement. Probably this meeting will be taking place in 1998.

4. Activities that already took place

Although the Agreement has not entered into force some actions have been taken already. After the establishment of the Interim Secretariat per 1-1-1996 the new secretary started with the normal activities needed for a secretariat such as to set up archives, databases, etc. Furthermore during several International Meetings introductions were given to promote AEWA.

A species conservation plan was made for the Greenland White-fronted Goose (*Anser albifrons*), financed by United Kingdom. Also species conservation plans were drafted for the Lesser White-fronted Goose (*Anser erythropus*), the Slender-billed Curlew (*Numenius tenuirostris*), Dalmatian Pelican (*Pelicanus crispus*), the Pygmy Cormorant (*Phalacrocorax pygmeus*), the White-headed Duck (*Oxyuara leucocephala*), the Marbled Duck (*Marmaronetta angustirostris*) and the Red-breasted Goose (*Branta ruficollis*). The drafting of these conservation plans was financed by the Council of Europe.

On initiative of the Trilateral Wadden Sea Conference 1994 a single species action plan for the Brent Goose (*Branta bernicla*) is under preparation. The Dutch Ministry of Agriculture, Nature Management and Fisheries, National Reference Centre for Nature will finance this project.

In close co-operation with the Dutch Reference Centre for Nature, the National Forest and Nature

Agency of Denmark will prepare a management for the Great Cormorant (*Phalacrocorax carbo*).

Wetland International will produce a Flyway Atlas for Migratory Anatidae Populations in the Western Palaearctic Region. The publication of this Atlas will take place in 1996. This project is funded by the Ministry of Agriculture, Nature Management and Fisheries of the Netherlands.

In accordance with the Programme for International Nature Management (1996-2000) of the Government of the Netherlands special attention is and will be given to wetlands and migratory birds in Western Africa.

5. Work programme for the Interim Secretariat

According to the Final act of the Negotiation Meeting AEWA (1995) the Meeting invited the Interim Agreement secretariat to prepare for the first Meeting of Parties a proposal concerning:

a) amendment of the Action Plan with regard to species or families listed in Annex II to the Agreement;

b) a review of the conservation status of populations covered by the Action Plan;

c) criteria related to emergency situations;

d) the Conservation Guidelines;

e) format for reports of the Parties;

f) a budget, financial rules, and other matters relating to the financial arrangements for the Agreement;

g) the establishment of the Technical Committee; and

h) a logo for the Agreement.

Gaviidae	Divers
Podicipedidae	Grebes
Pelecanidae	Pelicans
Phalacrocoracidae	Cormorants
Ardeidae	Bitterns, Herons, Egrets
Ciconiidae	Storks
Threskiornithidae	Ibises and Spoonbills
Phoenicopteridae	Flamingos
Anatidae	Whistling Ducks, Swans, Geese and Ducks
Gruidae	Cranes
Rallidae	Rails, Crakes, Gallinules and Coots
Dromadidae	Crab Plover
Recurvirostridae	Stilts and Avocets
Glareolidae	Courser and Pratincoles
Charadriidae	Lapwings and Plovers
Scolopacidae	Curlews, Sandpipers and Snipes
Laridae	Gulls and terns

Box 3: List of Species covered by AEWA

The Work program for the Interim Secretariat shows for the period 1996-1997 that priority will be given to prepare proposals for the above mentioned items b, c, d, e, and h. For the preparation of the Review of the conservation status of populations (b), and the Conservation Guidelines (d) Wetlands International will be contracted by the Interim Secretariat. The other issues will be addressed by the Secretariat itself.

6. Conclusion

It is widely felt that conclusions of the Agreement will strongly encourage international cooperation (surveys/research/habitat/protection/new reserves/changes in agricultural policies) between Africa and Eurasia.

In the future, AEWA will function as the governmental platform for integrated conservation and management on the whole Western Palaearctic Flyway. It is not new legislation but rather acts as a framework co-operation and coordination for conservation of a natural resource shared amongst 120 Range States. Currently it acts as an example for similar agreements in other flyways, such as that being prepared for the Asian Pacific Flyway.

The Kushiro Initiative
Development of a Flyway Approach to Migratory Waterbird Conservation in the East Asian-Australasian Flyway

Karen Weaver
Australian Fisheries Management Authority, Burns Centre, Barton, ACT 2600

Conventions and Agreements

Over the past two decades there has been increasing recognition by governments and non-government organisations of the need for international cooperation for the conservation. Governments have started to develop formal agreements for the conservation of migratory species and for specific habitat protection such as wetlands. The two most relevant conventions are the Ramsar Convention and the Bonn Convention.

The Ramsar Convention (Convention on Wetlands of International Importance especially as Waterfowl Habitat) has been developed as a multilateral treaty to promote wetland conservation (Ramsar 1997). In the East Asian-Australasian Flyway 15 of the 22 countries have joined this Convention. Over 30 wetlands of international importance for migratory shorebirds are presently listed under the Ramsar Convention (25 of these are in Australia).

The Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) came into force in 1983 (CMS 1997). This Convention is important because it provides a multinational framework for the conservation of migratory species. In Africa-Europe a formal intergovemental Agreement on waterbird conservation has been developed under this Convention. Presently, Australia and the Philippines are the only two countries in the East Asian-Australasian Flyway to have signed the Bonn Convention.

These two Conventions provide Governments with a formal framework to approach planning for the conservation of migratory shorebird on both the species and wetland habitat basis.

In addition to these two multilateral approaches to wetlands and migratory species conservation, seven countries in the East Asian-Australasian Flyway have developed nine bilateral agreements on the conservation of migratory birds (Table 1). Japan, for example, has bilateral agreements with four countries.

Table 1 Bilateral Agreements for Migratory Bird Conservation

Country	Aust.	China	Japan	K, R.	K, D.P.R	Russia	USA
Australia		Yes	Yes			Discuss	
China, P.R. of	Yes		Yes			Yes	
Japan	Yes	Yes		Discuss		Yes	Yes
Korea, R. of			Discuss			Yes	
Korea, D.P.R. of						Yes	
Russian Federation	Discuss	Yes	Yes	Yes	Yes		Yes
USA			Yes			Yes	

The formal intergovernment arrangement provided by these Conventions and Agreements have enabled Japan and Australia to take up a leadership role in promoting multilateral cooperation for the conservation of migratory waterbirds.

The Kushiro Initiative

At the Japan-Australia Migratory Bird Meeting in November 1993, the two governments agreed to convene a regional workshop to discuss the conservation of shorebirds in the flyway. In early 1994 a decision was made to broaden the agenda of the workshop to include all migratory waterbirds.

The workshop was held in Kushiro, Japan, over five days in December 1994. It was attended by 92 representatives of government and non-government organisations from 16 nations in the East Asian-Australasian flyway. The workshop produced a statement called the "Kushiro Initiative" which called for multinational cooperation to:

- determine priorities for action for the long term conservation of migratory shorebirds;
- identify critical sites and habitats used by migratory waterbirds and assist in management of these sites;
- determine and monitor population levels of species; and
- develop integrated research programs including those to understand the migration strategies and routes of populations.

The workshop recognised that in the absence of multilateral legal framework for the conservation of migratory waterbirds these issues should be addressed by the development of a conservation strategy for migratory waterbirds for the period 1996 - 2000. Key mechanisms identified for implementation of the strategy were the development of family-group Action Plans and Site Networks. These conservation actions were to be a cooperative effort between Government agencies and non-government organisations. The three lead organisations identified to advance Kushiro Initiative were identified as the Environment Agency of Japan, Environment Australia and Wetlands International.

During 1995 Wetlands International worked to coordinate the development of an Asia-Pacific Migratory Waterbird Conservation Strategy: 1996 - 2000 (Annon. 1996). This work was funded by the Environment Agency of Japan and the Environment Australia. The strategy calls for the development of individual action plans and site networks for shorebirds, cranes and Anatidae.

In addition to the development of planning documents the Strategy identifies the need for consultative committees to oversee the implementation of conservation action (Figure 1). Implementation of the Strategy in relation to migratory shorebirds will include:

- drafting of a Shorebird Action Plan
- development of a Shorebird Reserve Network
- establishment of a Shorebird Working Group.

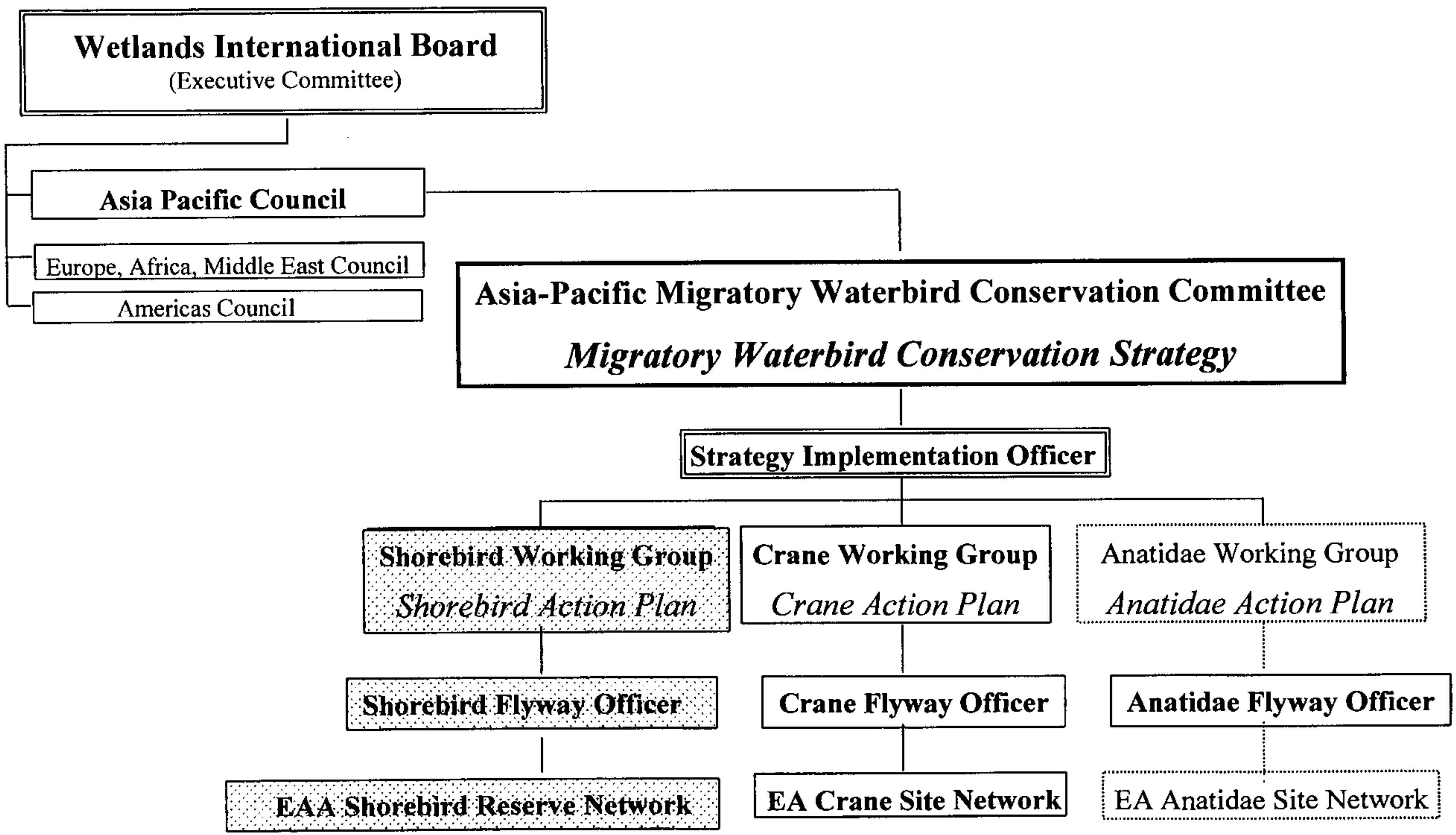
The Brisbane Initiative

In March 1996, at the Ramsar Conference of Parties in Brisbane, Australia and Japan jointly sponsored a recommendation calling on countries in the East Asian-Australasian Flyway to nominate sites for the Shorebird Reserve Network. This recommendation also recognised the development of the Asia-Pacific Migratory Waterbird Conservation Strategy: 1996-2000. The recommendation was accepted by the Conference (Rec. 6.4, Ramsar Bureau 1996). The recommendation was given effect with a launch ceremony during the Ramsar Conference that included 24 sites from 10 countries.

References

AEWA. 1997. Agreement on the Conservation of African-Eurasian Migratory Waterbirds. http://www.wcmc.org.uk:80/~cms/english/cms_saew.html.

Figure 1 Implementation of the Asia-Pacific Migratory Waterbird Conservation Strategy: 1996-2000



Anonymous. 1996. *Asia-Pacific Migratory Waterbird Conservation Strategy: 1996-2000*. Wetlands International - Asia Pacific, Kuala Lumpur, Publication No. 117, and International Waterfowl and Wetlands Research Bureau - Japan Committee, Tokyo.

Ramsar Bureau. 1996. Proceedings of the 6th Meeting of the Conference of Contracting Parties, Brisbane, Australia, 19 -27 March 1996. Vol 4/12 Resolutions and Recommendations. Ramsar Convention Bureau Gland, Switzerland.

Ramsar 1997. The Ramsar Convention on Wetlands. http://w3.iprolink.ch/iucnlib/themes/ramsar/index.html.

CMS. 1997. Convention on the Conservation of Migratory Species of Wild Animals. http://www.wcmc.org.uk:80/~cms/english/cms_body.html.

Part IV

Asia-Pacific Shorebird Action Plan

Developing an Action Plan for the Conservation of Migratory Shorebirds in the Asia-Pacific

Doug Watkins & Taej Mundkur

D. Watkins, Wetlands International-Oceania, Wetlands and Migratory Wildlife Unit, ANCA, GPO Box 636, Canberra, ACT 2601
T. Mundkur, Wetlands International-asia Pacific, Institute of Post Graduate Studies & Research, University of Malaya, Kuala Lumpur 50603

1.0 Background

At an international meeting at Kushiro, Japan in December 1994 it was agreed that there was an urgent need for multinational cooperation for the conservation of migratory waterbirds. The meeting recognised that that there was not a suitable international legal framework to develop conservation plans and called on Governments and non-government organisations to work in partnership to develop a regional conservation strategy (Wells and Mundkur 1996). In response an *Asia-Pacific Migratory Waterbird Conservation Strategy: 1996-2000* (the *Strategy*), has been developed (Anon. 1996).

The *Strategy* had been refined at regional workshops in Japan and Malaysia and was then launched at the Conference of Parties to the Convention on Wetlands of International Importance (Ramsar Convention) in Brisbane, Australia, in March 1996. Implementation of the *Strategy* is being coordinated by Wetlands International with funding from Environment Australia and the Environment Agency of Japan. Wetlands International has also undertaken to prepare a draft Action Plan for shorebirds in 1997.

2.0 Considerations in the development of an Action Plan

The *Strategy* is a forty page document that details 11 objectives and 49 action statements for the conservation of migratory waterbirds (Anon. 1996). These action statements are comprehensive in their scope and coverage of migratory waterbirds and their habitats.

However, the financial and human resources available to focus on shorebird conservation issues in the next five years are not sufficient to fully apply the *Strategy* to shorebirds. If a Shorebird Action Plan is to make a significant contribution during the 1996 - 2000 period it will need to select priority actions from the *Strategy* and develop these into a cohesive program.

The Action Plan must have a simplicity of approach that can deliver an integrated program of activities. It should draw on existing organisations and conservation activities. It must also capture the imagination of politicians, Government agencies, site managers, researchers, non-government organisations and if possible the general public.

3.0 Conservation through Networks of Important Sites

The *Strategy* identifies the development of networks of internationally important sites as a primary implementation mechanism for conservation actions. The development of Shorebird Reserve Networks will provide:

- an international recognition for important sites
- a focus for public awareness and education activities
- an international framework for public awareness and education, training and research activities
- an integrated conservation framework for Governments and funding bodies.

In March 1996 such a Network was launched for migratory shorebirds in the East Asian-Australasian Flyway. This Network at present involves 19 sites from 8 countries. The Shorebird Reserve Network is being coordinated by a Shorebird Flyway Officer engaged by Wetlands International with funding from Environment Australia (Watkins 1995).

The Shorebird Reserve Network could provide an ideal framework for the Shorebird Action Plan.

4.0 Focus on the East Asian-Australasian Flyway

The Asia-Pacific region contains three flyways for migratory shorebirds: Central Asia-Indian, East Asia-Australasian and the West Pacific.

In the East Asian-Australasian Flyway there is considerable documentation of the threats to shorebirds and their habitats, a significant knowledge base on populations and important sites and a number of organisational structures to implement actions. Information on shorebirds in the Central Asian-Indian Flyway is more limited and the organisational structures are not well developed. In the West Pacific Flyway, shorebirds are widely distributed in low abundance with little detailed information and very limited organisational structures.

In developing an Action Plan decisions will need to be made on how to address these differences. Will it be possible to mobilise sufficient resources to develop Shorebird Site Networks in each Flyway? Even if it is possible to obtain these resources, could these be applied successfully if organisational structures are not in place?

This paper argues that over the next five years the pragmatic approach will be to concentrate on the development of the Network in the East Asian-Australasian Flyway. This should be complemented by organisation building and data gathering in the Central Asia-Indian Flyway linked to the implementation of the *Strategy*. In the West Pacific Flyway conditions are quite different and it will be more constructive to use a general wetland management approach for shorebird conservation.

5.0 Mission Statement

A clear statement of purpose is an essential component of any Action Plan. Considerable thought and discussion needs to be given to this statement because it defines both the purpose and the means of implementation of the Plan.

Drawing from the *Strategy* the following mission statement is proposed for the Action Plan:

> ***To achieve the long term conservation of migratory shorebirds and their habitats in the Asia-Pacific through the establishment of networks of appropriately managed sites that are of international importance for migratory shorebirds.***

6.0 Priority Actions

Working with the mission statement three themes are proposed:

- Development of the East Asian-Australasian Shorebird Reserve Network
- Appropriate management of Shorebird Reserve Network sites
- Increasing the information base on migratory shorebirds

Under each of these themes a small number of priority actions need to be identified.

6.1 Development of the East Asian-Australasian Shorebird Reserve Network

Two conceptual models exist for the extent of coverage of the Shorebird Reserve Network. One is for the Network to have "symbolic" coverage of internationally important sites. In this model the Network would include only a small number of sites but these would exemplify the importance of wetlands and their management. The second model involves a "complete coverage" approach. This would work towards having all internationally important sites included in the Network.

While data is limited for many countries of the Flyway an "overview" of existing information suggests that there is a minimum of 250 internationally important sites for shorebirds.

Priority activities under this theme could be:

- Obtain nominations of foreshadowed sites
- Publish a map of important sites
- Obtain additional Network sites
- Increase the number of countries involved in the Network
- Conduct a ceremony at each site to promote community recognition and involvement.

6.2 Appropriate management of Shorebird Reserve Network sites.

Getting sites to be part of the Network needs to be linked to enhanced site management. Supporting the implementation of appropriate management (wise use of wetland resources) at each Shorebird Reserve Network site must be the highest priority of the Action Plan and as such have allocated the most resources.

Priority activities under this theme could be:

- Increased training for site personnel in wetlands management and shorebird conservation
- Promote the development and implementation of management plans
- Development of education and public awareness products
- Enhance the exchange of information on shorebird conservation and habitat management.

6.3 Increasing the information base on migratory shorebirds

Ongoing survey, monitoring and research work on shorebirds and their habitats is required to ensure that the Network is achieving the conservation of shorebirds in the East Asian-Australasian Flyway.

Priority activities under this theme could be:

- Increased monitoring of shorebird populations
- Identification of internationally important sites for shorebirds
- Support for migration research with a special focus on the use of colour leg flags and public involvement in resightings
- Compile a species status overview that reviews the adequacy of the Network

7.0 Implementation

The Shorebird Action Plan needs to be developed to make the maximum use of existing organisational structures and activities. Successful implementation will require cooperative action between Government agencies, site management agencies and non-government organisations. The Plan should seek to be inclusive. It needs to empower organisations and individuals to take a role in implementation.

Key personnel to be involved with implementation are the Shorebird Flyway Officer, site management staff, non-government organisations and Government agencies.

8.0 Review and Consultation Mechanisms

The Action Plan will need to have adequate review and consultation mechanisms in place for its development and implementation. Under the implementation of the Strategy it is already proposed to form a specialist Shorebird Working Group that will report to an Asia-Pacific Migratory Waterbird Conservation Committee. It is proposed for these consultative arrangements to draw members from a wide geographic area, with diversity of skills and from both Government and non-government organisations.

9.0 Resource Implications

The Action Plan needs to identify the minimum resources needed for implementation. This is essential if the Plan is to form the basis for priority setting and fund raising activities. Providing costings for priority actions will greatly assist to focus attention on the essential elements of the Action Plan.

It is also useful to develop a general approach to the allocation of resources for implementation. Given that three themes have been proposed, and that appropriate management of Network sites has been identified as the major priority, an appropriate allocation of resources would be:

- Development of the Network : 25%
- Improved management of Network sites : 50%
- Increasing the knowledge base on migratory shorebirds : 25%.

10.0 Summary

During 1997 Wetlands International will seek to finalise an Action Plan for migratory shorebirds in the Asia-Pacific. It is anticipated that the Action Plan with be a document of up to 5 pages in length and that its implementation will use the framework of the East Asian-Australasian Shorebird Reserve Network. The Action Plan will detail only a small number of priority actions and these will be fully costed.

Successful implementation of the Action Plan will depend on active support from Government agencies, non-government organisations, individuals and funding organisations. Wetlands International will perform a coordinating and facilitating role to link these major players.

This will be the first "flyway based" Action Plan for shorebird conservation produced in the world. We hope that with your involvement we can, not only improve the status of shorebirds in this part of the world, but also provide a valuable model for other flyways.

References

Anonymous. 1996. *Asia-Pacific Migratory Waterbird Conservation Strategy: 1996-2000.* Wetlands International - Asia Pacific, Kuala Lumpur, Publication No. 117, and International Waterfowl and Wetlands Research Bureau - Japan Committee, Tokyo.

Watkins, D. 1995. East Asian-Australasian Shorebird Reserve Network Proposal. *The Stilt* 27: 7-10.

Wells, D.R. and Mundkur, T. (eds.) 1996. *Conservation of Migratory Waterbirds and their Wetlands Habitats in the East Asian-Australasian Flyway.* Proceedings of an International Workshop, Kushiro, Japan. 28 Nov-3 Dec 1994. Wetlands International-Asia Pacific, Kuala Lumpur, Publication No. 116, and International Waterfowl and Wetlands Research Bureau-Japan Committee, Tokyo.

The Distribution of Waders Along the Queensland Coastline

Peter Driscoll

Introduction

The Asian/Australasian Flyway extends from breeding grounds in the Alaskan and East Siberian tundras and forests, and the steppes and deserts of Mongolia and extreme Northern China, to non-breeding areas in South-east Asia, Australasia and New Zealand. A brief history of studies on waders in the Flyway is given in Parish *et al.* (1987). Work on counting and banding waders began in earnest in southern parts of Australia in the late 1970s. Accessible but limited parts of Queensland were covered in count programmes since 1980.

An assessment of wader numbers, important sites and conservation priorities for the whole of Australia is given in the "National Plan for Shorebird Conservation in Australia" (Watkins 1993). However, due to limited geographical coverage of Queensland, the numbers collated for various parts of this state were less complete than for much of the rest of the country. In the last 6 years more comprehensive information has been gathered in Queensland by the Queensland Wader Study Group (QWSG) and the Queensland Ornithological Society Incorporated (QOSI).
The assessment of available data on wader numbers in Queensland presented here provides a basis for the protection and management of coastal wader habitats. The assessment is for birds using the actual coastline, and not offshore islands or freshwater wetlands adjoining the coast. An explanation of data sources, collation and limitations is given prior to a region by region appraisal of sites, species and gaps in knowledge. Estimates of numbers, important roosting sites and management issues are identified for 13 coastal regions during summer. The results as a whole are discussed, as are threats and conservation priorities. A guide is also provided to managers for valuing wader roosts.

P. Driscoll, Fahey Road, Mount Glorious, QLD 4520

Data sources and presentation

This overview of wader numbers in coastal Queensland is based on reports and published accounts, data from specific field studies and count results since 1977. Data from the Royal Australasian Ornithologists Union (RAOU), the Australasian Wader Studies Group (AWSG), the Queensland Wader Study Group and specific short term studies, especially since the late 1980s, have been assembled in the one computer database which holds over 4000 records for Queensland (Table 1).

The data are drawn from coastal mudflats or sandflats, the primary feeding habitats for most waders in Queensland. The data do not cover species or components of species' populations that may be found in sub-coastal, inland or offshore sites.

The way the numbers have been collated for each region (Tables 1 and 2) differs in accordance with the nature of the data. Specific details are described in the regional accounts. Notwithstanding this, some common principles were used as described below.

For migratory species, an estimate of numbers for the summer period between December and February was made. During this time, migratory species are most settled in their non-breeding site and are least likely to show fluctuation in numbers. The summer populations reflect the suitability of an area to sustain birds for a long period, and to meet their food requirements before northward migration. For resident species, counts at other times of the year were used if these exceeded those for the summer.

Data from comprehensive summer surveys were used, where they were available. However, where counts of individual species in an area at other times exceeded the survey results, the former were used. Because the surveys were generally more comprehensive than any type of regular or incidental monitoring of numbers, they generally yielded the highest values. In collating data for entire regions, survey results often had to be incorporated with more general records for other parts of the region.

It was not practical to generate an estimate of numbers for all species, in all regions for the same year. Instead, the numbers are the maximum summer

Table 1

Coastal regions and data sources.

The regions are matched against zones in Lane (1987).
The following symbols are used: * - region includes less than the zone; # - region includes more than the zone; $ - major difference.
The number of database records are in categories of population monitoring (Mon.), regular counts (Reg.) and special survey (Sur.)
The approximate distances in kilometres around the mainland shoreline and the shoreline including islands are as seen in Figures 2.01 to 2.11.

Region Name	Gulf	Central West Cape	Cape York	Princess Charlotte	Cook-town	Cairns	Towns-ville	Upstart	Central Coast	Shoal-water	Curtis Coast	Hervey Wide	South East	
Region #	1	2	3	4	5	6	7	8	9	10	11	12	13	
Code	QGF *	QWC #	QCY *	QPC	QCT	QCN *	QTV * $	QUP * $	QCC *	QSY #	QCU #	QHW	QSE	
Subcodes							QTN QHN	QBG QBK	QMK QPP	QSB QBS	QRH QGL	QBB QGS	QSC QMB	
								QBW					QGC	
Equiv. Zone(s)	1	2	3	4	5	6	7	7	8	9	10	11/12	13/14/15	
Extent														
Lat. north	15 00	12 30	10 00	13 30	14 00	16 00	18 00	19 00	20 00	22 00	23 00	24 30	26 00	
Lat. south	18 00	15 00	13 30	15 00	16 00	18 00	19 30	20 30	22 00	23 00	24 30	26 00	28 00	
Long. west	138 00	141 00	141 30	143 30	144 30	145 00	146 00	147 00	148 30	149 30	150 30	152 00	153 00	
Long. east	142 00	142 30	144 00	144 30	145 30	146 30	147 00	148 30	149 30	151 00	152 00	153 30	154 00	
Data														Total
AWSG														
Mon. 81-90	39	17	40	4	9	35	71	17	145		4	30	237	648
Mon. 91-94						8			8				8	24
Reg. 81-90		9	11			230	150	121	226		270	40	377	1434
QWSG														
Reg. 92-95	2					7	19	1	8		25	8	1407	1477
Sur. GS '95												25		25
Sur. SB '95										132				132
Sur. NEGP								9	171	7	138	2		327
Sur. QWS						14	40	56						110
Total recs	41	26	51	4	9	294	280	204	558	139	437	105	2029	4027

Shoreline distances

Mainland shore	771	561	1380	239	372	344	298	433	688	780	559	521	385	7331
Island shore	586	81	996	115	118	68	415	158	840	562	535	562	776	5812
Total shore	1358	642	2376	354	491	412	713	591	1527	1342	1094	1083	1161	13144
Mangrove	502	252	866	130	129	35	232	150	222	672	496	445	509	4640
% mang. shore	37	39	36	37	26	8	32	25	15	50	45	41	44	
% island shore	43	13	42	32	24	17	58	27	55	42	49	52	67	

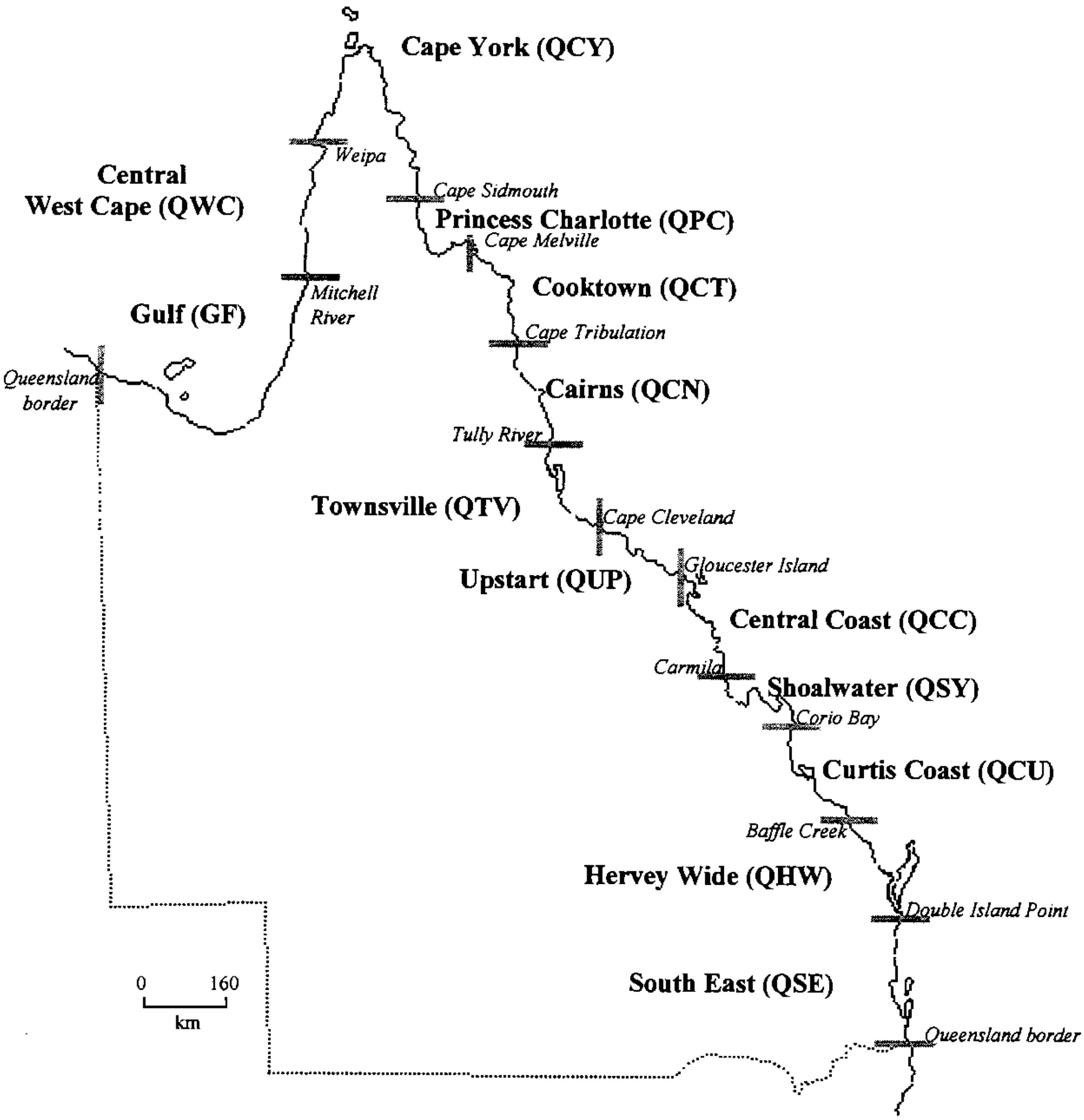


Figure 1. Coastal wader regions of Queensland as used in this study, and based primarily on zones depicted in Lane (1987). Details of the regions are given in Table 1 and each is mapped at a finer scale in Figure 2. The Regions are named and their computer codes given in brackets. Places at the approximate boundaries between regions are given in italics.

Table 2
Estimated numbers of waders in each of the coastal wader regions in Queensland.

These values are for summer months (see text). The values tend to be maximum for each species but not necessarily for the same year. Therefore, the totals for all birds are likely to be unrealistically high for any one year. On he other hand sampling for many of the regions is incomplete and the numbers too low. Species marked with an asterisk are those considered for listing in the regional accounts (see text for an explanation). The last column is the ratio of the species total to the Queensland total for the species given in Watkins (1993). In general, discrepancies arise from poor coverage of a species' distribution (coastal total is lower) or from improved sampling (coastal total is higher). However, poor knowledge of numbers in coastal parts of the Gulf region remain a major source of error in population estimates. (NB : Coastal strip only: Does not include islands or neighbouring wetlands)

	Region	Gulf	Central West Cape	Cape York	Princes s Char-lotte	Cook-town	Cairn s	Towns -ville	Upstart	Central Coast	Shoal-water	Curtis Coast	Hervey Wide	South East	
	Region code->	QGF	QWC	QCY	QPC	QCT	QCN	QTV	QUP	QCC	QSY	QCU	GHW	QSE	Totals
Species	Common name														
Gallinago hardwickii	Latham's Snipe									21				5	26
	Snipe sp.											6			6
Limosa limosa	Black-tailed Godwit *	50795	2235	33	480		195	357	163	353		41	37	368	55057
Limosa lapponica	Bar-tailed Godwit *	2000	88	299	90	185	280	705	2017	4015	5151	2726	14538	16638	48732
Numenius minutus	Little Curlew	236	10	32			58		1	52					389
Numenius phaeopus	Whimbrel *	1417	62	67	45	15	700	256	755	451	7124	610	3289	2149	16940
Numenius madagascariensis	Eastern Curlew *	945	42	142	50	5	149	339	473	745	2986	1532	6344	4726	18478
Tringa stagnatilis	Marsh Sandpiper *	1400	62	9	5		5	37	5	25	3	59	31	94	1735
Tringa nebularia	Common Greenshank *	1500	66	39	15		50	105	193	133	382	370	1086	498	4437
Tringa glareola	Wood Sandpiper											4			4
Xenus cinereus	Terek Sandpiper *	2800	123	153	40	5	128	49	305	502	3410	383	2584	949	11431
Actitis hypoleucos	Common Sandpiper	236	10	19	5		42	16	4	46	15		2		395
Heteroscelus brevipes	Grey-tailed Tattler *	472	21	237	80	100	144	252	304	483	3014	880	7701	4393	18081
Heteroscelus incanus	Wandering Tattler								4	4	9		1	1	19
	Tattler sp.									250			2		252
Arenaria interpres	Ruddy Turnstone *	236	10	11	5	100	8	12	41	190	17	8	28	221	887
Limnodromus semipalmatus	Asian Dowitcher														0
Calidris tenuirostris	Great Knot *	66000	2904	84	640		391	4484	7773	6307	820	260	1572	1476	92711
Calidris canutus	Red Knot *	4500	198			50	75	216	62	183	1		303	69	5657
Calidris alba	Sanderling	40	2						37	36				64	179
Calidris ruficollis	Red-necked Stint *	40000	1760	1750	540	15	1450	719	2389	1256	434	1195	2518	1382	55408
Calidris melanotos	Pectoral Sandpiper						7			4					11
Calidris acuminata	Sharp-tailed Sandpiper *	2500	110	190	50		262	325	997	556	61	111	325	299	5786
Calidris ferruginea	Curlew Sandpiper *	6000	264	28	10	10	185	7	544	80	27	446	683	2237	10521
Limicola falcinellus	Broad-billed Sandpiper *	1000	20				23	1	22						1066
Philomachus pugnax	Ruff	5	3					1							9
Rostratula benghalensis	Painted Snipe											1			1
Burhinus grallarius	Bush Stone-curlew			4				2		8		4			18
Esacus magnirostris	Beach Stone-curlew	10	3	11	5	3	5	8	12	21	25	22	7	3	135
Haematopus longirostris	Pied Oystercatcher *	518	71	26	120	5	5	117	85	397	381	245	533	1047	3550
Haematopus fuliginosus	Sooty Oystercatcher					7	31			28	14	23			103
Himantopus himantopus	Black-winged Stilt *	1000	236	30	310		74	130	149	500	22	108	234	357	3150
Cladorhynchus leucocephalus	Banded Stilt											2			2
Recurvirostra novaehollandiae	Red-necked Avocet *	950	42						525	2		70		726	2315
Pluvialis fulva	Pacific Golden Plover *	2000	88	244	50	10	148	81	569	188	13	10	941	277	4619
Pluvialis squatarola	Grey Plover *	709	31	35	10		4	7	104	117	58	36	222	217	1550
Charadrius hiaticula	Ringed Plover											1			1
Charadrius dubius	Little Ringed Plover														0
Charadrius ruficapillus	Red-capped Plover *	5000	220	278	80	10	85	483	888	221	160	210	823	287	8745
Charadrius bicinctus	Double-banded Plover							10			10	1		148	169
Charadrius mongolus	Lesser Sand Plover *	5000	220	827	250	70	150	406	3904	1740	186	434	1811	1887	16885
Charadrius leschenaultii	Greater Sand Plover *	5000	220	348	100	10	75	221	369	226	101	304	340	461	7775
Charadrius veredus	Oriental Plover	100	4				3			2				6	115
Elseyornis melanops	Black-fronted Plover		49				45	15	10	33		40		9	201
Erythogonys cinctus	Red-kneed Dotterel		40				7	13		10		6			76
Vanellus tricolor	Banded Lapwing									5					5
Vanellus miles	Masked Lapwing	114	58	62	20		53	92	42	66	19	40	162	80	808
Glareola maldivarum	Oriental Pratincole		24	2											26
Stiltia isabella	Australian Pratincole			40											40
	Totals	2E+05	9296	5000	3000	600	4837	9466	22746	19256	24443	10188	46117	41074	398506
	Region code->	QGF	QWC	QCY	QPC	QCT	QCN	QTV	QUP	QCC	QSY	QCU	GHW	QSE	Total
	Birds/km mainland shore	263	17	4	13	2	14	32	53	28	31	18	89	107	54
	Birds/km total shore	149	14	2	8	1	12	13	38	13	18	9	43	35	30

Table 3

The percentage contribution of regions to total counts for each species (derived from Table 2)

Region code->	QGF	QWC	QCY	QPC	QCT	QCN	QTV	QUP	QCC	QSY	QCU	GHW	QSE	Total %
Common name														
Latham's Snipe	0	0	0	0	0	0	0	0	80.8	0	0	0	19.2	100
Snipe sp.	0	0	0	0	0	0	0	0	0	0	100	0	0	100
Black-tailed Godwit	92.3	4.06	0.06	0.87	0	0.35	0.65	0.3	0.64	0	0.07	0.07	0.67	100
Bar-tailed Godwit	4.1	0.18	0.61	0.18	0.38	0.57	1.45	4.14	8.24	10.6	5.59	29.8	34.1	100
Little Curlew	60.7	2.57	8.23	0	0	14.9	0	0.26	13.4	0	0	0	0	100
Whimbrel	8.36	0.37	0.4	0.27	0.09	4.13	1.51	4.46	2.66	42.1	3.6	19.4	12.7	100
Eastern Curlew	5.11	0.23	0.77	0.27	0.03	0.81	1.83	2.56	4.03	16.2	8.29	34.3	25.6	100
Marsh Sandpiper	80.7	3.57	0.52	0.29	0	0.29	2.13	0.29	1.44	0.17	3.4	1.79	5.42	100
Common Greenshank	33.8	1.49	0.88	0.34	0	1.13	2.37	4.35	3	8.61	8.34	24.5	11.2	100
Wood Sandpiper	0	0	0	0	0	0	0	0	0	0	100	0	0	100
Terek Sandpiper	24.5	1.08	1.34	0.35	0.04	1.12	0.43	2.67	4.39	29.8	3.35	22.6	8.3	100
Common Sandpiper	59.8	2.53	4.81	1.27	0	10.6	4.05	1.01	11.7	3.8	0	0.51	0	100
Grey-tailed Tattler	2.61	0.12	1.31	0.44	0.55	0.8	1.39	1.68	2.67	16.7	4.87	42.6	24.3	100
Wandering Tattler	0	0	0	0	0	0	0	21.1	21.1	47.4	0	5.26	5.26	100
Tattler sp.	0	0	0	0	0	0	0	0	99.2	0	0	0.79	0	100
Ruddy Turnstone	26.6	1.13	1.24	0.56	11.3	0.9	1.35	4.62	21.4	1.92	0.9	3.16	24.9	100
Great Knot	71.2	3.13	0.09	0.69	0	0.42	4.84	8.38	6.8	0.88	0.28	1.7	1.59	100
Red Knot	79.6	3.5	0	0	0.88	1.33	3.82	1.1	3.23	0.02	0	5.36	1.22	100
Sanderling	22.4	1.12	0	0	0	0	0	20.7	20.1	0	0	0	35.8	100
Red-necked Stint	72.2	3.18	3.16	0.97	0.03	2.62	1.3	4.31	2.27	0.78	2.16	4.54	2.49	100
Pectoral Sandpiper	0	0	0	0	0	63.6	0	0	36.4	0	0	0	0	100
Sharp-tailed Sandpiper	43.2	1.9	3.28	0.86	0	4.53	5.62	17.2	9.61	1.05	1.92	5.62	5.17	100
Curlew Sandpiper	57	2.51	0.27	0.1	0.1	1.76	0.07	5.17	0.76	0.26	4.24	6.49	21.3	100
Broad-billed Sandpiper	93.8	1.88	0	0	0	2.16	0.09	2.06	0	0	0	0	0	100
Ruff	55.6	33.3	0	0	0	0	11.1	0	0	0	0	0	0	100
Painted Snipe	0	0	0	0	0	0	0	0	0	0	100	0	0	100
Bush Stone-curlew	0	0	22.2	0	0	0	11.1	0	44.4	0	22.2	0	0	100
Beach Stone-curlew	7.41	2.22	8.15	3.7	2.22	3.7	5.93	8.89	15.6	18.5	16.3	5.19	2.22	100
Pied Oystercatcher	14.6	2	0.73	3.38	0.14	0.14	3.3	2.39	11.2	10.7	6.9	15	29.5	100
Sooty Oystercatcher	0	0	0	0	6.8	30.1	0	0	27.2	13.6	22.3	0	0	100
Black-winged Stilt	31.8	7.49	0.95	9.84	0	2.35	4.13	4.73	15.9	0.7	3.43	7.43	11.3	100
Banded Stilt	0	0	0	0	0	0	0	0	0	0	100	0	0	100
Red-necked Avocet	41	1.81	0	0	0	0	0	22.7	0.09	0	3.02	0	31.4	100
Pacific Golden Plover	43.3	1.91	5.28	1.08	0.22	3.2	1.75	12.3	4.07	0.28	0.22	20.4	6	100
Grey Plover	45.7	2	2.26	0.65	0	0.26	0.45	6.71	7.55	3.74	2.32	14.3	14	100
Ringed Plover	0	0	0	0	0	0	0	0	0	0	100	0	0	100
Red-capped Plover	57.2	2.52	3.18	0.91	0.11	0.97	5.52	10.2	2.53	1.83	2.4	9.41	3.28	100
Double-banded Plover	0	0	0	0	0	0	5.92	0	0	5.92	0.59	0	87.6	100
Lesser Sand Plover	29.6	1.3	4.9	1.48	0.41	0.89	2.4	23.1	10.3	1.1	2.57	10.7	11.2	100
Greater Sand Plover	64.3	2.83	4.48	1.29	0.13	0.96	2.84	4.75	2.91	1.3	3.91	4.37	5.93	100
Oriental Plover	87	3.48	0	0	0	2.61	0	0	1.74	0	0	0	5.22	100
Black-fronted Plover	0	24.4	0	0	0	22.4	7.46	4.98	16.4	0	19.9	0	4.48	100
Red-kneed Dotterel	0	52.6	0	0	0	9.21	17.1	0	13.2	0	7.89	0	0	100
Banded Lapwing	0	0	0	0	0	0	0	0	100	0	0	0	0	100
Masked Lapwing	14.1	7.18	7.67	2.48	0	6.56	11.4	5.2	8.17	2.35	4.95	20.1	9.9	100
Oriental Pratincole	0	92.3	7.69	0	0	0	0	0	0	0	0	0	0	100
Australian Pratincole	0	0	100	0	0	0	0	0	0	0	0	0	0	100
Totals	50.8	2.33	1.25	0.75	0.15	1.21	2.38	5.71	4.83	6.13	2.56	11.6	10.3	100

counts available for any year for each species. In any one year the maximum numbers for all species are unlikely to be realised and on this basis, the combined totals in Table 2 and Figure 3 are unrealistically high. On the other hand, it must be remembered that without exception the regional estimates would not cover all of the places that birds could be found and in this sense will invariably understate the numbers of birds.

Specific roost sites are mapped where the known bird numbers have exceeded 300 (database records), or 1000 in the case of the Gulf of Carpentaria (Garnett 1989). There are likely to be additional important, but unknown sites. Feeding areas have not been mapped but occasional reference is made to such areas in the text. The presence of a significant roost site indicates the presence of significant feeding areas.

The maps are based upon digital information from the "AUSLIG Coast-100k Geodata" of the Queensland coastline which is presented with the mouths of narrow inlets and rivers closed off with straight lines. Hence, the maps sometimes appear to lack definition and do not show creeks and rivers but the shape of the coastline is very accurate and should enable use of the maps, particularly through reference to other maps of local areas.

A list of species is given in the text for each region. The list is those species that have four per cent or more of their total count represented in the region. The same lists occur on the maps of the regions. To avoid getting trivial results from very few data, only species with State wide counts of over 800, or about four per cent of the total for all species for the State, were considered for listing. Four per cent was chosen as an arbitrary figure that, upon inspection of the data, gave a selection of species whose numbers appeared to reflect an actual difference between regions.

The disadvantage in restricting the listing of species is that species such as Beach Stone-curlew and Sooty Oystercatcher, that are confined to the coastline in small but significant numbers and don't use the main roost sites, have been omitted from the lists. The distribution of such species needs a more thorough appraisal than what is possible with the data presented here.

Consideration of species totals in the context of the Ramsar Convention criterion of 1% of total population estimates has not been undertaken. The results presented here for Queensland need to be considered in any review of population estimates and site evaluations based on the 1% criterion that were made in Watkins (1993) for the whole of Australia. Of more immediate importance is the list of sites of importance given for Queensland in Watkins (1993), which now needs to be reviewed and expanded.

Regional Accounts

Table 1 lists thirteeen coastal regions for Queensland and their latitudinal and longitudinal boundaries (Figure 1), together with the number and sources of database records. Table 1 also gives estimates of distances of various types of coastline in each region. Table 2 presents the estimated number of each species for each region. It also gives values for the number of birds per kilometre of coastline. Table 3 is derived from Table 2 and gives the percentage contributions of regions to the species totals. For each region (Figure 2), the following points will be addressed: sources of count data, habitat characteristics, species of significance, gaps in knowledge of distribution and possible remedies

In assessing wader numbers in the past, the RAOU and AWSG have used a number of zones in Australia as detailed in Lane (1987). As far as practicable, the regions discussed here conform to the coastal zones for Queensland. Where there is a difference it is indicated in Table 1. The main difference is that two regions are allocated for the one zone between the Tully River and Bowen. There are a number of different areas in this zone where waders occur and a division was appropriate (see Pell and Lawler 1996). Another difference is the amalgamation of zones 13, 14 and 15 into one region between Double Island Point and the Qld/NSW border. Waders in this region are mostly within one large area that centres on Moreton Bay.

Gulf

Sources

An early aerial reconnaissance of the coastline between Karumba and Broome was made in mid August 1981, before the main influx of migrating birds (Minton 1981). A particularly high concentration of waders was noted from Karumba to Point Parker at a density of 263 birds per km of coastline. Highest numbers were within 100 km of the mouth of the Norman River, Karumba. Another significant concentration on the south coast of the Gulf was close to the mouth of the Roper River (NT). Guard and Garnett (1982) also report on high

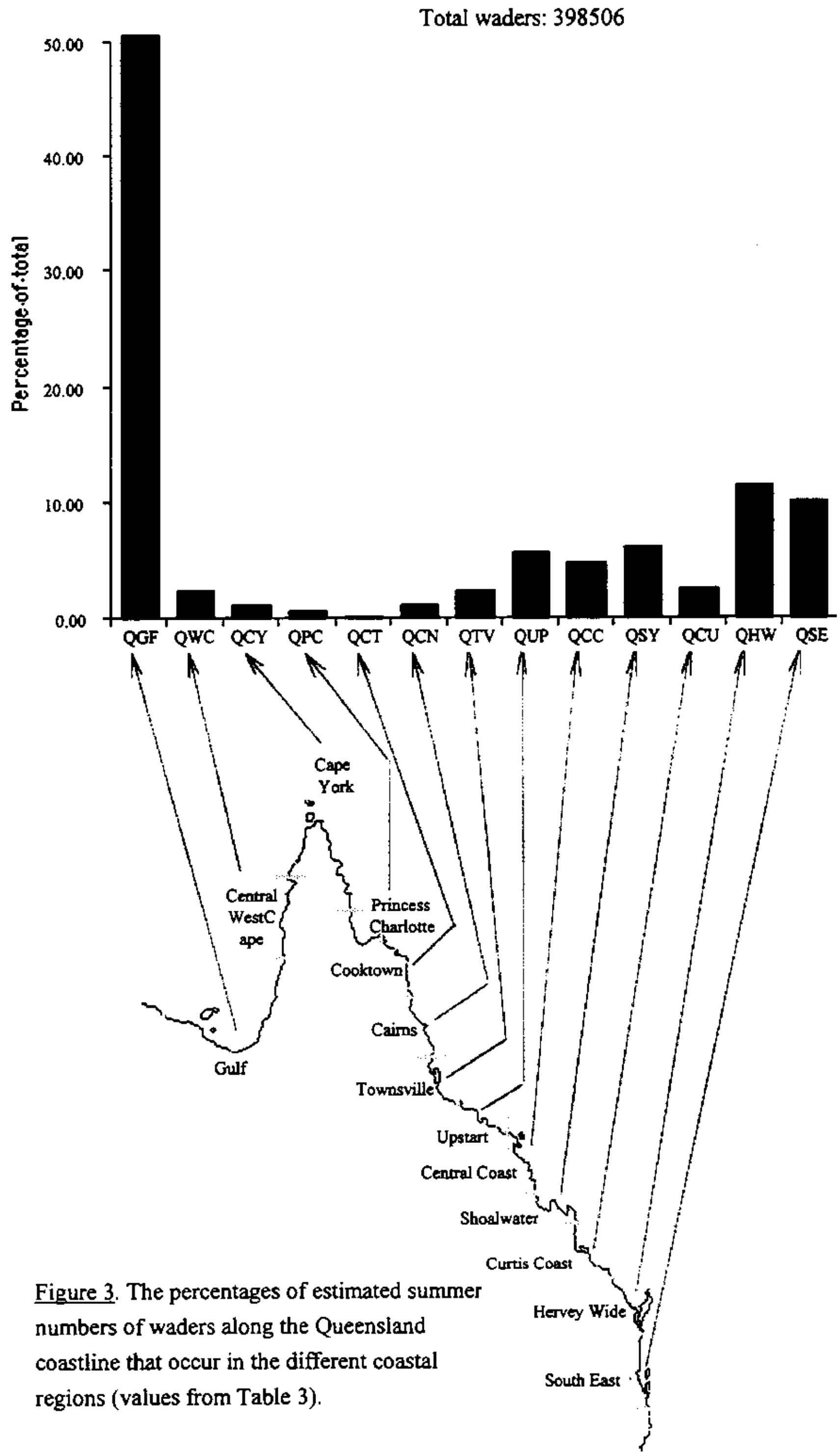


Figure 3. The percentages of estimated summer numbers of waders along the Queensland coastline that occur in the different coastal regions (values from Table 3).

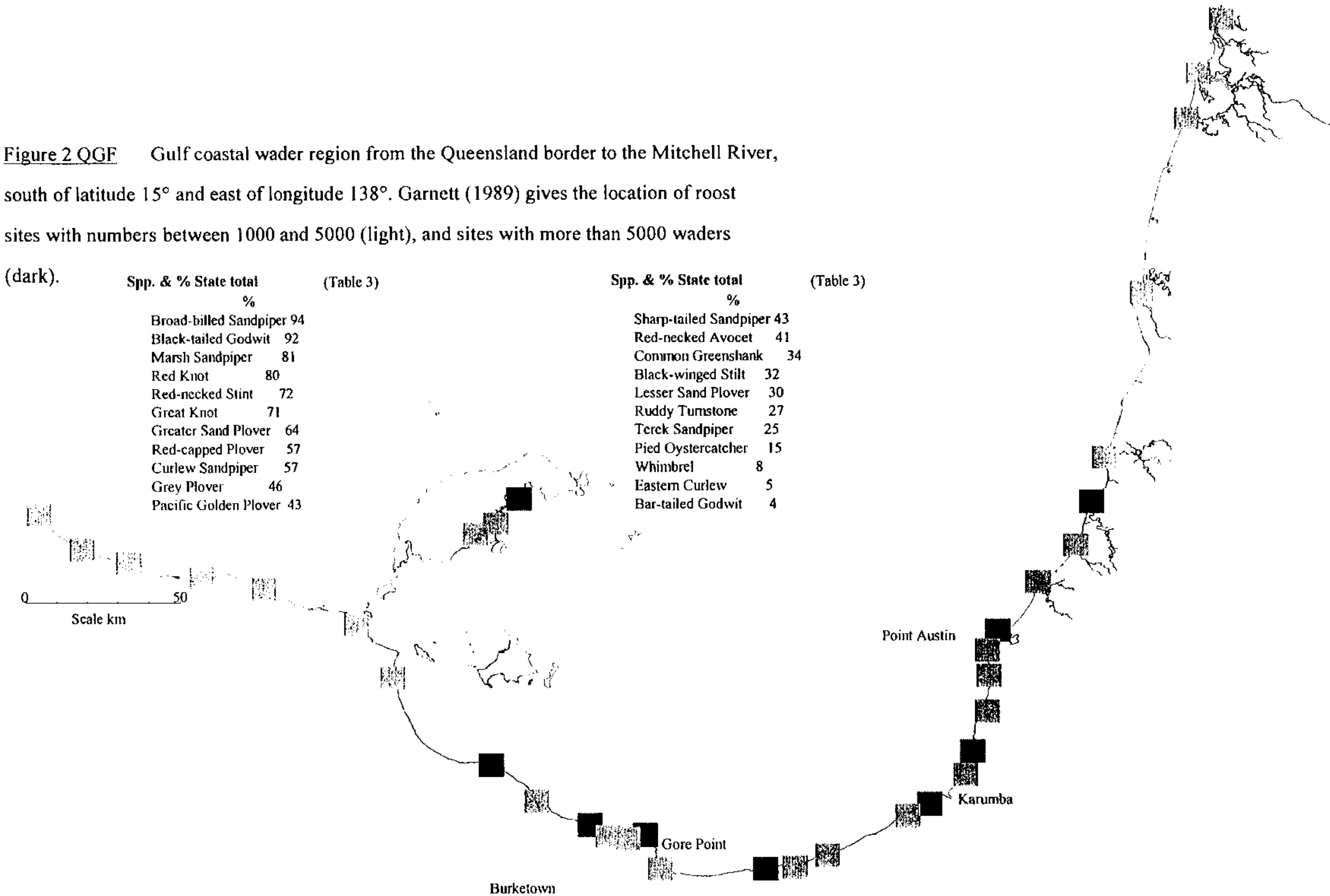


Figure 2 QGF   Gulf coastal wader region from the Queensland border to the Mitchell River, south of latitude 15° and east of longitude 138°. Garnett (1989) gives the location of roost sites with numbers between 1000 and 5000 (light), and sites with more than 5000 waders (dark).

Spp. & % State total (Table 3)	%
Broad-billed Sandpiper	94
Black-tailed Godwit	92
Marsh Sandpiper	81
Red Knot	80
Red-necked Stint	72
Great Knot	71
Greater Sand Plover	64
Red-capped Plover	57
Curlew Sandpiper	57
Grey Plover	46
Pacific Golden Plover	43

Spp. & % State total (Table 3)	%
Sharp-tailed Sandpiper	43
Red-necked Avocet	41
Common Greenshank	34
Black-winged Stilt	32
Lesser Sand Plover	30
Ruddy Turnstone	27
Terek Sandpiper	25
Pied Oystercatcher	15
Whimbrel	8
Eastern Curlew	5
Bar-tailed Godwit	4

numbers of waders in the Gulf. Near the mouth of the Smithburne River and at Fitzmaurice Point counting had to be done in units of 10000 with Black-tailed Godwits being the predominant species. From the NT-Qld border westward, the highest numbers were between Point Parker and Karumba. Garnett and Carruthers (1982) report on a February aerial inspection of the coast from Cairns to Gove when highest numbers were being seen south of the Nassau River. There were reasonable numbers on the southern side of Mornington Island. Overall, the aerial counts for 1981 and 1982 differed considerably
A February 1983 aerial survey (Garnett 1983) revealed 167920 birds, including very large numbers of Black-tailed Godwits and Grey Plover and significant numbers of Whimbrel, Eastern Curlew, Little Curlew and Greenshank. Garnett (1986) looks at seasonal changes in wader numbers in the Gulf and presents some useful information on the relative number of different species taken from counts at different times of the year. In a summary and interpretation of earlier results, Garnett (1987) makes the point that more than 85% of birds in both summer and late winter to early spring, were found along muddy coastline fringed by mangroves. Birds congregated near the mouths of the rivers with the largest catchments.

Garnett (1987) gives an average summer count for the Gulf coastline, as defined here, of 171500 waders. However, in certain years and during migration periods, recorded numbers are much higher. As a basis for deriving the values in Table 2, a peak total figure of 236000 was used in conjunction with the composition of feeding flocks taken from ground counts for December 1984 (Garnett 1986). Specific population values given in Garnett (1989) were then used to raise or lower the derived values. Finally, values were adjusted in accordance with the maximum counts from the database records for the period between February 1982 and June 1985 (see Table 1). The ultimate total of around 200000 waders seems an adequate compromise between a lower average summer value from aerial counts of all waders, and the peak values that have been reported for individual species and waders generally.

Sites and features

In addition to the very high summer density of waders in the Gulf of Carpentaria, the area is almost as important an arrival place for waders migrating into Australia from Asia as is the Broome-Port Hedland area of Western Australia. Also, there are large movements of birds into, around, and out of the south east Gulf in September (Lane 1987, 1988, Watkins 1993). Roost sites were located by Lane (1988) and Garnett (1989) (see Figure 2 QGF). In most cases, the birds are roosting on sandy beaches or muddy shores. Where sand is not as prevalent, such as along the coast between Karumba and Gore Point, they tend to roost along muddy shores where there is a break in the coastal strip of mangroves or, where the mangroves are continuous, most roost behind them on the shores of tidal creeks flowing across wet open saline flats (Lane 1988). Lane also noted that birds undertook movements of up to ten kilometres between their roosts and their feeding areas.

Species

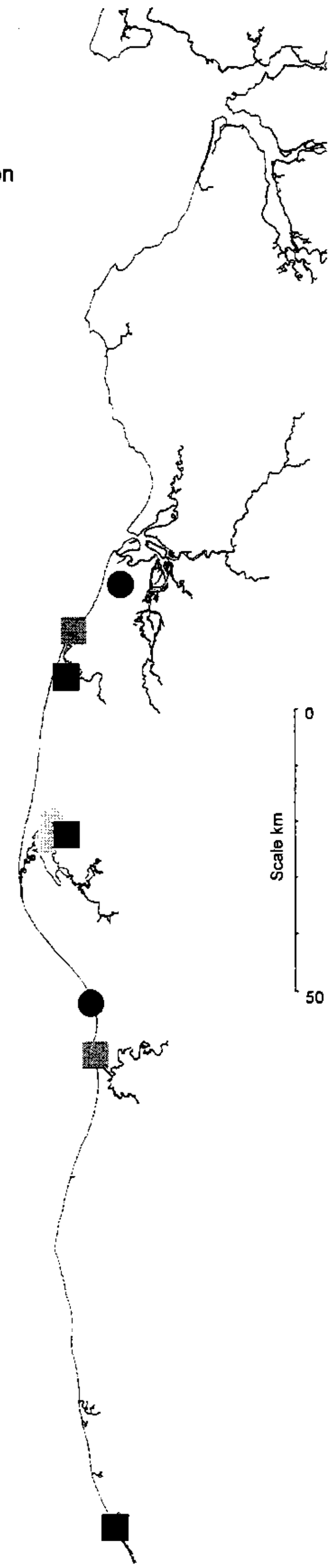
With the one exception of the Grey-tailed Tattler, all of the 23 species with total coastal numbers of more than 800 are represented in the Gulf by more than four per cent of their State totals. Other species with low percentage representation are Bar-tailed Godwit (4%), Eastern Curlew (5%) and Whimbrel (8%). All four species are more abundant in south eastern and eastern coastal regions of the State (Table 2, Figure 4). The species with greater than 50% of their numbers occurring in the Gulf are Broad-billed Sandpiper, Black-tailed Godwit, Marsh Sandpiper, Red Knot, Red-necked Stint, Great Knot, Greater Sand Plover, Red-capped Plover and Curlew Sandpiper.
Other waders are common in freshwater and grassland habitats in the Gulf (Garnett 1989) but are not included in the listings presented here. They include Red-kneed Dotterel (probably thousands), flocks of over 5000 Little Curlew (see also Garnett and Minton 1985), Black-fronted Plover (occasionally very common), and Sharp-tailed Sandpiper. There may be over 100000 Sharp-tailed Sandpiper (more than half the world population) for short periods on wetlands inland from the Gulf as they prepare for northward migration (Garnett 1986, Starks and Lane 1987, Garnett 1989). Flocks of thousands of Oriental Pratincole visit the dry grasslands irregularly and small numbers of Australian Pratincole occur here throughout the year. Painted Snipe may occur around the wet season swamps of the Gulf in larger numbers than expected and another 4000 Black-winged Stilts are likely to occur here also (Garnett 1989).

Information lacking

Both Garnett (1983) and Lane (1988) refer to the peculiar difficulties of getting a good estimate of numbers for the region, particularly during migration periods. The problems are due to a combination of restraints on aircraft movements, generally difficult access, features of the tide, and changes in the local

Figure 2 QWC. Central west Cape coastal wader region from Duyfken Point (Weipa) to 10 km south of Pormpuraaw, between latitudes 12° 30' and 15°. Close by to the south of this region, there are some very high concentrations of waders but the region itself has a much lower density of waders than the Gulf. A few locations from aerial transects in August 1990 and April 1991 yielded counts in a small area of over 1000 birds (dark circles) south of the Archer River mouth and north of the Holroyd River and over 300 birds (light circles) near Cape Keer Weer.

Also, Garnett (1989) gives the location of roost sites with numbers between 1000 and 5000 (light squares),, and sites with more than 5000 waders (dark squares).



Spp. & % State total (Table 3)

	%
Black-winged Stilt	8
Black-tailed Godwit	4
Marsh Sandpiper	4
Red Knot	4

movements and distribution of birds often because of variation in the condition of neighbouring freshwater habitat. Consequently, very little precise information is available about the distribution and fluctuation in wader numbers in the Gulf.

The Gulf is a major site, not only for Queensland and Australia, but for the Flyway as a whole and is important for the maintenance of populations of many species. Opportunity for further survey work in the region should be sought. Understanding the migratory movements in and out of the Gulf would greatly enhance our understanding of movements of birds to and from southern and eastern parts of Australia and New Zealand.

Central west Cape

Sources

For the stretch of coastline between Weipa south to the Nassau River, Guard and Garnett (1982) recorded 1582 waders by aerial survey on 9th December 1981. This includes all of the coastline defined here as the central west Cape and more, extending 100 km south of Pormpurraw. In Albatross Bay, Pied Oystercatchers, Common Sandpipers, Red-necked Stints, Beach Stone-curlews, Greenshanks, sand plovers and Whimbrels were noted. Moving south from Weipa waders were relatively few but increased in number. Garnett and Carruthers (1982) report on a February aerial inspection of the coast from Cairns to Gove where relatively few birds were noted between Weipa and the Nassau River. Garnett (1985) suggests the Chapman River is a boundary for the distribution of shore-frequenting migratory waders. North of the Chapman River the beaches are largely sandy and only small numbers of birds congregate around river mouths.

Despite these indications of relatively low numbers in the region, other evidence suggests some reasonable concentrations of birds do occur. Roost sites with several thousand birds have been reported (Garnett 1989, Driscoll 1994, Figure 2 QWC). The database records and information in Garnett (1987) suggest a total of around 9000 unidentified birds. I used the ratio of the different species as determined for the Gulf to initially calculate species numbers from this total. If actual summer counts for particular species exceeded an estimated value, the former value was used.

Sites and features

Mangroves are abundant along the estuaries of Albatross and Archer Bays but are otherwise less common here than farther north. The region has a diversity of coastal and sub coastal wetlands, especially between the Aurukun and Holroyd Rivers, that includes intertidal and supratidal flats, sedgelands, swamps, and open lagoons (Driscoll 1994). Farther inland, the flood plains of a number of rivers provide extensive seasonal wetlands. The area can cater for large waterbird, brolga, geese and duck populations at certain times of the year (Taplin 1993). It is possible that many wader species switch between using intertidal habitats and extensive sub-coastal freshwater wetlands, depending upon local conditions.

Species

The only wader species which warrant a mention using the criteria of four or more per cent of their State totals (Table 2) are Black-winged Stilt (8%), Black-tailed Godwit (4%), Marsh Sandpiper (4%) and Red Knot (4%).

Information lacking

Even with careful reading of the literature and examination of counts from a number of aerial surveys, the numbers of birds that occur along this section of the coast is still unclear. As with the Gulf region, access is difficult over several hundred kilometres of coastline. Further survey work is required to establish better baseline information on both wader and waterbird populations.

Cape York

Sources

Garnett and Carruthers (1982) and Guard and Garnett (1982) report that relatively few waders were seen along the coastline in this region during aerial inspections from Cairns to Gove in December 1981 and February 1982. Garnett (1987) notes a medium density of birds on parts of the mainland coastline in the north and north west of Cape York, including Newcastle Bay and the Jardine River mouth and to the south of here (see Figure 2 QCY).
On the database there are some summer population monitoring counts for 1982, 1983 and 1984 as well as monthly counts for Upai Beach, Badu in 1979. In summer 1984 over 6000 unidentified waders were counted but at no other time were the counts this high and I have chosen 5000 as a total to work with and used the ratio of species from all regional counts and maximum values for particular species to derive the results in Table 2.

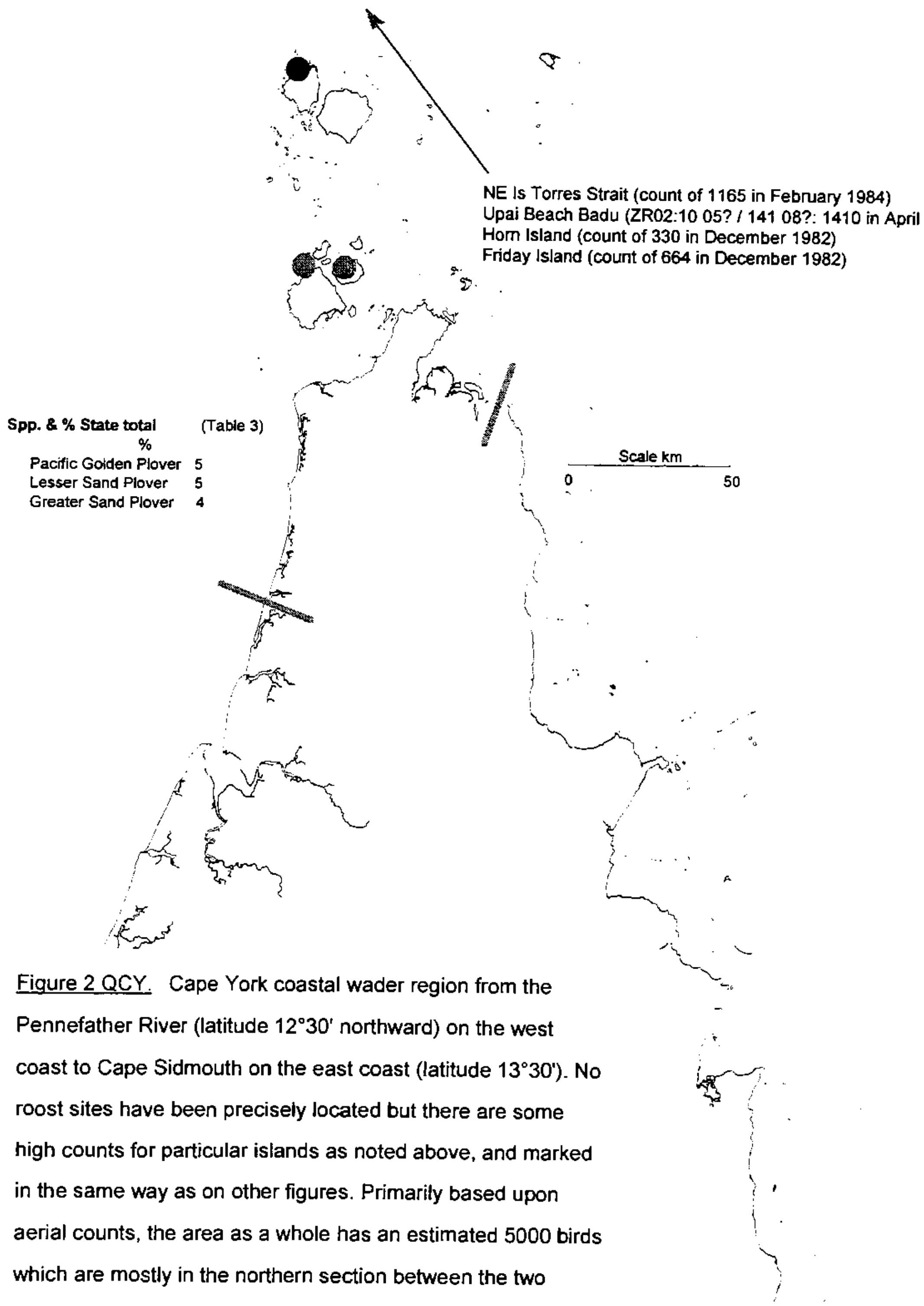


Figure 2 QCY. Cape York coastal wader region from the Pennefather River (latitude 12°30' northward) on the west coast to Cape Sidmouth on the east coast (latitude 13°30'). No roost sites have been precisely located but there are some high counts for particular islands as noted above, and marked in the same way as on other figures. Primarily based upon aerial counts, the area as a whole has an estimated 5000 birds which are mostly in the northern section between the two lines marking boundaries and including Newcastle Bay and the Jardine River mouth (see Garnett 1987).

Sites and features

In the north and north west of Cape York, several estuaries and bays have extensive cover of mangroves, notably Newcastle Bay and Port Musgrave. These often abut supratidal flats and sedgelands. A series of smaller creek and river systems occur from Vrilya Point to the Skardon River, south of the Jardine River. A high diversity of coastal wetland types also occurs between Port Musgrave and Albatross Bay (Driscoll 1994). However, farther south there appears to be lower numbers of waders.

Relatively few waders have been recorded on the north eastern coast of Cape York. Sandy foreshores with limited tidal flats, dune fields with perennial waterbodies and rocky headlands are typical features of this section of the Cape. However, there are locally extensive areas of mangroves at Temple and Lloyd Bays. Som expansive tidal flats occur here and farther south.

Species

In the region, numbers of Pacific Golden Plover (5%), Lesser Sand Plover (5%) and Greater Sand Plover (4%) are equal or greater than four per cent of their respective State totals.

Information lacking

There are few records for waders in the region but this is also the case for the fauna in general and is not necessarily a reflection of generally poor habitat. The coastline is mostly isolated and accessible only by boat or from the air. Some places are potentially more suitable for waders, such as in the vicinity of large bays and estuaries and should be looked at more carefully by boat. Aerial survey is not necessarily going to give an accurate assessment, especially where waders occur in only low to medium densities.

Princess Charlotte

Sources

Guard and Garnett (1982) and Garnett and Carruthers (1982) reported relatively few waders on the east coast of Cape York except around Trinity Inlet at Cairns and Princess Charlotte Bay. Garnett (1987) expresses some surprise at the relative scarcity of waders in the northern Torres Strait and Princess Charlotte Bay, considering the nature and extent of the local mudflats.

No map is given for the Princess Charlotte region (QPC), bounded by Cape Sidmouth (latitude 13°30') and Cape Melville (west of latitude 144°), because no specific roost sites have been identified.

The only information on the database is for February 1984 (33 unidentified waders) and for February 1982 which consists of 430 unidentified waders, 2 Beach Stone Curlew, 18 Pied Oystercatcher, 42 Black-winged Stilt, 2 Eastern Curlew, 3 Whimbrel, 50 Black-tailed Godwit, and 80 Great Knot.

Aerial counts were done in the summer of 1981, 1982 and 1984 and Guard and Garnett (1982) recorded 3203 waders in the region by on 9th December 1981. Garnett (1987) gives a value of 1770. I have used 3000 as the region total and mean proportions for the different species from the proportions for Cape York and the information above, to determine a species breakdown of 3000 birds for Princess Charlotte (Table 2).

Sites and features

Subcoastal freshwater swamps occur along the stretch of coastline to the north of Princess Charlotte Bay where there are some wide tidal flats but few mangroves or supratidal areas. It seems wader numbers are lower here than within Princess Charlotte Bay (Garnett 1987), which is characterised by muddy tidal flats and mangroves that back onto open saline areas, grasslands and sedgelands (Driscoll 1994). The region seems to have

Species

With the available data, only the Black-winged Stilt (10%) qualifies for a mention.

Information lacking

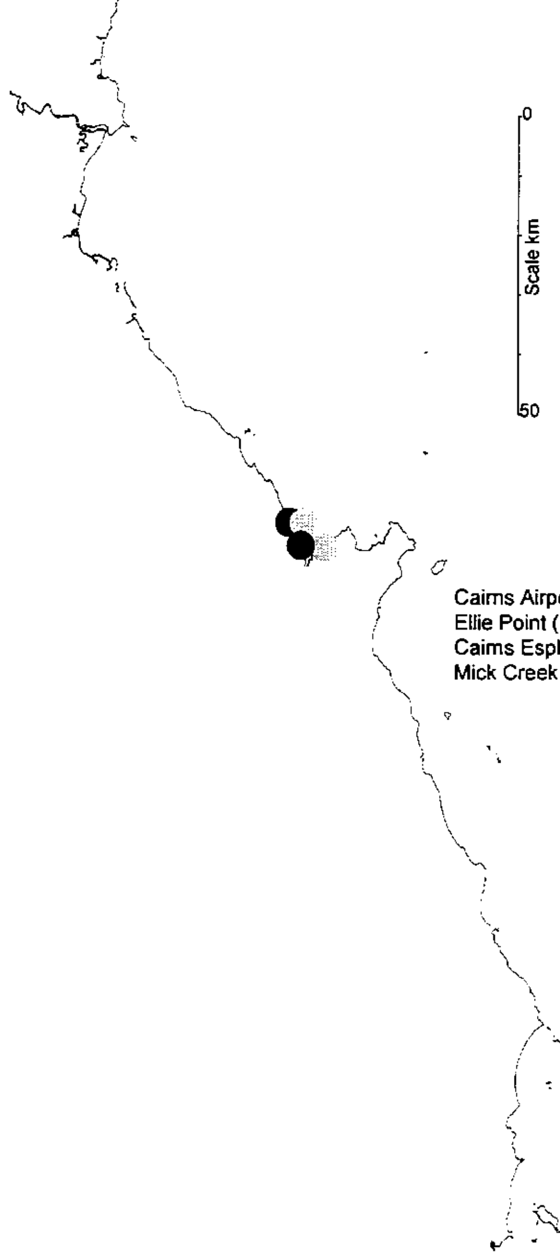
The region seems potentially important for waders, and waterbirds. However, there is a lack of accurate, detailed records. The region is in need of land or boat based bird surveys to properly ascertain the significance of the area.

Cooktown

Sources

The region (QCT) lies between Cape Melville (latitudes 14°) and Cape Tribulation (latitude 16°), but there are no records available for specific coastal sites

Figure 2 QCN. Cairns coastal wader region from Cape Tribulation to the Tully River, between latitudes 16° and 18°. Known high tide roost sites with count(s) of 300 to 1000 (light), and over 1000 (dark) are indicated. The sites are listed below from north to south and are shown on the map. Four letter computer site codes and the latitudes and longitudes are given in brackets where these are recorded, followed by the maximum count recorded for sites.



Spp. & % State total (Table 3)

	%
Sharp-tailed Sandpiper	5
Whimbrel	4

Cairns Airport saltflats (pers. comm. K. Fisher - see Pell) approx.
Ellie Point (ELPT: 16 52 41 / 145 46 36) approx. 500 (see Pell)
Cairns Esplanade (CAES: 16 54 35 / 145 46 00) mx ct: 2137
Mick Creek (27 20 30 / 153 15 30) approx. 600 (see Pell)

and no map is given. However, two counts were made in February 1985 at two small islands, Eagle and Nymph, just to the west of Lizard Island. Other database records are for aerial counts of the coastline on three occasions, February 1982, July 1983 and February 1984. The totals for all records combined consist of just 3 Beach Stone Curlew, 4 Pied Oystercatcher, 7 Sooty Oystercatcher, 13 Pacific Golden Plover, 72 Lesser Sand Plover, 101 Ruddy Turnstone, 2 Eastern Curlew, 14 Whimbrel, 87 Grey-tailed Tattler, 3 Terek Sandpiper, 186 Bar-tailed Godwit, 78 Red Knot, 14 Red-necked Stint, 8 Curlew Sandpiper and 182 unidentified waders.

Guard and Garnett (1982) recorded 573 waders by aerial survey on 9th December 1981 for the stretch of coastline between Mowbray River, just south of Port Douglas, and Cape Melville. This section of coastline lies predominantly within the Cooktown region as defined here. Therefore, I have used 600 as an estimate of total numbers, probably an underestimate, and the ratio of species as listed above to determine values for Table 2.

Sites and features

The coastline has a variety of important conservation and scenic values, but there is limited habitat suitable for a range of wader species. Both to the north and to the south of the Cape Flattery-Cape Bedford dunefields, there are some enclaves of mangroves, tidal flats and open saline areas.

Species

With the available data, only the Ruddy Turnstone (11%) qualifies for a mention.

Information lacking

It is tempting to dismiss the importance of this area entirely for waders but, as with much of the northern part of the State, inadequate information is still a problem and some more thorough sampling in strategic locations would be advisable to further clarify the situation.

Cairns

Sources

The southern part of this region largely corresponds with the Cardwell to Cairns section assessed by Pell and Lawler (1996). In addition to the records from that survey, the database holds 193 regular count records from the Cairns Esplanade for December 1977 until June 1990. There are also 37 records for Green Island over the period July 1983 to July 1984. Total counts on Green Island were never higher than 57 birds. The maximum count for the Esplanade was in 1977 at 2125 birds but summer values are generally half this number and the winter values a quarter. In September and October 1994, QWSG has records of around 1600 birds.

In determining the values in Table 2, I used the estimate of total numbers from Pell and Lawler (1996) and the ratio of feeding birds that they recorded. I then raised the individual species values in accordance with maximum values in the database and the proportions of the various species that were recorded over all the summer records that were available. I have also included a high number of Whimbrel that use Trinity Inlet (Pell and Lawler 1996).

Sites and features

A number of specific roost sites are shown in Figure 2 QCN which are those noted by Pell and Lawler (1996). Large intertidal areas are also indicated by Pell for Trinity Inlet, Mission Bay (Yarrabah) and at the mouth of the Mulgrave and Russell Rivers. Wader densities are high from the Barron River to Bessie Point and the Cairns Harbour area generally offers good wader habitat.

Estuaries and creeks south of Cairns have moderately extensive mangrove stands with less extensive open tidal flats that support small wader populations. Small roost sites were located by Pell and Lawler (1996) at the mouths of the Johnstone River and Liverpool Creek.

To the north of Cairns, there is a long stretch of open coastline but estuaries beyond Port Douglas are likely to only hold small numbers of birds. Guard and Garnett (1982) noted that waders were more abundant in Trinity Inlet than anywhere else to the north of Cairns until Princess Charlotte Bay.

Species

Whimbrels and Sharp-tailed Sandpiper occur in numbers that are four and five percent of their respective State totals.

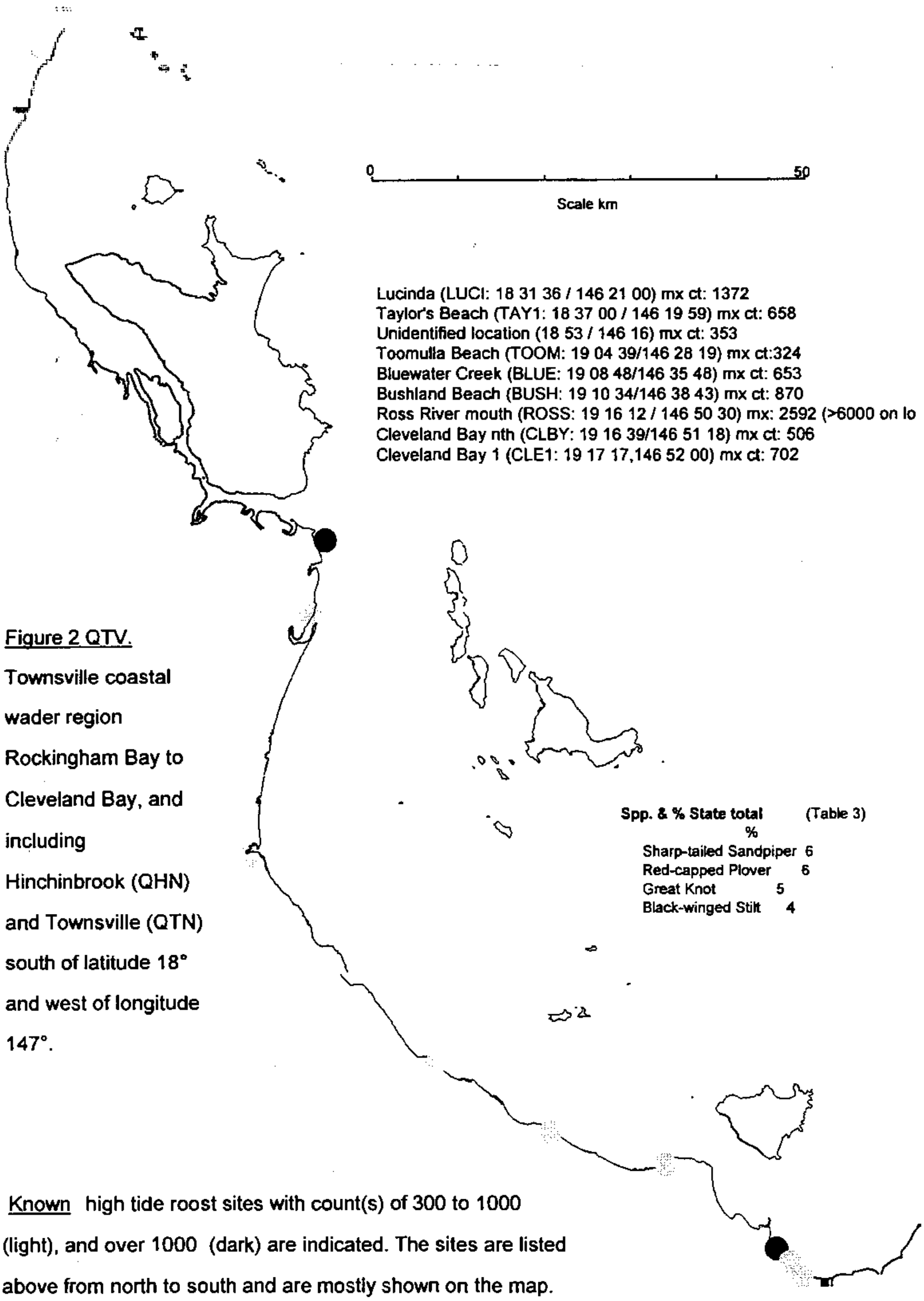


Figure 2 QTV.
Townsville coastal wader region Rockingham Bay to Cleveland Bay, and including Hinchinbrook (QHN) and Townsville (QTN) south of latitude 18° and west of longitude 147°.

Known high tide roost sites with count(s) of 300 to 1000 (light), and over 1000 (dark) are indicated. The sites are listed above from north to south and are mostly shown on the map. Four letter computer site codes and the latitudes and longitudes are given in brackets followed by the max. count

Information lacking

The recent survey work reported by Pell and Lawler (1996) has greatly clarified the distribution of waders in this region but follow up work, either as irregular checks of feeding grounds, regular roost counts or opportunistic monitoring from the air is still justified. From all accounts, the coastline north of Cairns has few good sites for waders but it could be looked at more carefully. There is also the likelihood of dramatic seasonal changes in numbers in the region and opportunistic use of some feeding grounds that normally may hold few birds.

Townsville

Sources

The Townsville region, which includes Hinchinbrook Channel, and Cleveland and Halifax Bays (Pell's sections 4, 5 and southern part of 6) has been monitored in part for several years. There are 63 regular (monthly) count records for Blakey's Crossing (BLAK: freshwater wetland in Townsville) between January 1985 and April 1990 and 44 records for the Ross River mouth (ROSS) between July 1983 and December 1987. For the latter site, there are high counts of up to 3000 birds in late spring and early summer. The database holds 32 records for Bushland Beach (BUSH) between July 1983 and February 1987 with a maximum of 870 birds and 11 records for Bolgers Bay between July 1983 and July 1984 with a maximum of 324 birds.

As a basis of estimating numbers for the region (Table 2), I used Pell's estimate of total birds and his species ratio of feeding birds coupled with his maximum roost counts for species. I then raised the species values in accordance with maximum summer counts in the database, but did not use values for Blakey's Crossing (freshwater site). I also checked these totals against recent QWSG records for the region (see Table 1).

Sites and features

There are large areas of mangroves and seagrass beds in the Hinchinbrook Channel but apparently limited feeding areas for waders (Pell and Lawler 1996). In Missionary Bay (north of Hinchinbrook Island) and around Lucinda Point (south), intertidal flats are more extensive but only in the latter area were a large (LUCI) and two small (HIGP, TAY1) wader roosts located (Pell and Lawler 1996). To the north of Hinchinbrook small wader roosts were identified at the mouths of the Tully and Murray Rivers, and Dallachy and Meunga Creeks.

Waders feed along the shores of Halifax Bay where localised intertidal areas and adjoining mangroves occur, mostly in the context of small estuaries. A number of moderately sized roost sites are indicated on Figure 2 QTV. Pell and Lawler (1996) give two additional sites at the mouths of Rollingstone Creek and Black River.

Four major estuaries empty into Cleveland Bay and there are extensive intertidal flats with associated mangroves and saltmarsh in an area of high density of waders. A sewage outfall in the vicinity of Sandfly Creek contributes to a rich food resource for the birds (Pell and Lawler 1996). There is a major roost site near the mouth of the Ross River and other roost sites farther south in Cleveland Bay.

Species

Sharp-tailed Sandpiper, Red-capped Plover, Great Knot and Black-winged Stilt occur in the region in numbers that are from six to four percent of their respective State totals.

Information lacking

Cleveland Bay is difficult to access, yet appears to be a regionally significant area for waders. Regular sampling occurs on the Ross River roost site but the remainder of Cleveland Bay is poorly known except for the recent survey. Additional regular sampling generally in the region would be most useful for clarifying the significance of sites. Assistance with boat transport is probably necessary to achieve this objective, especially in the two most important areas of Cleveland Bay and around Lucinda Point.
Also, a further look at the more expansive tidal flats around the northern end of Hinchinbrook Island might help to solve the puzzle of why an area that seems to be of potential significance, had so few waders during the recent survey by Pell and Lawler.

Upstart

Sources

High concentrations of waders occur in this region, particularly around the Burdekin River delta. Pell and Lawler (1996) divided the Upstart region into three sections and their data constitute the major source of information. In addition, QWSG receives roost counts

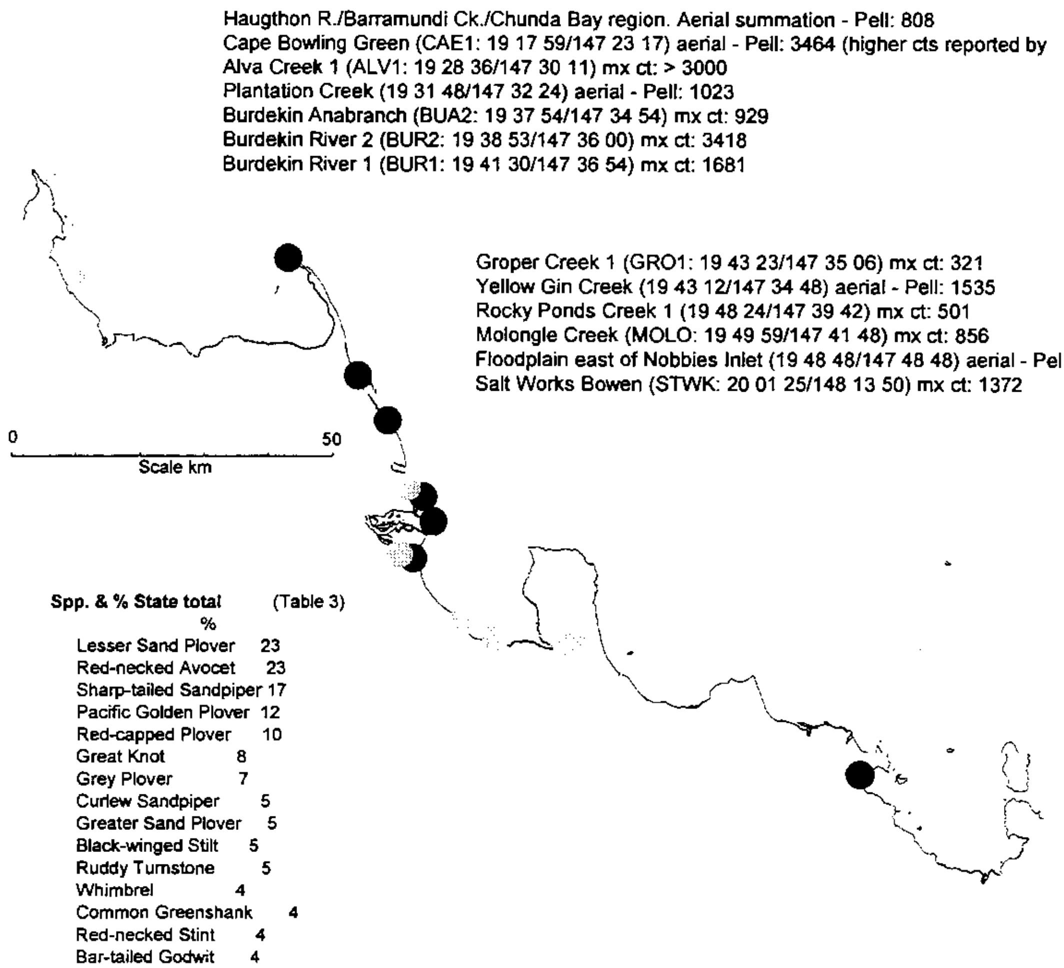


Figure 2 QUP . Upstart coastal wader region including the Bowling Green Bay (QBG), the Burdekin area (QBK) and Bowen region (QBW), between latitudes 19° and 20° 30' and longitudes 147° and 148° 30'. Known high tide roost sites with count(s) of 300 to 1000 (light), and over 1000 (dark) are indicated. The sites are listed above from north west to south east and are mostly shown on the map. Four letter computer site codes and the latitudes and longitudes are given in brackets followed by the maximum count recorded for sites.

from three sites around Bowen and has records on a few minor wader roost sites at the southern end of the Port of Bowen and Edgecumbe Bay (Driscoll 1995). There are also 138 records for the region from both regular monitoring and population monitoring in the 1980s.

The same approach to the estimate of numbers as used for the Townsville and Cairns regions has been used here. As a basis, the estimate of total numbers from Pell and his low tide ratio of species counts were used to get species totals. These were adjusted upwards if his maximum roost counts were higher, or if there were records of higher species totals for any summer.

Sites and features

Bowling Green Bay is a shallow embayment on a large, low gradient coastal floodplain with associated dune systems and other swamps (Blackman *et al.* 1996). There are four estuaries, and extensive intertidal flats, mangroves and saltmarsh. A major roost site occurs on the tip of Cape Bowling Green and at least two other smaller ones are in Chunda Bay (Figure 2 QUP) and at the mouth of Barratta Creek (Pell and Lawler 1996).

The highest number of waders in the region occur in the section of coastline from Alva Creek to Cape Upstart. This includes the Burdekin River Delta which alone caters for around 10000 waders (Pell and Lawler 1996). There are roost sites at Alva Creek, Mud Creek, Plantation Creek, Burdekin Anabranch, Burdekin River, Groper Creek, Yellow Gin Creek, Rocky Ponds Creek, Molongle Creek and Nobbies Inlet (Figure 2 QUP, Pell and Lawler 1996). Extensive mangrove stands, saltmarsh areas and intertidal flats are associated with these rivers and creeks. The Burdekin Delta is described by Blackman *et al.* (1996) as a low-lying delta, with low gradient creeks, low frontal dunes and extensive intertidal areas. These give way to brackish and freshwater lagoons and swamps. South from the Delta, southern Upstart Bay is a low coastal plain area with low intertidal mudflat extending eastwards to Molongle Creek. South and east of Nobbies Inlet are large areas of saltmarsh which also hold good numbers of waders (see Pell and Lawler 1996).

Wader numbers are less towards the south of the region from around Cape Upstart to Edgecumbe Bay. However, on occasions, large numbers of birds have been reported in the Elliott River Estuary (Pell and Lawler 1996) and the Bowen area supports a moderate but consistent number of birds on a small network of roost sites (Driscoll 1995). Patchy mangrove cover and some wide tidal flats lie along the western side of Edgecumbe Bay where there are Lesser and Greater Sand Plovers, Bar-tailed Godwit, Whimbrel and Eastern Curlew. Roosting birds were located on a narrow gravel beachfront to the north of Yeates Creek. Nearby in Sinclaire Bay, fair numbers of waders were recorded feeding on soft muddy substrate and roosting on a neighbouring sandspit (Driscoll 1995).

Species

There are fifteen species with four or more percent of their State totals (Figure 2) being recorded for the region. They are listed here with their respective percentages in brackets: Lesser Sand Plover (23%), Red-necked Avocet (23%), Sharp-tailed Sandpiper (17%), Pacific Golden Plover (12%), Red-capped Plover (10%), Great Knot (8%), Grey Plover (7%), Curlew Sandpiper (5%), Greater Sand Plover (5%), Black-winged Stilt (5%), Ruddy Turnstone (5%), Whimbrel (4%), Common Greenshank (4%), Red-necked Stint (4%), and Bar-tailed Godwit (4%).

Information lacking

The newly uncovered importance of the Burdekin River Delta and surrounding coastline, requires that the area be monitored, at least on an irregular basis. Consideration should be given to surveying the associated freshwater wetlands with a view to eventual formal acknowledgment of the importance of the whole area as a wetland complex.

Bowling Green Bay was only partially surveyed by boat and, as an existing National Park and Ramsar site, requires much more complete assessment of wader numbers and distribution. There remains some inconsistency in records from the past and what was observed by Pell and Lawler (1996).

The southern and central areas of Edgecumbe Bay (south of Bowen) are difficult to access and the coverage remains incomplete but the area seems of much less significance than other parts of the region.

Central Coast

Sources

The data used as a basis for assessment of numbers for this region are the AWSG or QWSG counts for summer or winter between 1981 to 1994 for one or

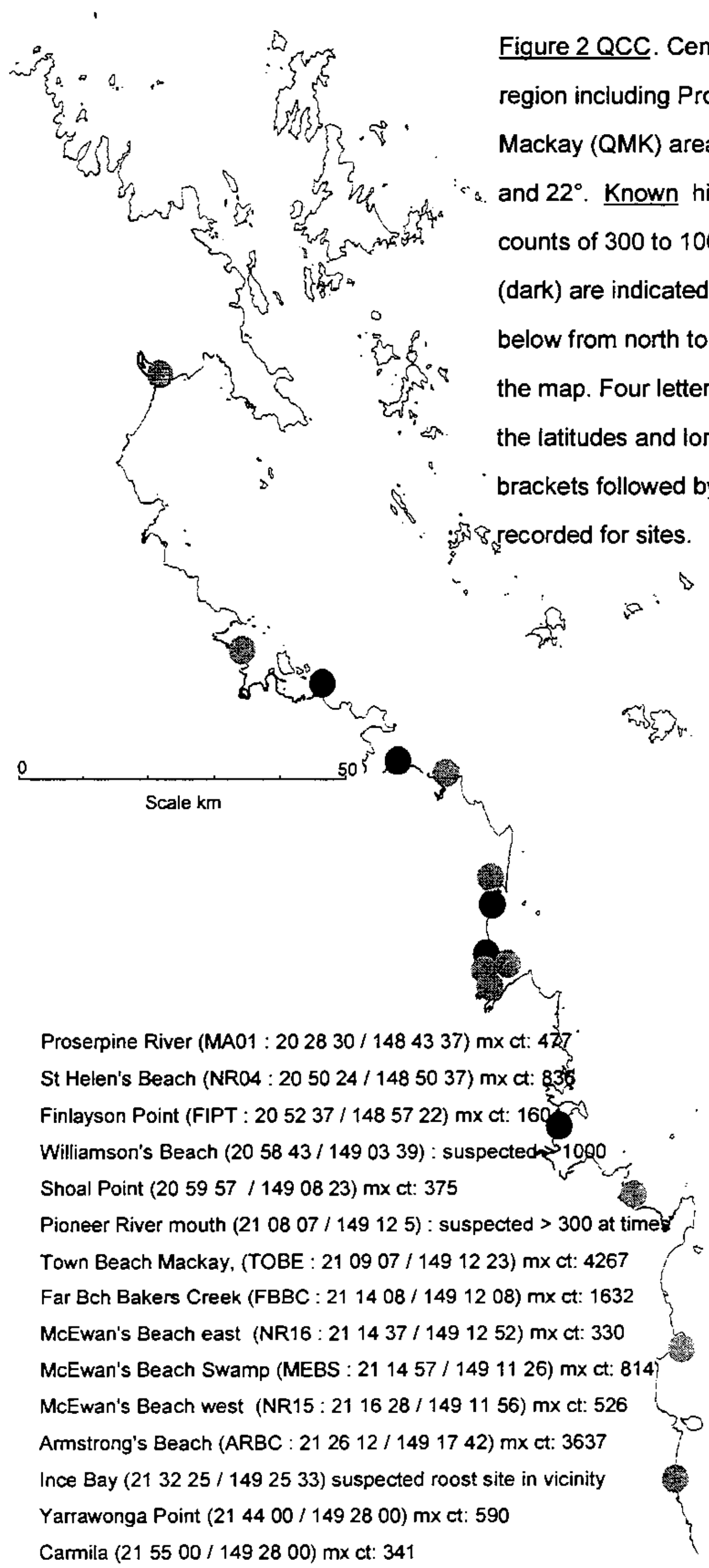


Figure 2 QCC. Central Coast coastal wader region including Proserpine (QPP) and Mackay (QMK) areas between latitudes 20° and 22°. Known high tide roost sites with counts of 300 to 1000 (light), and over 1000 (dark) are indicated. The sites are listed below from north to south and are shown on the map. Four letter computer site codes and the latitudes and longitudes are given in brackets followed by the max. count recorded for sites.

Spp. & % State total (Table 3)

Species	%
Ruddy Turnstone	21
Black-winged Stilt	16
Pied Oystercatcher	11
Lesser Sand Plover	10
Sharp-tailed Sandpiper	10
Bar-tailed Godwit	8
Grey Plover	8
Great Knot	7
Terek Sandpiper	4
Pacific Golden Plover	4
Eastern Curlew	4

Proserpine River (MA01 : 20 28 30 / 148 43 37) mx ct: 477
St Helen's Beach (NR04 : 20 50 24 / 148 50 37) mx ct: 836
Finlayson Point (FIPT : 20 52 37 / 148 57 22) mx ct: 160
Williamson's Beach (20 58 43 / 149 03 39) : suspected >1000
Shoal Point (20 59 57 / 149 08 23) mx ct: 375
Pioneer River mouth (21 08 07 / 149 12 5) : suspected > 300 at time
Town Beach Mackay, (TOBE : 21 09 07 / 149 12 23) mx ct: 4267
Far Bch Bakers Creek (FBBC : 21 14 08 / 149 12 08) mx ct: 1632
McEwan's Beach east (NR16 : 21 14 37 / 149 12 52) mx ct: 330
McEwan's Beach Swamp (MEBS : 21 14 57 / 149 11 26) mx ct: 814
McEwan's Beach west (NR15 : 21 16 28 / 149 11 56) mx ct: 526
Armstrong's Beach (ARBC : 21 26 12 / 149 17 42) mx ct: 3637
Ince Bay (21 32 25 / 149 25 33) suspected roost site in vicinity
Yarrawonga Point (21 44 00 / 149 28 00) mx ct: 590
Carmila (21 55 00 / 149 28 00) mx ct: 341

more of the following sites: Finlayson's Pt, Seaforth, Bucasia Beach, Town Beach, Baker's Creek, Armstrong's Beach, Yarrawonga Point, and Carmila Beach. In addition, several sites in the region were sampled as part of the AWSG Regular (monthly) Counts programme and included the following that were sampled between mid 1983 and mid 1984: Yarrawonga Point (ZR05, 9 records), Carmilla Beach (ZR06, 9 records), Bucasia (ZR07, 12 records), Town Beach Mackay (ZR08, 15 records), Pleystone Effluent (ZR09, 10 records), Shoal Point (ZR10, 10 records). In addition there are 79 records for Finlayson's Point (ZR11) between July 1982 and December 1990, 39 for Bakers Creek/Far Beach (ZR22) between February 1986 and February 1991 and 43 records for Armstrong's Beach (ZR23) between January 1986 and February 1991.

A survey by Driscoll (1995), and other work that included Repulse Bay (Environmental Consultants 1982, and Elvish 1986), provides supplementary data on places not covered by regular AWSG or QWSG sampling.

The approach used was first to list the maximum summer values for species from the AWSG data. Whatever appropriate additional information that was available from other areas was used to augment these maximum species counts. These additional data are from Repulse Bay to St Helen's Beach, parts of Sand, Sandringham, Llewellyn and Ince Bays, and scattered sites south from Notch Point to Carmila (Driscoll 1995).

Sites and features

The Whitsunday Passage and neighbouring coastline have not been sampled, mainly because the predominantly rocky and steep sided shorelines are unlikely to cater for many waders. Farther to the south in Repulse Bay, there are broad sandflats and some mudflats supporting a moderate area of seagrass. Expansive stands of mangroves, some saltmarsh and saline flats adjoin these intertidal feeding areas. There are rocky intertidal areas south of Repulse Bay around Midge Point. The coastline from here south to St Helen's Bay is also quite exposed and rocky.

Beginning with St Helen's Bay there are a series of estuaries and embayments all the way to Cape Palmerston that cater for good numbers of waders. There are very wide tidal flats varying from deep mud to coarse sand and well developed stands of mangroves. Neighbouring saline flats and freshwater sedge and Melaleuca wetlands have in many cases been taken over for urban development, sugar cane or other types of farming. The relative significance for waders of these embayments is difficult to ascertain, although some of the important roost sites have been monitored for several years. The main areas appear to be St Helen's Bay to Finlayson's Point, Sand Bay to Shoal Point, Mackay Town Beach to Sandringham Bay, and Llewellyn Bay to Ince Bay.

Except at the far southern end, this section of coastline lies alongside the high rainfall Central Coast Rainforests Biogeographic Zone for Queensland. The relatively high numbers of waders that occur here is possibly a reflection of the high productivity of neighbouring terrestrial ecosystems, together with expansive feeding flats that result from the physical nature of much of the coastline and an extreme tidal range.

Species

There are eleven species with four or more percent of their State totals (Figure 2) being recorded for the region. They are listed here with their respective percentages in brackets: Ruddy Turnstone (21%), Black-winged Stilt (16%), Pied Oystercatcher (11%), Lesser Sand Plover (10%), Sharp-tailed Sandpiper (10%), Bar-tailed Godwit (8%), Grey Plover (8%), Great Knot (7%), Terek Sandpiper (4%), Pacific Golden Plover (4%), and Eastern Curlew (4%).

Information lacking

Long term monitoring of parts of this region has established its significance for waders but even recently new information has highlighted significant additional sites (Driscoll 1995). There are still parts of this coastline that could be looked at more thoroughly. In particular, more basic survey work would be beneficial in the Repulse Bay area and in the bays and coastline south of Armstrong's Beach to Carmila, especially in Ince Bay and just south of Cape Palmerston.

Shoalwater

Sources

Information on significant wetlands of the region is summarised in Blackman et al. (1996) and there are a number of publications and reports suggesting certain areas are important for waders (Lane 1987, Arthington and Hegerl 1988, Schodde *et al.* 1992, Watkins 1993, O'Neill 1995).

Data for a large part of the coastline are taken from a week long sea-based wader survey of Shoalwater Bay, Canoe Passage, Island Head Creek and Port Clinton in December 1995, conducted jointly by QDEH and QWSG (Driscoll 1996). This survey did not include the coastline south from Clairview into the Broad Sound and around to Stanage Bay and West Bight, nor did it include Corio Bay. However, some auxiliary data from these other areas were presented in Driscoll (1995) but totalled no more than an additional 750 birds. Therefore, the bulk of the data referred to in Table 1 and presented in Table 2, are from the recent intensive survey when numbers of birds would have been stable and at their summer peak. The results clearly support past assertions of the importance of at least part of the region for waders.

Sites and features

The average number of waders per kilometre of mainland shoreline ranks sixth of the thirteen regions but based upon current knowledge, the birds are concentrated along much less than half of the coastline, mostly in Shoalwater Bay and Port Clinton. During the intensive Shoalwater Bay survey for waders noted above, five subareas were used. Of these, Island Head Creek and Port Clinton are separate estuaries, while three subareas within Shoalwater Bay were different in the type and combination of wader habitat. The "west" has more open water and wide intertidal flats that back onto mangroves or open foreshore. There are also some extensive supratidal saltflats and herblands. The numbers of birds and species were highest here and in Port Clinton. The "east" was quite different with very limited supratidal areas, a maze of channels and relatively narrow, steep sided intertidal flats that were backed almost exclusively by wide swathes of mangrove. By far the most numerous species here were Whimbrel and Terek Sandpiper, in a habitat which offered less variety but obviously suited these species. The "north" foreshores, including those of Townshend and Leicester Islands, were generally quite open, with small embayments often lined with mangroves between rocky headlands. Feeding areas were less extensive and there were lower numbers of birds but this area is also important for waders because it also holds good numbers and a range of species.

In the Broad Sound, fine grained sediment occurs around the mouths and upstream along the Styx River, and Waverley, St Lawrence and Clairview Creeks. However, a tidal range of 9 m results in strong currents that run across expansive intertidal flats where the substrate is mostly coarse grained sand. These course grained flats areas support relatively few waders (Driscoll 1995).

Corio Bay is part of a diverse system of local wetland types (Blackman et al. 1996) and has a variety of intertidal substrates. It supports a diverse, but small wader community that includes as many as 200 Eastern Curlew (Driscoll 1995) and, at least at certain times of the year, up to six hundred sand plover (pers. comm. W. Houston). The latter are not included in Table 2.

Species

The total number of waders for the region, and the totals for some species, are very high (Tables 2 to 4, Figure 2 QSY). The most notable records are for Terek Sandpiper (30%) and Whimbrel (42%), both over 30% of the State totals. Other species with high numbers include Grey-tailed Tattler (17%), Eastern Curlew (16%), Bar-tailed Godwit (11%), Common Greenshank (9%), Pied Oystercatcher (11%), and Grey Plover (4%). Also of note is the number of Beach Stone-Curlew that occur here and have been observed in considerable detail by Paul O'Neill in Shoalwater Bay. The number recorded in Table 2 probably understates the importance of the whole region for this resident species. The region may also be of note for Sooty Oystercatchers.

Information lacking

More general survey work is required around the Broad Sound and across into Stanage Bay, preferably as a sea-based exercise. Corio Bay also needs adequate initial surveys and could be looked at more regularly by using volunteers in conjunction with DoE or QWSG. Most of the rest of the coastline is inaccessible for regular volunteer sampling.

Only now is there detailed information on wader numbers in Shoalwater Bay, Island Head Creek and Port Clinton. Such information needs to be sought periodically in order to verify the latest results but also to look at seasonal and longer term changes in numbers. Shoalwater may be an excellent site to monitor in the sense of a control area for the detection of offshore impacts on wader numbers. It has a high density of waders and is likely to be one of the most stable, least disturbed environments on the Queensland coastline.

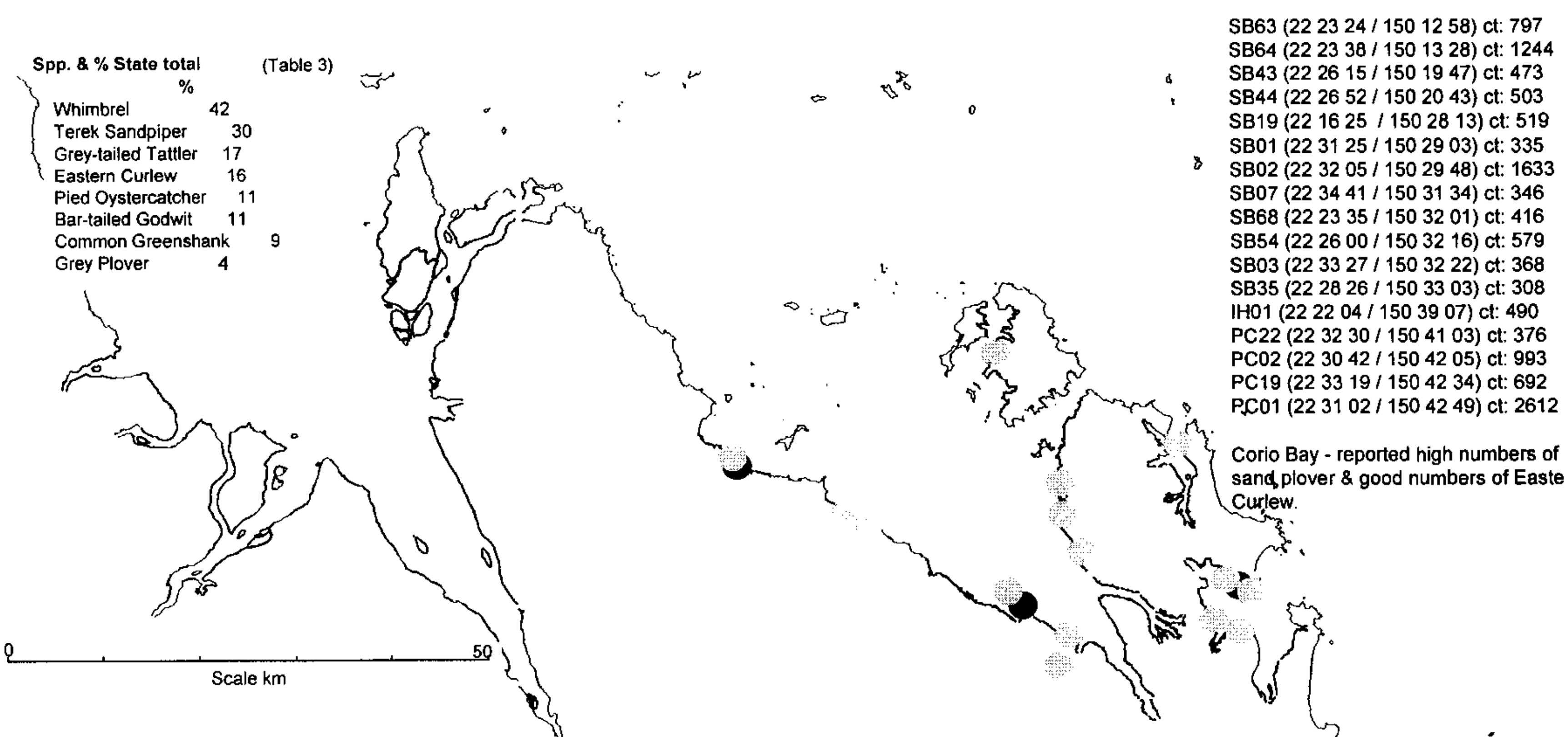


Figure 2 QSY . Shoalwater coastal wader region including the Broad Sound (QBS) and Shoalwater Bay (QSB) to Corio Bay between latitudes 22° and 23°. Known high tide roost sites with counts of 300 to 1000 (light), and over 1000 (dark) are indicated. The sites are listed opposite from west to east and are shown on the map. Four letter computer site codes are given with latitudes and longitudes in brackets followed by the count recorded during a recent survey in Dec. 1995. The first two characters of the codes indicate SB: Shoalwater Bay, IH: Island Head Creek and PC: Port Clinton. The last site listed is the southern side of the entrance

Curtis Coast

Sources

The Curtis Coast Study conducted recently and jointly by the Gladstone Port Authority and QDEH (QDEH 1994) covers the coastline defined here, except that the coastline north of Port Alma to Yeppoon is also included in the region.

Pre 1990 records cover just one area relevant to the present report at Kinka Beach, south from Yeppoon. Despite the usefulness of these data for assessing seasonal changes in numbers (see Alcorn *et al.* 1994), they represent a small proportion of the total count for the region. Most information is from special surveys (Arnold *et al.* 1993, QDEH 1994, Driscoll 1995) and from ongoing monitoring in the southern part of the region by the Port Curtis Wader Study Group. PCWSG data is regularly provided to QWSG.

Estimates for a large part of the region were reported in Driscoll (1995). These estimates have been adjusted with a) maximum values for Kinka Beach, b) subsequent sampling at additional sites in Gladstone Harbour, and c) low tide counts in areas at the mouth of the Fitzroy River and the Narrows. At the latter sites, high tide roosts have not been adequately located which probably means numbers for the region are understated, especially considering there is no information at all for Yellow Patch Inlet, a small but potentially significant area for waders on the eastern side of Curtis Island.

Sites and features

The coastline is variable and ranges from massive mud deposits, and mangrove islands and channels at the mouth of the Fitzroy River to the sandy, picturesque coastline of Seventeen Seventy. The area includes the Narrows and Curtis Island. The latter lies at the northern side of Port Curtis. Just to the south is Facing Island, which forms the eastern boundary of the Port. The tidal flats between Curtis and Facing Islands are important feeding areas for waders.

Farther to the south is a series of interconnected estuaries, much of which have been identified as important wader habitat, in particular the Seven Mile Creek to Rodds Harbour area and Pancake Creek (Arnold et al. 1993, Driscoll 1995). The estuaries have formed from former river valleys and fine mud is the predominant sediment. However, there are abundant sandy sediments at Pancake Creek (Bustard Head), Round Hill Creek (Seventeen Seventy) and Yellow Patch Inlet.

Species

The numbers of Eastern Curlew, Beach Stone-curlew and Sooty Oystercatcher in the region have been noted as significant by Arnold *et al.* (1993) .There are eight species with four or more percent of their State totals (Figure 2) being recorded for the region. They are listed here with their respective percentages in brackets: Common Greenshank (8%), Eastern Curlew (8%), Pied Oystercatcher (7%), Bar-tailed Godwit (6%), Grey-tailed Tattler (5%), Curlew Sandpiper (4%), Greater Sand Plover (4%), and Whimbrel (4%).

Information lacking

The area around the mouth of the Fitzroy River and north of the Narrows needs further sampling, despite the availability of at least some data. The number of Eastern Curlew and Whimbrel using the many channels in the area is of particular interest (Driscoll 1995), but also is the question of whether large flocks of waders sporadically use the flats, which are presumably rich in nutrients.

The Port Alma saltworks and southern side of the mouth of the Fitzroy may also be important but not until sampling is more rigorous can we be sure of the situation. Yellow Patch on Curtis Island has not been assessed at all, and nor has Keppel Creek. These sampling inadequacies may mean the number of waders for the region is a considerable underestimate.

Hervey Wide

Sources

Estimates of numbers based on a survey of the Great Sandy Strait in the summer of 1990 are reported in Driscoll (1993). Another survey was jointly undertaken in February 1995 by QWSG and QDEH, with a team of 40 people over one weekend and were reported in the QWSG newsletter of March 1995. The highest species' totals from these surveys are used here together with additional numbers recorded in Driscoll (1995) for the coastline north of the Great Sandy Strait to Seventeen Seventy. Also, there are 70 database records for counts in the 1980's but these deal with just a few sites. One of these sites, Gataker's Bay is not represented elsewhere in the data and the records have been used to augment the species' totals.

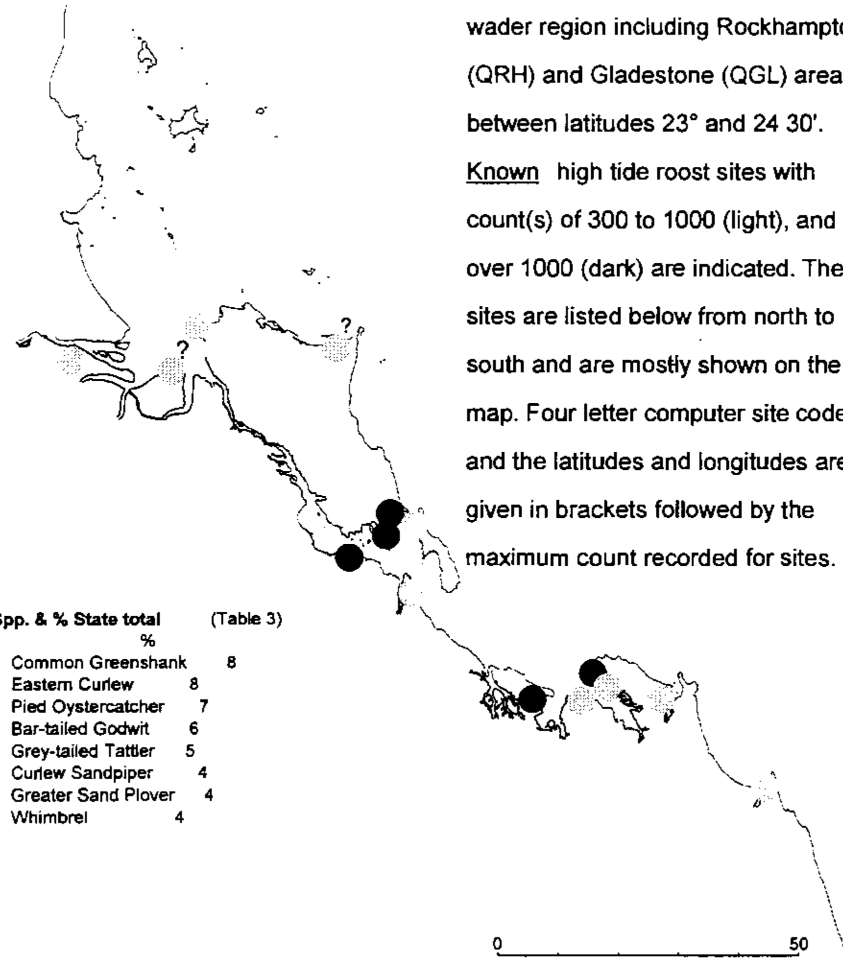
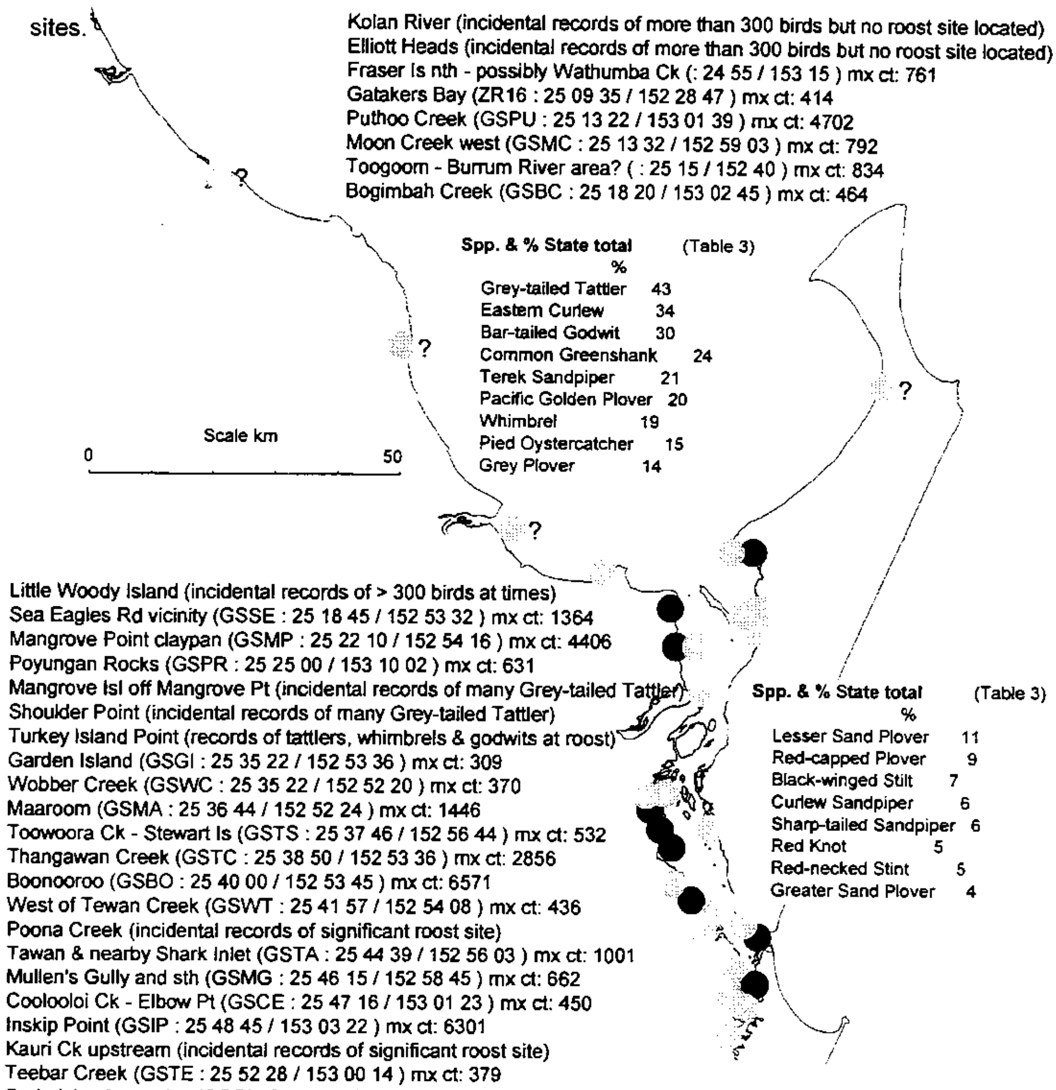


Figure 2 QCU . Curtis Coast coastal wader region including Rockhampton (QRH) and Gladestone (QGL) areas, between latitudes 23° and 24 30'. Known high tide roost sites with count(s) of 300 to 1000 (light), and over 1000 (dark) are indicated. The sites are listed below from north to south and are mostly shown on the map. Four letter computer site codes and the latitudes and longitudes are given in brackets followed by the maximum count recorded for sites.

Spp. & % State total	% (Table 3)
Common Greenshank	8
Eastern Curlew	8
Pied Oystercatcher	7
Bar-tailed Godwit	6
Grey-tailed Tattler	5
Curlew Sandpiper	4
Greater Sand Plover	4
Whimbrel	4

Sea Hill (nth west Curtis Isl. - incidental obs. suggests a roost site)
Yellow Patch (nth east Curtis Isl. - incidental obs. suggests a roost site)
Shoal Bay salt flats (23 32 / 23 32) mx ct: 445
Curlew Spit (Balaclava Isl. - incidental obs suggests a roost site)
Pelican Banks (PEBK: 23 45 31 / 151 17 07) mx ct: 1494
Farmer Point (south) (FARM: 23 46 48 / 151 19 19) mx ct: 688
Chinaman Is - sth end (CHII: 23 47 08 / 151 17 13) mx ct: 1511
Clinton ash ponds (CAPT: 23 49 44 / 151 13 25) mx ct: 1789
Boyne Island Beach (BOYN - not nec. high tide site): 23 53 44 / 151 19 44) mx ct: 364
Spit End (NR09: 24 00 25 / 151 35 55) mx ct: 1076
Morris Creek mouth (NR08: 24 01 08 / 151 37 41) mx ct: 324
Pancake Creek inner north (NR12: 24 02 42 / 151 42 40) mx ct: 639
Mundoolin Rocks (opposite) (NR10: 24 02 45 / 151 31 28) mx ct: 1223
Mangrove Bay (NR11: 24 02 53 / 151 35 16) mx ct: 882
Seventeen seventy opp. boat ramp (NS35: 24 10 18 / 151 52 35) mx ct: 377

Figure 2 QHW . Hervey to Wide Bays coastal wader region from Baffle Creek and Hervey Bay to Wide Bay and Double Island Point including the Bundaberg (QBB) and Great Sandy Strait (QGS) areas, between latitudes 24° 30' and 26°. Known high tide roost sites with count(s) of 300 to 1000 (light), and over 1000 (dark) are indicated. The sites are listed below from north to south and are mostly shown on the map. Four letter computer site codes and the latitudes and longitudes are given in brackets followed by the maximum count recorded for sites.



Sites and features

A number of small rivers and creeks with associated estuaries lie along the coastline between Seventeen Seventy and Hervey Bay. The larger of these, the Kolan, Burnett, Elliott and Burrum River estuaries each support several hundred waders as well as waterbirds and seabirds. Even the smallest estuary has a reasonable diversity of waders (Driscoll 1995). These waterways generally open onto a sandy beachfront but have estuaries of varying size where there are mangroves and tidal flats. The substrate becomes muddier upstream from the creek mouth and a range of wader species may be present throughout the estuary. Fair to medium numbers of sand plovers typically occur downstream, whereas Terek Sandpipers often occur well upstream on muddy banks. Farther south, especially south of the Burrum River, waders feed on tidal flats that lie along the open coastline, beyond the mouths of estuaries.

High numbers of waders occur even farther south into Hervey Bay and throughout the Great Sandy Strait and Tin Can Bay, feeding on expansive tidal flats alongside the mainland or Fraser Island, or on banks in the middle of the Strait (Driscoll 1993). Roughly a third of the waterway is intertidal mudflat or sandflat, and the remainder includes mangroves, seagrass, saltmarsh, sandy spits and forested islands. The Great Sandy Strait is a major feeding ground for migratory waders on the east coast of Australia (Lane 1987, Driscoll 1993, Watkins 1993) and important for a wide range of other waders, waterbirds and seabirds.

A few high tide roost sites in Hervey Bay and the Great Sandy Strait have been monitored by AWSG over the years but there are many others, primarily along the mainland shoreline of the Strait but also on Fraser Island. Most roost sites were mapped by Driscoll (1993), but a few others were found in the most recent survey of the area for waders in February 1995. The known major sites are depicted in Figure 2 QHW.

Species

There are 17 species with four or more percent of their State totals (Figure 2) being recorded for the region. They are listed here with their respective percentages in brackets: Grey-tailed Tattler (43%), Eastern Curlew (34%), Bar-tailed Godwit (30%), Common Greenshank (24%), Terek Sandpiper (21%), Pacific Golden Plover (20%), Whimbrel (19%), Pied Oystercatcher (15%), Grey Plover (14%), Lesser Sand Plover (11%), Red-capped Plover (9%), Black-winged Stilt (7%), Curlew Sandpiper (6%), Sharp-tailed Sandpiper (6%), Red Knot (5%), Red-necked Stint (5%), and Greater Sand Plover (4%).

Information lacking

The Great Sandy Strait has been intensively surveyed on at least two occasions but some areas such as the Fraser Island shoreline north of Moon Point, and the open coastline of Hervey Bay could afford to have more exploratory sampling to ascertain the significance or otherwise of these areas. The use and vulnerability of mainland roost sites is also a major management issue. Also, the activity of waders such as Sanderling and Beach Stone-curlew on the Fraser Island Beach front needs to be understood to better manage the island. The numbers of these species are not included in the totals and, at least for Sanderling, may be quite significant (R. Hobson, pers. comm.).

What is also relevant is the lack of knowledge of seasonal changes and the need for establishing a sampling programme that could look at some of the key roost sites on a regular basis but also enable a full scale assessment of numbers over the years as a basis for population monitoring. The coherent and concentrated nature of wader populations in a relatively undisturbed environment which can be readily accessed, make the area ideal as a major site for long term, comprehensive monitoring in the context of populations of the Flyway as a whole.

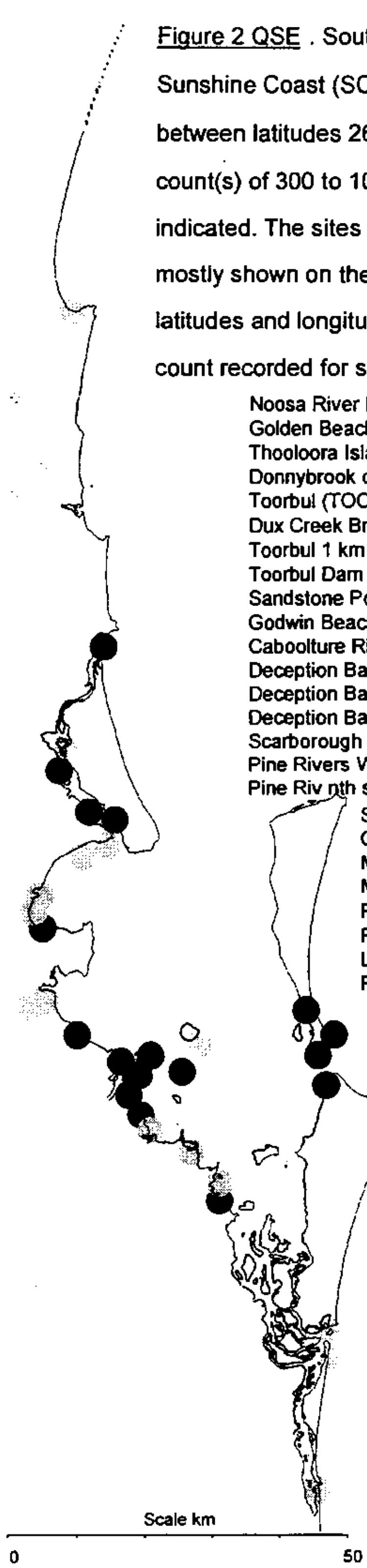
South East

Sources

By far the highest concentrations of waders in this region occur in Moreton Bay and its northern extension, Pumicestone Passage. Moreton Bay has received considerable attention from wader enthusiasts over the years, particularly since 1992 when QWSG began monitoring numbers at far more sites than had traditionally been used by counters for the AWSG. Primarily, the eastern side of the Bay, where many of the birds occur was not being sampled. A report documenting the earliest results of more intensive volunteer sampling was produced in 1993 (Driscoll *et al.* 1993). The increased interest in waders of Moreton Bay was partly created through earlier studies by Thompson and Kikkawa (1988a,b,c,1989) and Thompson (1990a,b,c,1992,1993a,b).

The main set of data for the region is for much of Moreton Bay for summer 1995 which was collected as part of the regular counting done by QWSG since

Figure 2 QSE . South east coastal wader region including the Sunshine Coast (SC), Moreton Bay (MB) and Gold Coast (GC), between latitudes 26° and 28°. Known high tide roost sites with count(s) of 300 to 1000 (light), and over 1000 (dark) are indicated. The sites are listed below from north to south and are mostly shown on the map. Four letter computer site codes and the latitudes and longitudes are given in brackets followed by the max. count recorded for sites.



Noosa River Mouth (ZR13:26 13 47 / 153 02 23) mx ct: 338
Golden Beach and northern Bribie Island (Only low tide counts done) mx ct: >1000
Thooloora Island surrounds (Tripcony Bight - occasional records) mx ct: > 500 at ti
Donnybrook claypan (DONN: 27 00 46 / 153 04 06) mx ct: 2102
Toorbul (TOOR: 27 02 30 / 153 06 30) mx ct: 4833
Dux Creek Bribie Island (DUCR: 27 03 / 153 08 30) mx ct: 4999 Nearly destroyed
Toorbul 1 km nth of TOOR (TRNT: 27 03 00 / 153 06 20) mx ct: 1418
Toorbul Dam behind TOOR (TRDM: 27 03 00 / 153 06 30) mx ct: 422
Sandstone Point (SAPT: 27 05 00 / 153 08 00) mx ct: 317
Godwin Beach (GOBC: 27 06 00 / 153 05 30) mx ct: 369
Caboolture River mouth (CABO: 27 09 06 / 153 02 15) mx ct: 680
Deception Bay Fisheries (DBFR: 27 10 36 / 153 01 40) mx ct: 321
Deception Bay (DEBA: 27 11 30 / 153 02) mx ct: 581
Deception Bay - mangroves (DBMN: 27 12 00 / 153 02 30) mx ct: 1270
Scarborough to Clontarf foreshore (SCCL/REWP: Extensive - not shown /) mx ct:
Pine Rivers Wetland Reserve (PRWR: 27 17 30 / 153 02 30) mx ct: 792
Pine Riv nth side opp. PRWS (PRNS: 27 17 53 / 153 02 00) mx ct: 894
Sandhills Moreton Is (SAHL: 27 17 57 / 153 24 15) mx ct: 2015
Cabbage Tree Creek or Dynah Is (CATC: 27 20 10 / 153 05 20) mx ct:
Mirapool Moreton Island (MIPO: 27 20 15 / 153 26 10) mx ct: 10325
Mud Island sth east rubble (MUSE: 27 20 30 / 153 15 30) mx ct: 307
Fisherman Island main roost (BSIS: 27 21 42 / 153 10 30) mx ct: 7306
Reeders Point Moreton Is (REPO: 27 21 48 / 153 25 25) mx ct: 6959
Luggage Point (LUPO: 27 22 30 / 153 09 34) mx ct: 7197
Fisherman Island clay (FICP: 27 23 35 / 153 10 30) mx ct: 1230
St Helena Is (SHIH/SHIS/SHIP/SNIH: 27 23 10 / 153 14 00) mx ct:
Amity Pt Nth Stradbrook Is (AMPO: 27 24 35 / 153 26 07) mx ct: 3
Lytton Claypan No. 2 (LYN2: 27 24 55 / 153 09 40) mx ct: 668
Lytton (LYTT: 27 25 20 / 153 09 40) mx ct: 2902
Manly Boat Harbour (MAHA: 27 27 00 / 153 11 00) mx ct: 2057
Thornside Mooroondu Pt (THMP: 27 28 30 / 153 12 00) mx ct: 495
Geoff Skinner Reserve (WEGS/EAGS: 27 29 11 / 153 14 33) mx ct
Raby Bay (CLRB: 27 31 / 153 16 30) mx ct: 4633 Destroyed (not s
Nandeebie Park Clevel (NAPK: 27 31 59 / 153 16 49) mx ct: 842
Oyster Point (OYPO: 27 32 10 / 153 17) mx ct: 826
Thornlands Rd (THLD: 27 33 30 / 153 16 58) mx ct: 1838
Swan Bay Nth Stradbrooke Is (SWBA: 27 43 48 / 153 26 21) mx ct:
Nth South Stradbroke - north tip (NSST: 27 45 28 / 153 26 26) mx

Spp. & % State total (Table 3)

	%		%
Bar-tailed Godwit	34	Black-winged Stilt	11
Red-necked Avocet	31	Common Greenshank	11
Pied Oystercatcher	29	Lesser Sand Plover	11
Eastern Curlew	26	Terek Sandpiper	8
Ruddy Turnstone	25	Pacific Golden Plover	6
Grey-tailed Tattler	24	Greater Sand Plover	6
Curlew Sandpiper	21	Marsh Sandpiper	5
Grey Plover	14	Sharp-tailed Sandpiper	5
Whimbrel	11		

1992. Some minor sites in the Bay weren't counted at the time and records for other summer periods for these sites have been included. For the Raby Bay roost site, which was destroyed prior to 1995, the summer 1993 maximum was used.

There has been recent regular counting for the Gold Coast at minor sites and the 1995 count was used. However, other incidental records for a site on the Spit and one at the southern end of South Stradbroke Island have also been incorporated.

A total for Pumicestone Passage (not included above) was taken from estimates of numbers by Thompson (1990) and Driscoll (1991). Farther north in the Currimundi estuary and the Noosa River mouth, which are not currently being monitored, a few early AWSG counts were used as minor addition to the totals.

Sites and features

There are many kilometres of open beachfront in the region. In the north, it represents the predominant type of shoreline. High numbers of waders occur farther to the south in the maze of estuaries and rich tidal flats that are sheltered by the large, inshore sand islands of Bribie, Moreton, North and South Stradbroke. Together, these islands form Pumicestone Passage and Moreton Bay.

The feeding substrate for waders differs throughout Moreton Bay with a major distinction between predominantly muddy sediment on the western side and sandier sediment on east shores which is reflected in the relative numbers of different species of wader. Variation also occurs along the western foreshore due to local impacts from sewage outfalls, direct disturbance of birds and changes in the substrate including the cover of seagrass (see Thompson 1992). Major feeding areas occur in Tripcony Bight and between Donnybrook and Toorbul in Pumicestone Passage, in Deception Bay, Hays Inlet, and the shoreline between Nudgee all the way south to Redland Bay.

The expansive flats at the southern end of Moreton Island and the western side of North Stradbroke Island to Russell Island hold the highest concentrations anywhere in the Bay. Farther south in the Bay, where the tidal flats are narrower along a network of channels, waders appear to be less numerous. Within the Broadwater and channels of the Gold Coast, waders can still be found but in much lower densities than in the central regions of Moreton Bay.

Most major and minor roost sites have been identified and are being monitored by QWSG and many of these are mapped in Figure 2 QSE. Sites with even smaller numbers of birds have also been identified and a very general assessment of the conservation status of roost sites in Moreton Bay is presented in Lawler (1995). The roost sites take a variety of forms and come under the control of both Government and private ownership. In many instances, birds are using artificial structures and substrates where there has been significant loss of more natural roost sites.

Species

There are 17 species with four or more percent of their State totals (Figure 2) being recorded for the region. They are listed here with their respective percentages in brackets: Bar-tailed Godwit (34%), Red-necked Avocet (31%), Pied Oystercatcher (29%), Eastern Curlew (26%), Ruddy Turnstone (25%), Grey-tailed Tattler (24%), Curlew Sandpiper (21%), Grey Plover (14%), Whimbrel (11%), Black-winged Stilt (11%), Common Greenshank (11%), Lesser Sand Plover (11%), Terek Sandpiper (8%), Pacific Golden Plover (6%), Greater Sand Plover (6%), Marsh Sandpiper (5%), and Sharp-tailed Sandpiper (5%).

Information lacking

The region includes the open beachfronts of the Cooloola Coast, Noosa North Shore, Moreton, Bribie, North and South Stradbroke Islands. No data from these open beaches was readily available which would mean that species such as Sanderling, Red-capped Plover, sand plovers, Beach Stone-curlew and Pied Oystercatcher are understated in Table 2. The latter species probably being most severely under represented as a consequence. However, this type of error is inherent in the assessments made for other regions as well.

Insufficient basic survey work has been conducted in southern parts of the Bay down into the Broadwater. Consequently there is no regular monitoring of sites in the south. There is also a need for a comprehensive review of the location and status of both feeding and roosting sites for waders in Moreton Bay where there are a number of threats to these sites linked to the close proximity of an expanding city.

Distribution patterns

The following comments are based upon Figures 3 and 4, and Table 2 which give an indication of the

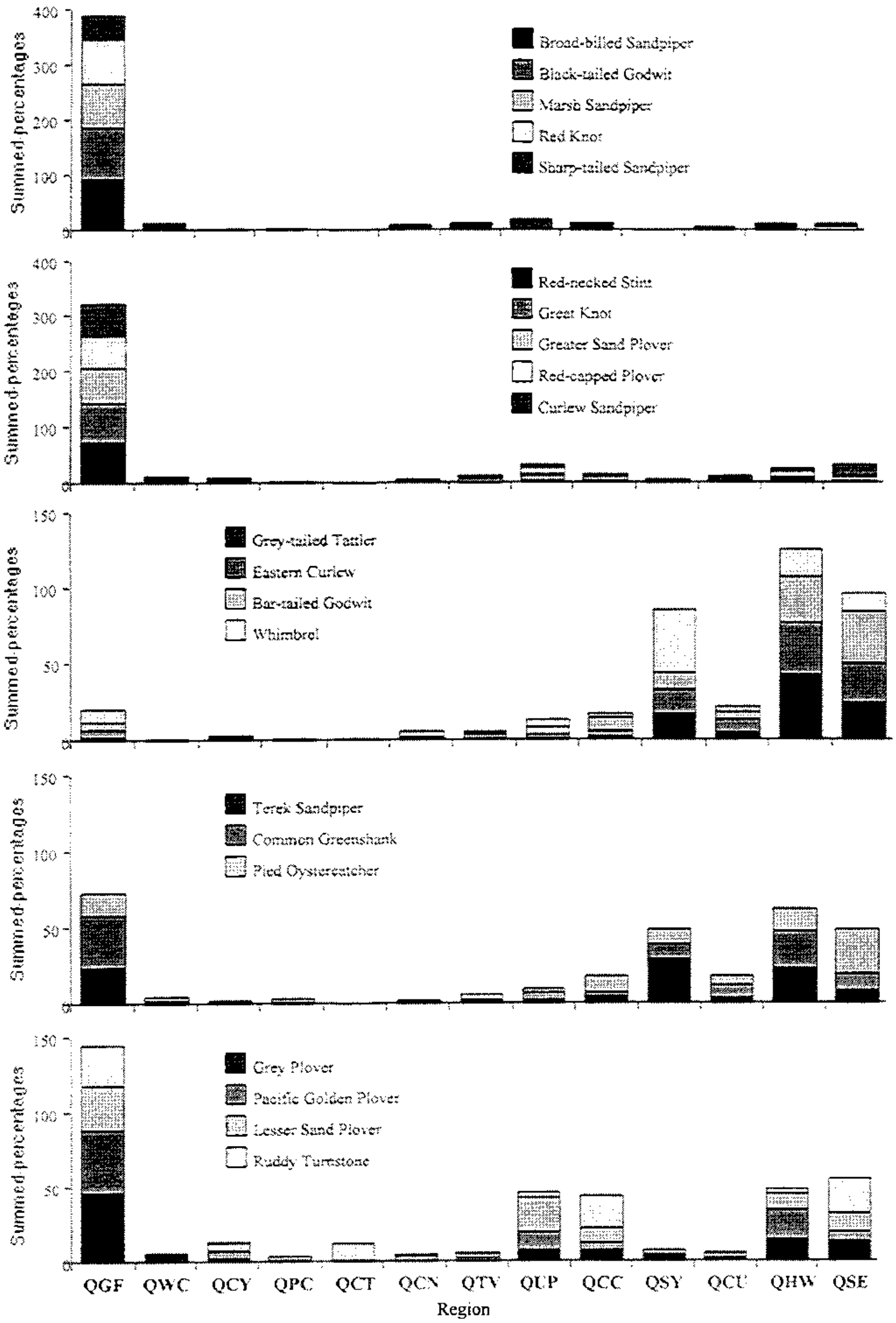


Figure 4. Groups of species showing similar distribution patterns between regions. The region codes can be matched against names and locations given in Figure 1 The histograms are derive from values in Table 3.

distribution of waders throughout coastal Queensland. In some instances, regional variation in the numbers of a species is pronounced but in others is only suggestive of possible variation in distribution. This section begins with comments on total numbers and the density of waders (birds per kilometre of mainland coastline), followed by a consideration of the groups of species with similar distribution patterns (Figure 4).

There has been no attempt to statistically test any hypotheses and the comments to follow are speculative. An important consideration is that the length of coastline differs between the regions and to help account for this bias a measure of birds per kilometre of coastline for the regions is given in Table 2. Nevertheless, some places within a region (subregions) may be highly populated with waders and others sparsely populated and in this respect the measure of numbers per kilometre can also be misleading. What is needed for a better comparison of variation in the density of waders is a full assessment of the extent of suitable habitat in each region.

Based on the figures for all waders, the Gulf has almost 51% of the State total (Figure 3). At the other extreme, the regions from Central Western Cape to Cairns have about 6% of the total over a much longer length of coastline at an average of about 10 birds per kilometre compared with 263 birds per kilometre for the Gulf (Table 2). However, there are some concentrations of waders in the regions around Cape York and farther south which have been mentioned in the Regional Accounts (eg. Cape Keer Weer, the Jardine River area, Princess Charlotte Bay and Cairns). South of the Cairns region, wader numbers are higher and for some species much higher than in the Gulf.

The contrast between the Gulf and other parts of the State is less pronounced in terms of birds per kilometre of mainland coastline than in terms of total numbers. The Hervey Wide and South East regions have around 100 birds per kilometre of coastline or about 40% of the value for the Gulf. Next in order of magnitude is the Upstart region with about 50 birds per kilometre and then Townsville, Central Coast, Shoalwater and Curtis Coast with around 20 to 30 birds per kilometre. In terms of total numbers, a simple ranking of regions is similar, although Upstart and Townsville do not rank as highly.

On the basis of similarity in the regional distribution of numbers for individual species, five species groups have been subjectively determined (Figure 4, Table 2). For two of these groups (ten species), the Gulf holds the highest numbers of birds. Each of the ten species has more than 50% of its numbers in the Gulf. Four species of the first group (Broad-billed Sandpiper, Black-tailed Godwit, Marsh Sandpiper and Red Knot) have a particularly high percentage representation in the Gulf. However, the Marsh Sandpiper is probably relatively more common elsewhere than indicated by these results since it is a species that also uses freshwater wetlands. In the case of Red Knot, medium sized flocks are recorded during the southward migration in Moreton Bay (Thompson 1992) and, judging from flag sightings and recaptures (QWSG records), many birds move through South Eastern Queensland to New Zealand and south eastern Australia. Similarly, Sharp-tailed Sandpiper are recorded in higher numbers during southward migration than in summer in Moreton Bay (QWSG records) when many are travelling through to New South Wales and Victoria.

The five species of the second group depicted in Figure 4 (Red-necked Stint, Great Knot, Greater Sand Plover, Red-capped Plover and Curlew Sandpiper) also have a high percentage representation in the Gulf but appear to have reasonable and stable numbers in other parts of the State as well. For instance, the Great Knot is found in good numbers in the Townsville, Upstart and Central Coast regions and in lower, but consistent numbers farther south in Moreton Bay. Curlew Sandpiper numbers also indicate an uneven spread of birds in addition to the high numbers in the Gulf. Moreton Bay has high numbers of this species in comparison to other regions.

In contrast to the first two groups, species of the third group (Grey-tailed Tattler, Eastern Curlew, Bar-tailed Godwit and Whimbrel) have their highest numbers in the southern parts of the State where from 77% to 88% of their State totals are from the regions of Shoalwater and those farther south. Fewer than 8% of counts of any of these species were for the Gulf. Members of the fourth group (Terek Sandpiper, Common Greenshank and Pied Oystercatcher) tend to conform to this pattern as well, but with lower percentages for the southern regions of around 60% and correspondingly higher values for the Gulf. The Terek Sandpiper has distinctively high numbers in three regions: Shoalwater, Hervey Wide and the Gulf.

Species of the last group (Grey Plover, Pacific Golden Plover, Lesser Sand Plover and Ruddy Turnstone) appear to be distributed more evenly along the east coast as well as occurring in high numbers in the Gulf. However, Lesser Sand Plover numbers tend to be relatively higher in the Upstart and Central Coast regions than they are in south east Queensland (see also Pell and Lawler 1996). The Ruddy Turnstone appears to have an unusual distribution pattern but the overall counts are quite low and it is difficult to be conclusive.

Surveys and monitoring

At the AWSG conference, the workshop on Surveys and Monitoring came up with a number of survey objectives that included:

- to determine the significance of sites for waders
- to fill gaps in knowledge of distribution
- to generate information in a form suitable for planning purposes
- to provide local stimulus, support and training
- to assess areas under imminent threat
- to assess the status of rare and threatened wader species

At least the first four of these objectives would apply to any further survey work in Queensland. How the surveys would be organised and funded needs to be addressed, but DoE and QWSG in the past have worked effectively together. AWSG involvement may also be desirable, as would that of tertiary institutions and local community groups.

In the "Information Lacking" section for each region, several locations have been identified where there is a lack of basic information on bird numbers and distribution. Also, in general there is very little information on the relative significance of particular feeding sites, information that requires close observation of bird movements and feeding behaviour.

Basic survey work is still needed in particular regions, especially in the Gulf where too few ground surveys have been conducted to determine accurately the distribution of birds and the relative significance of roosting and feeding sites. Seasonal changes in numbers in the Gulf are also poorly known and consideration should be given to collaborative involvement of Government and non-Government organisations to establish better baseline data and monitoring regimes for one of the most significant wader regions in the Flyway.

Moreton Bay and central Queensland coastal areas around Mackay are also in urgent need of further survey but more from the point of view of existing and increasing threats from pollution and loss or disturbance to feeding and roosting habitats. That is, there is a need in these areas for appropriate conservation planning to be put into place using the latest and best knowledge available that includes information on the status of habitats and detailed information on local movements of birds.

There is a need, and a responsibility of Governments under international agreements, to play a role in monitoring wader numbers and encouraging research programmes. The AWSG conference has determined that wader populations are under increasing threat, particularly from habitat loss in other parts of the Flyway. Australia is well placed with human and material resources, and as the main non-breeding destination for waders in the Flyway, to take a leading role with research and monitoring. Queensland needs to participate in monitoring within a broad framework that is consistent with the activities of other Government and non-government organisations.

The workshop on surveys and monitoring provides a set of guidelines as a basis for designing and managing wader monitoring programmes, many of which would be applicable to a review of the current monitoring of waders in Queensland and to any expansion of that programme, hopefully with Government backing and financial assistance. The guidelines included:

- Monitoring of sites should be based on a thorough knowledge of how waders use that site. In this respect, it was important not to fix the focus of the monitoring counts too tightly, as conditions for ideal monitoring counts often occurred under a locally specific set of weather/tidal/rainfall conditions.
- An integrated and consistent approach was required to monitoring throughout the flyway. This should focus on a set of "prime" monitoring sites with an additional set of "secondary" sites.
- It was absolutely essential to achieve constant effort in monitoring between years.
- Existing and new survey/count results could provide clear guidance on whether a site was suitable for the foregoing.
- It was necessary to ensure that the data generated by monitoring counts was uniform. This required consistency of observer skill, wader identification and counting expertise and knowledge of the area.
- A thorough statistical analysis of existing monitoring count data should be undertaken as a basis for designing future monitoring approaches.
- It was essential that at least two replicate counts of an area were undertaken in a monitoring "window period".
- It was essential to establish the levels of change that researchers should be concerned with. This relates to two matters a) the nature of the sampling design (ie it should be sufficient to detect the relevant level of change with the desired level of precision), and b)

the point at which concern for the status of a species triggers remediation measures. The levels of change would need to be established through consensus among wader researchers and with government agencies responsible for wildlife/environment management and remediation. In this respect, an understanding of natural changes was essential.

- There should be investigation of the means of monitoring environmental change in wader habitats in order to establish the causes of change. These may vary between sites.
- Autecological studies of how waders respond to changes in their habitat were an important research priority in understanding population changes.
- Wader and habitat monitoring should, where possible, be cognisant of and be linked with existing local and/or national environmental monitoring programmes (eg State or the Environment Reporting).
- Migratory studies should include attempts to understand the nature of staging site turnover and how this might change in response to habitat change and loss.
- It is absolutely essential that monitoring not be undertaken in a manner that generates its own change.
- Monitoring should cover all periods of the life cycle of the bird: adults and juveniles; breeding; migration; and non-breeding grounds.
- Monitoring should be done in a manner that is coordinated with migration studies so that declines can be related to particular species, sub-species, populations, sites and/or habitats.
- Rare and threatened species may require separate, targeted monitoring programmes.
- Banding should continue to be undertaken on the breeding grounds to obtain valid data on breeding success.
- It is necessary to develop simple indicators of habitat change that can be related to changes in wader numbers.
- For all of the above, it would be essential to train sufficient people to enable all parts of the Flyway and of the birds' life cycle to be monitored.

The foregoing desirable features of a monitoring programme are the responsibility of any group involved with monitoring. Inadequacies in procedures in one area will serve to weaken the usefulness of work done elsewhere.

Potential threats to wader habitats

This section provides a summary of the broad categories of potential threat to wader habitats in Queensland. An appraisal of these threats in particular regions is summarised in Table 4. The broad categories of threat are:

- water pollution;
- siltation and sedimentation;
- hydrodynamic changes;
- feeding habitat loss;
- roosting habitat loss;
- human disturbance;
- encroachment of development; and
- aquaculture and ponded pasture

These are described briefly below, together with general strategies for minimising their likelihood of occurrence. In assessing the level and sources of threat to wader habitats, managers are encouraged to gather first hand information on the threats in their region and not rely on the general information provided in Table 4.

• Water pollution includes any pollution of waterways that might occur in concentrations sufficient to affect the invertebrate food supply of waders. A potentially significant source of pollution is sediment runoff which can smother intertidal ecosystems or increase turbidity leading to reduced photosynthesis by epibenthic algae and seagrass. This has the potential to reduce the abundance of intertidal invertebrates. Organic nutrient pollution is potentially significant as the eutrophication it causes can lead to substantial changes in the species mix of intertidal invertebrates and, consequently, the range of wader species for which food is available. Although it has not been studied, levels of fertilisers, pesticides and herbicides running off into coastal rivers from hinterland agriculture may also lead to similar changes. Heavy metal pollution may also impact upon waders, causing physiological dysfunction and a decline in breeding success. Toxic pollution is generally declining in Australia due to better regulation and environmental management, and there are few examples of serious toxic pollution in Queensland coastal waters.

Massive spillage of oil or other dangerous liquids from ships or coastal installations could have serious impacts on waders and wader habitat. The potential for a disaster is greatest where bird numbers are high in the proximity of major ports or shipping routes such as Moreton Bay, Gladstone Harbour and in the vicinity of Karumba.

It is beyond the scope of this report to describe all the ways in which water pollution can be prevented and controlled. Suffice it to say that all potential water pollution associated with development in and near wader habitat and in the hinterland draining to such habitat should be identified during the environmental

Table 4

Threats to wader habitat in regions of coastal Queensland

The table gives a subjective appraisal of broad categories of threat
The categories are described in the text and are based on a detailed list of more specific threats given by Lawler (1994, pp 36-37).

Two levels of threat are used in the table as follows: serious specific and imminent (•), general and/or medium term (+). Threats may well apply in regions other than those listed. It is not a comprehensive assessment, intended only as a guide requiring input from other sources.

Region name (See Table 1 and Figure 1 for details)	Gulf	Central West Cape	Cape York	Princess Charlotte	Cook-town	Cairns	Towns-ville	Upstart	Central Coast	Shoal-water	Curtis Coast	Hervey Wide	South East
Region code	QGF	QWC	QCY	QPC	QCT	QCN	QTV	QUP	QCC	QSY	QCU	QHW	QSE
Threat category:													
Water pollution						+	+	+	+		+		+
Siltation /sedimentation						+		+			+		+
Hydrodynamic changes						*					+		+
Feeding habitat loss						*							+
Roosting habitat loss						*			+		+	+	*
Human disturbance					+	*	+	+	*	+	+	+	*
Encroachment of development						*			*		*	+	*
Aquaculture or ponded pasture	+	+					+	+		+		+	

impact assessment stage and adequate environmental management measures put in place to prevent pollution.

• Siltation and sedimentation can lead to water pollution described above and its consequences. There are many causes of siltation and sedimentation. These include but are not limited to: inadequate erosion and sediment control measures at coastal development sites; excessive hinterland erosion due to inappropriate land management practices; and dredging operations (either capital or maintenance).

Techniques are available for reducing the generation of sediment during construction and dredging works in coastal areas. The erosion and sediment control measures in plans for the construction and operation of coastal developments should be critically reviewed at the impact assessment stage to ensure they will prevent harmful sedimentation. Sediment generated during dredging can be minimised through a range of techniques, including ensuring adequate settling of sediment from tail waters at dredge spoil disposal sites.

• Hydrodynamic changes are permanent changes in water current speed and direction (eg. tidal currents) due to coastal reclamation, dredging, changed river entrance structures, marinas and canal estates. Dredging can lead to a drop in current velocity. Coastal reclamation can concentrate flow, leading to higher velocities. Changes in harbour and river entrances can lead to changes in tidal range with possible consequences for wader habitat. The construction of marinas and canal estates in coastal waterways increases the volume of water in the waterway, leading to increases in tidal current velocity. Reduced current velocity may increase the deposition of sediment that otherwise might flow out to sea. Increases in current velocity may lead to erosion of the seabed. These changes can affect the stability and total area of intertidal feeding areas for waders.

Hydrodynamic changes cannot generally be avoided with such developments and often, they have insignificant effects on wader habitat. However, any such development that has the potential to affect hydrodynamic processes in and near wader habitats should be subject to appropriate analysis of possible changes and the likely impact of these on beaches, mangroves and intertidal feeding areas.

• Feeding habitat loss in Table 4 refers to the direct loss of intertidal wader feeding habitat through reclamation or occupation of intertidal land for coastal development. A range of developments cause this loss, although it may be prevented or minimised by appropriate design. Developments such as marinas, ports, canal estates and tourist resorts have, in the past, lead to direct reductions in the area of wader feeding habitat.

No reclamation of intertidal habitat should be allowed in intertidal areas used by significant numbers of waders. If required for infrastructure (eg. piers, etc.) then the area involved should be kept to an absolute minimum.

• Roosting habitat loss in Table 4 refers to the destruction of coastal high tide wader roosting habitat, usually as part of a coastal development. A range of developments cause this loss, although it can be avoided or compensated for with appropriate design. Developments such as marinas, ports, canal estates, residential and industrial estates and tourist resorts have, in the past, lead to significant losses of high tide roosting habitat.

Roosting habitat loss can be prevented through appropriate local government strategic planning measures and state government reserve planning and acquisition policies aimed at protecting habitat. Where existing development rights exist, sensitive development design, perhaps involving allocations of open space over wader habitats in exchange for development opportunities in non-sensitive areas, should be pursued.

• Human disturbance occurs when too many horses, dogs, windsurfers, boats, fishermen, bait collectors and people in general approach feeding or roosting waders on a regular basis, leading to a significant reduction in the availability of that habitat to waders. Human disturbance can be generated by increased access from new road and track construction, increased off-road vehicle activity in an area, and the advent of new urban development close by. Even the inappropriate siting of visitor facilities in national parks and other reserves can lead to detrimental human disturbance of waders. Waders are particularly vulnerable to disturbance when roosting at high tide because few alternative, secure sites are available to them.

Human disturbance needs to be prevented by not allowing development to encroach too close (see below), through government (state and local) and community group public education activities, by providing infrastructure for preventing disturbance (fences, tracks, bird hides) and by limiting access and facilities near significant habitats.

• Encroachment of development refers to increased development and human population in and near areas used by waders. This leads to a general increase in all of the foregoing potential threats.

Preventing the encroachment of development on sensitive wader habitat is an issue that must be tackled in local government strategic planning and in state government reserve planning and acquisition programmes.

• Aquaculture and ponded pasture. Aquaculture refers to both land-based aquaculture operations and water-based operations such as cage and oyster culture. The former can lead to losses of upper intertidal and hinterland wader roosting habitat and the latter (in particular oyster farming) has the potential to occupy intertidal wader feeding habitat. Land-based and cage-based aquaculture can lead to significant impacts on water quality, particularly with regard to nutrients and turbidity.

The development of ponded pastures on marine plains in the Broadsound area (Cummins 1991) and the possibility of similar developments elsewhere (Doohan 1991), particularly in the Gulf of Carpentaria, is a potential threat to both feeding and roosting habitats of waders (Clarkson 1991). Not only is there the possibility of direct loss of habitat but increased pollution, changes in the supply of nutrients, and alteration of freshwater and tidal currents could affect the quality of feeding habitat. Trampling of areas by cattle could also impact upon local populations of waders.

Preventing the encroachment of aquaculture and ponded pasture onto significant wader habitat depends on appropriate strategic planning by local government and reserve planning and acquisition policies by state government. Where neither has been possible and a significant area is subject to a development proposal, the environmental impact process will need to identify the scope for potential losses and disturbance to wader habitats (both high tide roosts and intertidal feeding areas) and identify and implement effective design and management measures to prevent detrimental effects.

On the basis of the threats in particular regions given in Table 4, the following points can be made.

The most significant imminent threats to waders and their habitats on the Queensland coast, based on the number of regions they affect, are:

- human disturbance;
- roosting habitat loss; and
- the encroachment of development.

The most significant medium-term threat to waders and their habitats in Queensland include the above-listed threats which will emerge as human population and development pressure continue, in currently, more isolated regions. In addition to these, water pollution, siltation and sedimentation, and aquaculture and ponded pastures are potential medium-term threats.

The regions experiencing the most imminent problems from the foregoing threats are:

- the Cairns region, due to the well known regional significance of the city foreshore for waders combined with its proximity to the city and associated human and development pressures;
- the Mackay region of the central coast which continues to expand through urban and coastal developments that impinge upon important wader habitat;
- the Curtis coast, as one of Queensland's largest port and industrial development areas; and
- the South-east region, where population growth, high levels of coastal urban development and coastal recreation are placing unprecedented pressures on waders and their habitats, particularly in Moreton Bay.

There is also a potential for serious disruption of very significant mainland roost sites in the Great Sandy Strait that currently have no formal conservation status. Other medium-term threats exist due to patterns of human population growth and development along the Queensland coast.

A potentially significant threat to waders on the Queensland coast comes from likely future aquaculture development. Queensland is very suited to both land-based and water-based aquaculture and this industry is emerging as a significant source of seafood (and investment income) as wild, capture fisheries decline around the world. The potential impacts of this type of development on waders should be considered in planning the development of this industry. Of particular concern is the possibility of aquaculture developments in the Gulf of Carpentaria where the density of waders is very high and little is known about local distributions and habitat use.

The above threats affect about half the wader habitats in Queensland and probably much less than half of the total number of waders in the State. Significantly, the Gulf of Carpentaria and the Cape York coastline south to Cairns are experiencing no widespread threats. Human population densities are low and development pressures are confined to comparatively small areas. However, potential impacts from the foreshadowed port development at Karumba and localised disturbance to roost sites (Garnett 1989) sbould be carefully monitored in an area of sucb prime importance to waders. There is also the potentially disastrous consequences for waders of a shipping accident and fuel spillage in the Gulf.

It is species confined more to the southern part of the State that require the greatest attention in threat mitigation strategies (see Table 3 and Figure 4 for species that occur in large proportions in southern regions). In places such as Moreton Bay and the Mackay coast, identification, protection and management of important areas is urgently needed.

Mitigation of threats may include the enhancement and restoration of feeding or roosting habitats as practised overseas (Helmers 1992). There are many examples of artificial roost sites in Australia and some instances of intentional creation of these sites, sucb as in the Hunter River Estuary. In Moreton Bay there is the possibility of this approacb in some areas where natural roost sites have been lost (Lawler 1995).

Valuing wader habitats

Valuing wader habitats is the first step in developing guidelines and measures for their protection. The stringency with which planning and management measures are applied to wader habitats will vary depending on the value of the habitat.

Until now, planning and management on the Queensland coast have been based on general statements like "all intertidal areas in region x are important for waders". This statement is neither useful biologically nor informative in the various processes and fora (many of which are political) involved in the State's complex land-use planning system. It is also the kind of blanket claim that, if rejected due to its generality and uselessness for detailed planning, could lead to the loss of significant habitats. It also has the potential, if used regularly, to devalue, in the eyes of decision-makers, all wader habitats, including the most valuable ones. Clearly, a more sophisticated, pragmatic approach is called for.

Counting the numbers of waders at roost sites has long been used as a basis for determining the significance of wader habitats. The information in this paper, combined with other data that may be available locally, offers a reasonable start to valuing coastal wader habitats in Queensland. However, analysis of the roost count data presented here in order to place a value on every roost identified so far in Queensland is beyond the scope of this report.

As indicated in the Regional Accounts, the data are by no measure complete. Local Department of Environment staff may have access to local information that is not included in the data base and local bird-watchers may have more data. The following discussion is presented to aid local planners and managers in valuing wader roosts (and, by implication, the adjacent intertidal feeding habitats) based on as many information sources as they can muster, including this paper.

Wader habitats can be valued according to a range of attributes, including:

- the threat status of the species involved (rare, vulnerable, etc.);
- the total numbers of waders using the habitat or the numbers of a particular species;
- the number of species using the habitat;
- whether or not the species is occurring at its distributional or biogeographic limit;
- whether or not a concentration of a species in a habitat is common in the region, state or country;
- the distance to other significant concentrations of a particular species;
- the education/awareness opportunities at the habitat;
- the tourism potential of the habitat; and
- the value of the waders as flagships or icons for conservation in the locality/region.

These values are considered in the rest of this section. Not all of these values are present at one habitat area. Some may even be generally incompatible in practical terms (eg. endangered species and tourism potential). Managers must make their own judgements about the most appropriate mix of values for a site based on a consideration of local and regional concerns. Other sources should be referred to, including national and regional data, in compiling values statements for wader habitats.

• Threat status refers to the likelihood that a species may go extinct due to environmental change. A range of categories are used to describe threat status. The terms used here follow those used in the *Nature Conservation Act 1992* which governs the conservation of wildlife in Queensland. Managers should refer to the Nature Conservation (Wildlife) Regulation 1994. This lists species considered to fall into each of the threat status categories. As government regulations tend to be reactive, managers should refer to more up-to-date classifications of threat status of birds, including those from Birdlife International and the International Union for the Conservation of Nature and the national account of threatened birds by the Royal Australasian Ornithologists' Union (latest version is Garnett 1992a).

Further details can be found in Lane (1987), Garnett (1992b) and Watkins (1993). The Queensland Wader Study Group of the Queensland Ornithological Society Inc. should be consulted for the most recent information on the threat status of waders in Queensland.

Although not specifically a threat status, many species of waders have the status "special cultural interest" under the *Queensland Nature Conservation Act 1992*, reflecting the state's obligations to protect migratory species under international migratory birds agreements. These agreements include the Japan - Australia Migratory Birds Agreement (JAMBA), and the China - Australia Migratory Birds Agreement.

Most of the waders that occur in Queensland are listed on one or both of these treaties and the regulations to the act should be referred to determine if a species has this legal status.

• Size of roost/number of individuals of a species. Most authorities consider that one of the best measures of the value of a wader habitat is the numbers of individual waders or numbers of individuals of a species of wader using it. The roost counts are an excellent, repeatable measure of this value.

Various numerical criteria for assessing the significance of habitats have been developed. The most widely accepted and used is the criterion developed for identifying wetlands of international importance under the Ramsar Convention. This is an international treaty that encourages member countries to nominate internationally important wetlands to a list and manage them based on principles of wise use. One of the many criteria for determining if a wetland is of international importance is if it regularly holds more than 1% of the flyway or biogeographic population of a wader (or other waterbird), or more than 20000 individual waders.

This criterion should be used in valuing wader habitats in Queensland. Data on the total flyway and biogeographic populations of waders coming to Australia has been provided in Watkins (1993), a publication obtainable from the Royal Australasian Ornithologists Union in Melbourne. This should be updated with the data presented in this and other papers in order to derive an up-to-date figure for species' flyway populations.

For determining the significance of wader habitats in the State context, a different criterion is proposed. Any area that supports more than four percent of the State population of a species is considered to be of State significance. This criterion was introduced earlier in this paper.

As a measure of the fulfilment of the management intent of the *Nature Conservation Act 1992* as it relates to waders (species of "special cultural interest") in Queensland, it is recommended that areas meeting the four percent criteria in the State context, be protected and/or be subject to wader-sensitive management and development.

Data presented here, together with national and flyway data, enable the application of widely applicable rigorous, quantitative criteria for determining habitat value. Developing a widely applicable quantitative method for identifying the most significant wader habitats within a region is problematic for the following reasons:

- the coverage and nature of count data within regions varies significantly; and
- the relative distribution of species and numbers between habitats within a region may be very different.

For this reason, identifying which habitats within a region should be managed appropriately to protect its international or state value (based on the above criteria) is difficult. It is recommended that the international and state criteria be applied to habitats within a region and, should that habitat meet the international and/or state criteria then it be managed appropriately. However, for highly dispersed species or species for which their regional occurrence is considered of value for other reasons, qualitative judgements must be made by managers.

A potentially useful basis for such judgements about value is a list of qualitative criteria that are appropriate to the region and the available data, and that incorporate the "precautionary principle". The manager will need to prepare such a list and ensure that the criteria are applied consistently across all habitats in the region. As long as the criteria are applied consistently and by the same person or, by consensus, the same group of local experts, then the resulting values will be both useful and defensible.

Such a list of qualitative criteria must include statements that are as precise as possible in describing their application, and might include but not be limited to the following:

- the habitat is considered to be essential to the survival of most of the regional population of a species considered to occur in the region in numbers of state or international significance;

- maintenance of the habitat is considered essential to ensure that populations of international or state significance have alternative roosting sites in the event of inclement weather, exceptional tidal conditions or disturbance; and/or

- the habitat supports a population(s) of a threatened species listed in the *Nature Conservation (Wildlife) Regulation 1994*, the maintenance of which is considered to be essential to the survival of the species in the region and/or in the state and flyway.

The quantitative data on the maximum counts at roost sites in each region is given in many of the maps in already presented. This is an important source of information for managers valuing habitats.

In addition to these criteria, statements could be formulated based on the values described under subsequent headings in this section.
• Number of species ("species richness"). The number of species that occurs in a habitat is referred to as the "species richness". This is distinct from the "species diversity" which is a measure of the combined relative abundance of all species present. The former is easy to measure while there is considerable variation in methods for measuring species diversity.
Species richness is an easy attribute to measure. High species richness is an indication of the biodiversity values of the habitat. Information is needed on the species richness in other habitats to enable a comparative judgement about value to be made.

• Range limit. If the regular occurrence of a species in a habitat represents or is close to the limit of its range then this occurrence is of value. Standard texts (Blakers *et al.* 1984; Lane 1987; Watkins 1993) should be consulted to determine actual distributional limits.

• Only occurrence. If a species occurs regularly in a habitat and this habitat is the only place in the state or region where it occurs, then this habitat has regional biodiversity value. This can be determined only based on fairly complete data on the distribution of waders in a region. In the absence of this, the value should be qualified by stating that the habitat is the only "known" area where the species occurs in the state or region.

• Distance to other regular occurrences. Habitats can have value because they support a population of a species isolated from factors that may lead to local extinction of the species elsewhere. In this way, the habitat acts as "survival insurance" for the species.

• Value for education/awareness. Habitats that support good numbers of waders that are accessible to the public have value for their real or potential contribution to education and awareness raising. This value may not be related to any other values that the habitat may have.

• Value for tourism. Habitats can have value because they support waders that are accessible to tourists. Examples include the remaining waders on the Nerang River on the Gold Coast or those on the Cairns foreshore in north Queensland.

• Value as flagship/icon. Waders are unusually accessible to people in Queensland, with the foreshores of two of its largest cities, Brisbane and Cairns, supporting significant numbers of waders. The image of flocks of waders feeding or wheeling about in the air is one that easily captures the public imagination. For these reasons, they have potential as flagships or icons for raising awareness of the values of the habitats that they use and of coastal wetlands and conservation in general.

Acknowledgments

Funding for this review came from a Walker-Reimer Memorial Fund grant from the Queensland Department of Environment to the Queensland Ornithological Society Inc. The same grant was used for fieldwork reported in Pell and Lawler (1996). I thank Brett Lane and Stuart Pell for many suggestions and contributions they made to the review. Brett Lane is largely responsible for the sections on potential threats and valuing habitat.

The data used here has been gathered over the years by many volunteers involved in different count programmes coordinated by the Royal Australasian Ornithologists Union, the Australasian Wader Studies Group and the Queensland Wader Study Group. Specific surveys also form the basis of this report and have been conducted by individuals or groups, often with logistical and financial support from the Qld Department of Environment or the Australian Heritage Commission. The support and help of all these people and organisations is gratefully acknowledged. Hopefully, I have adequately represented their work and take responsibility for any errors, omissions or misinterpretation of the data.

References

Alcorn, M., Alcorn, R., and Fleming, M. 1994. Wader movements in Australia. Australasian Wader Studies Group, October 1994, Royal Australasian Ornithologists Union Report No. 94.

Arnold, D., and Bell, I., and Newberry, P 1993. An inventory of shore and waterbirds on the Curtis Coastline 1992-93. Gladstone Port Authority and Qld Dept of Environment and Heritage, February 1993.

Arthington, A. H., and Hegerl, E. J. 1988. The distribution, conservation status and management problems of Queensland's Athalassic and tidal wetlands. p. 59-101. In McComb, A. J., and Lake, P. S. eds. The Conservation of Australian Wetlands. Surrey Beatty, Sydney.

Blackman, J. G., Perry, T. W., Ford, G. I., Craven, S. A., Gardiner, S. J., and De Lai, R. J. 1996. Queensland. p. 177-432. In Australian Nature Conservation Agency, A Directory of Important Wetlands in Australia Second Edition. ANCA, Canberra.

Blakers, M., Davies, S. J. J. F., and Reilly, P. N. (Royal Australasian Ornithologists Union) 1984. The Atlas of Australian Birds. Melbourne University Press, Melbourne.

Clarkson, J. R. 1991. The spread of pondage species beyond the pasture system - the risk and associated ecological consequences. In Proceedings of Probing Ponded Pastures Workshop, University of Central Queensland, Rockhampton, July 1991, 8 pages.

Cummins, V. G. 1991. Construction of pondage banks in Central Queensland - background and present status. In Proceedings of Probing Ponded Pastures Workshop, University of Central Queensland, Rockhampton, July 1991, 3 pages.

Doohan, M. 1991. Fisheries management and ponded pastures. In Proceedings of Probing Ponded Pastures Workshop, University of Central Queensland, Rockhampton, July 1991, 5 pages.

Driscoll, P. V. 1991. Survey of waterbird, seabird and wader feeding areas and roosts in Pumicestone Passage, spring 1990. A report for the Qld Dept of Environment and Heritage, January 1991.

Driscoll, P. V. 1993. Survey of waders in the Great Sandy Strait, South-eastern Queensland, Australia. Stilt 22: 24-36.

Driscoll, P. V. 1994. Wetland definition and fauna assessment. Report on project NR09: Wetland fauna survey. Cape York Peninsula Land Use Strategy (CYPLUS), Natural Resource Analysis Program. Prepared on behalf of the Qld Dept of Environment and Heritage, November 1994.

Driscoll, P. V. 1995. Survey of wader and waterbird communities along the central Queensland coast. report prepared on behalf of Queensland Ornithological Society Inc for the Queensland Dept of Environment and Heritage and the Australian Heritage Committee, August.

Driscoll, P. V. 1996. Survey of shorebird feeding areas and roosts in the Shoalwater Bay area. report on fieldwork conducted in December 1995 for QDEH.

Driscoll, P. V., Geering, A., Gynther, I., Harding, S., and Stewart, D. 1993. Monitoring of migratory waders in the Moreton Bay region. Report prepared for the Coastal Management Unit of the Qld Dept of Environment and Heritage.

Elvish, R. A. 1986. Bird Habitat Relations on a Tropical Coastal Floodplain. M. Sc. thesis, University of Qld.

Environmental Consultants 1982. Condor Oil Shale Project: Initial Environmental Studies. Terrestrial Fauna. Environmental Consultants Ltd, Bardon, Brisbane. 100 pp + 6 appendices.

Garnett, S. 1989. Wading Bird Abundance and Distribution - South-eastern coast of the Gulf of Carpentaria. RAOU Report No. 58. Report to the Queensland National Parks and Wildlife Service.

Garnett, S. 1992a. Threatened and extinct birds of Australia. RAOU and ANPWS, RAOU report no. 82.

Garnett, S. 1992b. The action plan for Australian birds. Australian National Parks and Wildlife Service, Canberra.

Garnett, S. T. 1983. Report on the fifth aerial survey of migrating wading birds between Weipa and Milingimbi, 9-13 February 1983. Stilt 4: 15-17.

Garnett, S. T. 1986. Seasonal changes in the wader population in the south-east of the Gulf of Carpentaria. Stilt 8: 9-13.

Garnett, S. T. 1987. Aerial surveys of waders (Aves: Charadriiformes) along the coast of north-eastern Australia. Australian Wildlife Research 14: 521-528.

Garnett, S. T., and Carruthers, I. B. 1982. Report on the second aerial survey of waders in north-eastern Australia, February 1982. Stilt 3: 18-20.

Garnett, S. T., and Minton, C. D. T. 1985. Notes on the movements and distribution of the Little Curlew Numenius minutus in northern Australia. Australian Bird Watcher 11: 69-73.

Garnett, S., and Taplin, A. 1990. Wading bird abundance and distribution during the wet season - south-western coast of the Gulf of Carpentaria. A report to the Conservation Commission of the Northern Territory for the Territory Branch of the Australian Heritage Commission, June 1990.

Garnett, S.T.G., and R. Bredl. 1985. Birds in the vicinity of Edward River settlement. Part I. Introduction, methods, study area, list of non-passerines. Sunbird 15: 6-23.

Guard, R. and Garnett, S. T. 1982. Report on the first aerial survey of waders in north-eastern Australia, December 1981. Stilt 3: 16-17.

Helmers, D. L. 1992. Shorebird Management Manual. Western Hemisphere Shorebird Reserve Network, Manomet, MA.

Landin, M. C. 1991. Needs, construction, and management of dredge material islands for wildlife. Pages 99-117, in Jenings, D. compiler. Proceedings of the Coastal Nongame Workshop. U.S. Fish and Wildlife Service, Region 4, and Florida Game Fresh Water Fish Commission, Gainsville, Fla.

Lane, B, A., and Davies, J. N. 1987. Shorebirds in Australia. Nelson, Melbourne.

Lane, B. 1988. Wader expeditions to Northern Australia in 1986. Royal Australasian Ornithologists Union Report No. 42.

Lawler, W. 1994. Draft management manual for migratory shorebird feeding habitat in New South Wales estuaries. Environmental Survey & Research Branch, New South Wales National Parks and Wildlife Service.

Lawler, W. 1995. Wader roost construction in Moreton Bay: a feasibility study into the construction of migratory wader (shorebird) high tide roosts in Moreton Bay, Qld, using Raby Bay as a case study. a report for the Qld Wader Study Group and Qld Dept of Lands, August 1995.

Minton, C. 1981. North-west Australia wader studies expedition, 1981. Stilt 2: 14-26.

O'Neill, P. 1995. A preliminary survey of the shorebirds of the Shoalwater Bay area, Central Queensland, Australia. QDEH document, Rockhampton.

Pell, S., and Lawler, W. 1996. Wader communities along the north-east Queensland coast (Bowen to Cairns). A report to the Queensland Department of Environment and Heritage on behalf of the Queensland Ornithological Society Inc, Brisbane, February 1996.

Qld Dept of Environment and Heritage 1994. Curtis Coast Study Resource Report. draft report, Gladstone.

Schodde, R., Catling, P. C., Mason, I. J. Richards, G. C., and Wombery, J. C. 1992. The land vertebrate fauna of the Shoalwater Bay Training Area, Queensland. A survey for the Dept of Defence by Divn of Wildlife and Ecology assisted by the Qld Museum .

Scots, F. R., Jr., and Landin, M. C. 1978. Development and management of avian habitat on dredged material islands. Technical Report DS-78-18 U.S. Army Waterways Experiment Station, Vicksburg, Mississippi.

Smith, P. 1990. The biology and management of waders (suborder Charadrii) in NSW. Species Management Report No. 9. NSW National Parks and Wildlife Service.

Starks, J., and Lane, B. 1987. The northward migration of waders from Australia, February to April, 1985. Stilt 10: 20-27.

Stokes, T., Hulsman, K., Ogilvie, P., and O'Neill, P. 1996. Management of human visitation to seabird islands of the Great Barrier Reef Marine Park Region. Corella 20: 1-13.

Taplin, A. 1993. A regional approach to migrant bird conservation issues: an example using waterbird surveys on western Cape York Peninsula. p. 83-92, In Catterall, C. P., Driscoll, P. V., Hulsman, K., Muir, D., and Taplin, A. eds. Birds and their Habitats: Status and Conservation in Queensland. Queensland Ornithological Society Inc., P.O. Box 97, St Lucia, Qld 4067.

Thompson, J. 1990. A survey of migrant waders in Southern Moreton Bay. Report for Qld National Parks & Wildlife Service.

Thompson, J. 1990. An assessment of Pumicestone Passage as a habitat for migrant waders. Report for Qld National Parks & Wildlife Service .

Thompson, J. 1990. The sex and age-related distribution of Bar-tailed Godwits in Moreton Bay, Queensland, during the northward migration. Emu 90: 169-174.

Thompson, J. 1992. Spatial and temporal patterns of shorebird habitat utilisation in Moreton Bay, Queensland. Ph. D. Thesis, Univ. of Queensland.

Thompson, J. 1993. Pumicestone Passage migratory shorebird monitoring project. A report prepared in relation to the Queensland Ornithological Society Inc. (Wader Study Group) Consultancy Agreement, 1992/93.

Thompson, J. J. 1990. A reassessment of the importance of Moreton Bay to migrant waders. Sunbird 20: 83-88.

Thompson, J. J. 1993. Patterns of shorebird abundance in eastern Moreton Bay, Queensland. Wildl. Res. 20: 193-201.

Thompson, J. J., and Kikkawa, J. 1988. Roost and feeding ground utilisation by wading birds in central Moreton Bay, Queensland. Commissioned by the QNPWS, March-May 1988.

Thompson, J. J., and Kikkawa, J. 1988. Wading bird studies - central Moreton Bay. Commissioned by the QNPWS, dated December 1988.

Thompson, J., and Kikkawa, J. 1988. Moreton Bay wading bird review. Commissioned by the QNPWS, manuscript February 1989.

Thompson, J., and Kikkawa, J. 1989. Northward migration of waders: Moreton Bay. February 1989 - April 1989. Commissioned by the QNPWS, received June 1989.

Watkins, D. 1993. A national plan for shorebird conservation in Australia. Australasian Wader Studies Group, Royal Australasian Ornithologists Union and World Wide Fund for Nature. RAOU Report No. 90.

Shorebird Researcher Training

Kioaki Ozaki

Kioaki Ozaki, Yamashina Institute for Ornithology, 115 Tsutsumine, Konoyama, Abiko-shi, Chiba-Ken, Japan

Most shorebirds migrate long distances through many countries. We need more and more knowledge about their migration behaviour, especially migration routes, to preserve them effectively. Shorebird banding is an important method of proving their migration routes, but has not been actively done in most East Asian countries.

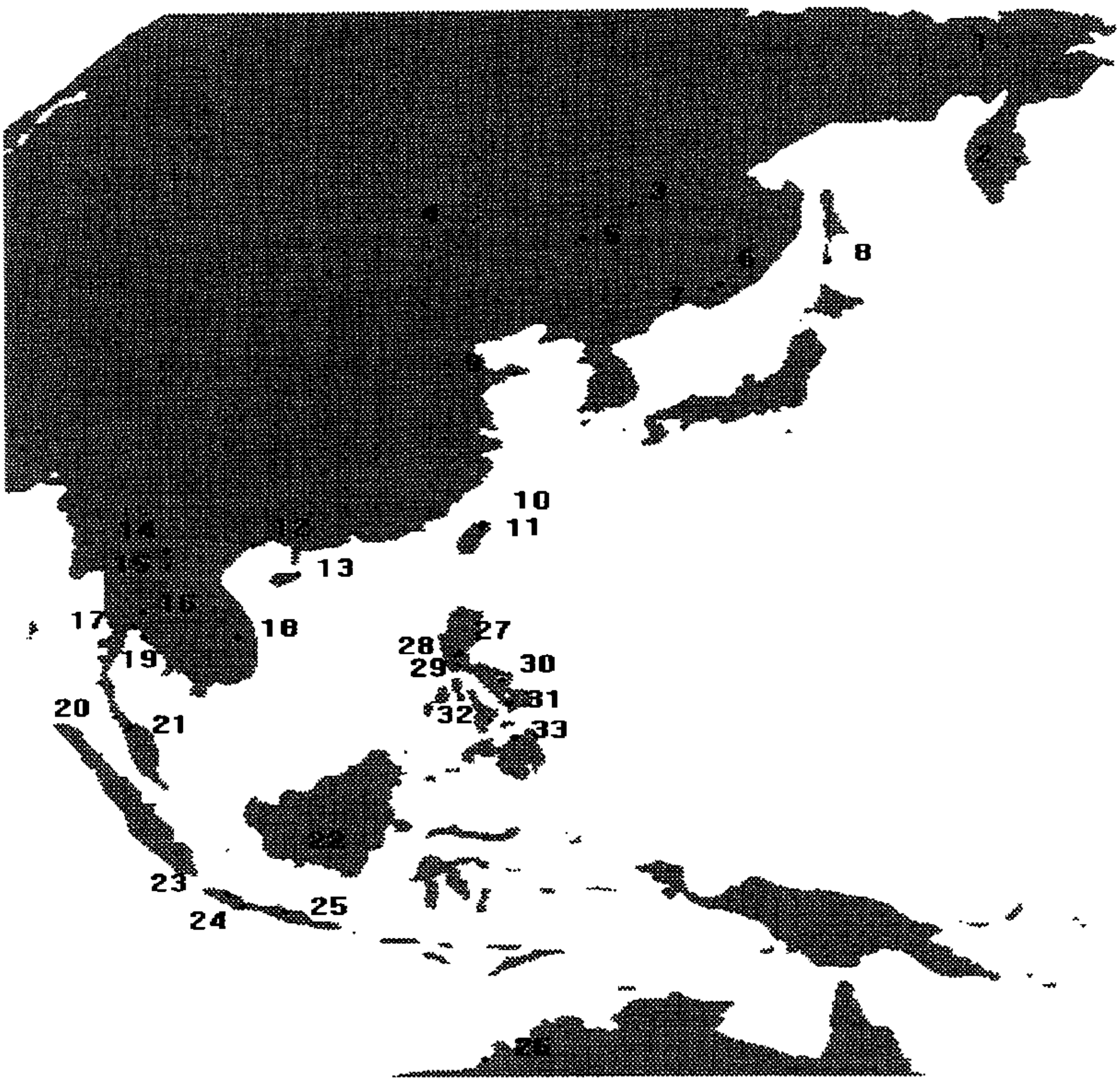
Yamashina Institute for Ornithology has started bird banding training workshops to encourage banding activities in East Asian Countries. The first of these was run in 1984 in the Philippines. Since that time we have run several training workshops or cooperated in banding activities 28 times in seven countries including the Philippines, Thailand, Vietnam, Indonesia, Taiwan and also in China and Russia (the last two countries already have national banding schemes). Sixteen of these activities were mainly focused on waterbirds including shorebirds (see Fig. 1).

For those training activities we have used ODA budgets through the Japanese Environment Agency and Ministry of Education as well as funding from NGO's and companies. With the Ministry of Education funds, we have annually invited one or two researchers from each country to Japan for several months of training in banding field work and to learn about the work of the banding centre.

The final target of those training activities is to help set up national bird banding schemes in those countries that don't have a scheme already. Recently, Thailand and Taiwan started national banding schemes using their own bands. Other countries still have difficulties, mainly in getting support and funds from their governments.

Training for banders should continue to be as widely available as possible in as many countries as possible. It is extremely necessary to get government support for banding schemes through international agreements such as multilateral treaties for migratory birds.

BIRD BANDING WORKSHOPS
1984 - 1996



Bird Banding Training Workshops Conducted By
The Yamashina Institute For Ornithology

Bird banding training workshops or activities focused on waterbirds:

3. July 1992 & July 1993
4. July 1992
5. July 1992
6. May 1988
7. July 1992
11. February 1987
13. November 1993
16. January 1991
20. January 1992
25. December 1995
26. March 1996
27. Dember 1994
30. August 1984
31. November 1989
32. December 1995

The use of Colour Marking in the East Asian-Australasian Flyway

D. Watkins

D. Watkins, Wetlands International - Oceania, Wetlands and Migatory Wildlife Unit, ANCA, GPO Box 636, Canberra, ACT 26011.0

1.0 Background on Colour Marking

Migratory shorebirds have special conservation needs because of their annual migrations of up to 25 000 km each year. Knowledge of shorebird migration strategies is essential for the development of effective plans for the conservation and management of migratory shorebirds and their habitats. Such information is especially required in the East Asian-Australasia region where habitat destruction is widespread (Howes and Parish 1989). The loss of coastal habitats in East Asia, which are used as staging sites, is considered to be the major threat to migratory shorebirds (Anon. 1996a).

In addition to a having sound scientific understanding of shorebird migration, conservation action requires community awareness and support. Colour marking is an efficient and cost effective method of meeting both of these needs. The majority of the colour flagging effort in the East Asian-Australasian region is undertaken by volunteers within community organisations. The efforts of the public and recreational bird watchers are crucial to generating resightings of colour marked birds. Demonstrated movements become a powerful tool for the conservation of important sites in the Flyway because they focus local decision makers' attention on an international responsibility for shorebirds conservation.

Until the last decade the use of uniquely numbered metal bands was the main method used to generate knowledge of migration routes. Colour marking has a major advantage over banding in that data can be collected from visual observations. This makes it much easier to collect data on the movement and activities of birds.

The three major colour marking techniques are colour dyeing, colour banding and leg flagging.

Colour dyes are used on the breast feathers and underwings of shorebirds. While dyes are the most visible form of colour marking they have the disadvantage of being temporary because of feather moult. Also, there is only a small number of suitable colours and as such colour dyeing is of limited use for the differentiation of individuals in a population. This method is however very useful for studying local movements and turnover rates at staging sites.

The most important form of colour marking is the use of colour leg bands and flags. It is used extensively in breeding and behavioural studies where there is a need to identify a large number of individuals. The durability and colour stability of these leg marks is dependent on the material used.

In the past decade the use of colour leg flags has dramatically increased in popularity with shorebird researchers. These marks look like a colour band with a trailing tab. This "flag" greatly increases the visibility of the colour mark. When made from UV stable plastic these leg flags are anticipated to last a number of years and in many cases the lifetime of the bird.

The use of colour leg flags has now become the predominant colour marking method. While this paper deals with the three major colour marking methods the focus is on colour flagging.

2.0 Contemporary use of Colour Marking

2.1 Asia Pacific

In reviewing the contemporary use of colour marking activities it is also valuable to examine the use of individually numbered metal bands because of the close relationship between these two research methods. A review of contemporary (5 -10 years) banding activities is shown in Table 1. Existing bird banding activities in the region can be used as a guide to the potential for colour marking because it illustrates the capacity to catch shorebirds and the existing level of expertise.

There is no formal coordination of colour marking in

Asia Pacific. Wetlands International has acted on an *ad hoc* basis as a referral body for sightings of colour marked shorebirds. It has worked with the Australian Bird and Bat Banding Scheme (ABBBS) and the Australasian Wader Studies Group (AWSG) to provide advice on colour marking for migration studies. A directory of waterbird banding in the region has been produced by Wetlands International (Mundkur 1992).

2.1.1 Australia

Australia has been the most active country in conducting shorebird banding. In the past five years researchers in Australia banded twice as many shorebirds as all the other countries in the region combined. During the last 20 years approximately 160 000 shorebirds have been banded in Australia. From this total only 374 birds have been recovered outside Australia. This compares with the recovery in Australia of only 86 foreign-banded shorebirds (Watkins *et al.* 1996).

In Australia, the approval agency for bird banding and colour marking is the ABBBS administered as part of Environment Australia. State and Territory government agencies are also involved in issueing approvals to conduct research and to permit the capture of native birds. The ABBBS operates as a service agency for banders. It is not directly involved in bird research projects and does not administer funding programs for bird research.

The majority of shorebird banding effort has been contributed by five regional groups (in Victoria, Queensland, New South Wales, Tasmania and Western Australia) and one national group (AWSG). The two most active banding groups have been the Victorian Wader Studies Group (100 000+) and the AWSG (40 000+) (Watkins *et al.* 1996).

The AWSG has strong links with the shorebird study groups in each State and is a sub-group of the Royal Australasian Ornithologists Union. It acts as an umbrella organisation to develop research and conservation priorities for shorebirds. It publishes a quarterly newsletter *(The Tattler)* and a biannual research bulletin (*The Stilt*).

Between 1980 and 1985 a number of studies were conducted on shorebird movements in Australia using colour dyeing (mainly picric acid). These have generated information on movements between south-east and north-west Australia (Minton 1980, Lane 1987), local movements in south-east Australia (Minton 1980, 1981, 1985, 1987) and Tasmania (Fletcher *et al.* 1982).

Colour banding was used in a comprehensive project on Double-banded Plover to study migration between New Zealand and Australia (Minton and Pierce 1986).

The major development in the use of colour marking commenced in late 1989 with the trialing of leg flags in south-eastern Australia. Since that time over 41 000 migratory shorebirds have been leg flagged. This work accounts for approximately 90 per cent of the shorebirds flagged in the Asia Pacific (Table 2).

The colours used in different regions of Australia are green, white, orange and yellow (Table 3). Barter and Rush (1992) have provided details on the design, manufacture and attachment of flags. Only one leg flag design has been used in Australia. The flag has usually been attached to the tibia of the left leg, with the metal band on the right tarsus.

In north-west Australia 21 000 shorebirds of 30 species have been flagged (Table 2). This work has been conducted during special expeditions organised by the AWSG and Broome Bird Observatory. Work in Queensland has concentrated on a small number of species. A small number (172 birds) were also flagged in New South Wales before this project ceased because of potential conflict with colour marking in New Zealand and Japan.

The information that has been generated on international movements from shorebirds flagged in Australia is summarised in Table 4. The bulk of resightings have come from Hong Kong, Japan and New Zealand. This emphasises the importance of birdwatchers in obtaining resightings of colour marked birds. Movements through Hong Kong have comprised a large number of Red-necked Stint and Curlew Sandpiper. In Japan six species have been recorded. Movements from Australia to New Zealand have mainly been Red Knot from south-eastern Australia along with Bar-tailed Godwit and Red-necked Stint.

Preliminary analysis of movement information has been conducted for Red-necked Stint and Curlew Sandpiper (Minton 1996).

A detailed analysis has been made of information generated on international movements from South-eastern Australia since 1990 using banding and colour flagging. This analysis shows that colour leg flags have generated approximately 17 times more international movement records than bands during the same period (Table 5). It is also important to note that the number of species for which international movements were recorded was doubled with the use of colour flags.

Colour flagging has been conducted by volunteers without direct funding support from government agencies.

There have been expressions of interest in developing flagging activities in the Northern Territory, South-west Australia and central New South Wales (Clive Minton pers. comm.). These projects will not be approved until a satisfactory regional colour marking protocol is established (ABBBS pers. comm.). Other potential flagging areas based on their importance for migration and/or accessibility are: Adelaide area (South Australai), Tasmania, North-eastern Queensland and the Gulf of Carpentaria (Queensland).

2.1.2 New Zealand

Banding and colour marking is administered by the New Zealand Bird Banding Scheme (part of the Department of Conservation). The Scheme operates in a simular way to the ABBBS. It publishes annual reports on bird banding in New Zealand (Cossee and Wakelin 1991; Cossee 1992, 1993).

Most shorebird banding and leg flagging are conducted by the New Zealand Wader Study Group (Riegen and Davies 1993). Banding and colour marking activities are centred around Auckland in the North Island of New Zealand.

Bar-tailed Godwit, Red Knot and Double-banded Plover are the only species of migratory shorebirds that are caught in significant numbers in New Zealand (Table 1). Approximately 650 shorebirds have been white flagged in the past few years (Bar-tailed Godwit (248), Red Knot (384) and Ruddy Turnstone (5)) (Table 2).

There is potential interest in commencing a colour flagging project at Farewell Spit in South Island (Adrian Riegen pers. comm.).

2.1.3 Japan

The Yamashina Institute for Ornithology is the agency responsible for banding and colour marking in Japan. In addition to servicing a banding scheme the agency is a research institute. An annual report is published on banding in Japan (Ozaki 1995).

In 1992, the Institute operated ten Class 1 bird observation stations which conducted banding and ecological studies for 120 days during the year. In addition there were fifty Class 2 bird observation stations which conduct banding for 36 days during the year (Environment Agency of Japan 1995). In 1995 approximately 2 000 shorebirds of 39 species were banded at 85 sites (Ozaki 1995).

Over the past four years more than 4 000 migratory shorebirds of 33 species have been colour flagged (Table 2). The material used was a special tape rather then the PVC flags that have been used in Australia and New Zealand. Four colours have been used; white, brown, mauve and blue (Table 6). Red wing tags have also been used on approximately 500 shorebirds (Kiyoaki Ozaki pers. comm.).

In recognition of the need for increased coordination of colour marking the Yamashina Institute has now restricted colour flagging to the use of blue and will change to using the same material as Australia and New Zealand (Kiyoaki Ozaki pers. comm.).

Colour flagging of shorebird has occurred at the two sites in Tokyo Bay and in north-east Hokkaido (Yoshimitsu Shigeta pers. comm.). The major focus of these studies has been local and national movements. There is potential interest in colour flagging in the Kyushu area.

2.1.4 Russian Far East

Research in the Russian Far East has been very restricted in recent years by a lack of funding. It is conducted by approximately ten professional researchers, only a few of which are resident in the Russian Far East (Pavel Tomkovich pers. comm.).

In 1987 a Russian Working Group on Waders was established to promote and assist in coordinating research on shorebirds (Tomkovich 1991). Currently the Russian Working Group on Waders is seeking to coordinate banding and colour marking (Tomkovich 1996). Colour marking has mainly been used in breeding and behaviour research.

2.1.5 Alaska

In Alaska there are a number of shorebird research programs that include banding. The U.S. Bird Banding Laboratory of the U.S. Fish and Wildlife Service is responsible for the banding scheme.

Research is focused on breeding studies and primarily involves professional researchers.

Colour marking research is conducted under the Pan-American Shorebird Program which is currently coordinated by an Officer within the Canadian Wildlife Service (Cheri Gratto-Trevor). This program was developed in 1982 to coordinate shorebird banding programs in the Americas (Myers *et al.* 1984) and it includes a detailed scheme for the use of colour flags in the Americas (Myers *et al.* 1981).

The colour marking scheme involves the use of one or two colour flags to uniquely identify the country in which the bird was colour marked. Colour bands can be used in addition to the flags to identify the individual or the marking site. The colour marking combination allocated for the US (including Alaska) is one dark green flag attached to the tarsus.

Only a small number of shorebirds that may migrate in the East Asian-Australasian Flyway have been marked. Estimates of the order of magnitude are: Lesser Golden Plover (10's), Bar-tailed Godwit (10's), Pectoral Sandpiper (100's), Rock Sandpiper (10's), Dunlin (100's) and Red-necked Phalarope (1's) (Cheri Gratto-Trevor pers. comm.)

2.1.6 Other areas

Bird banding schemes also operate in the following areas: South Korea, China, Hong Kong, India, Iran, Kazakhstan, Thailand, Malaysia, Pakistan, Sri Lanka, and the island of Taiwan. The only areas in which significant amounts of shorebird banding have been conducted in recent years are South Korea, the island of Taiwan, Hong Kong, Malaysia, India and Sri Lanka.

2.2 Other Regions of the World

2.2.1 The Americas

In the Americas, the challenge of coordinating flyway studies was addressed in the early 1980s. Researchers in the US and Canads recognised the need to became involved in research and conservation projects in South America. This led to the development by researchers of a proactive flyway colour marking scheme (Myers *et al.* 1981).

The colour marking scheme that has now been in operation for almost 15 years uses nine colours: white, red, yellow, grey, black, orange, blue, dark green and light green.

In this scheme each country has a specific colour combination involving one or two flags. Other essential elements of the scheme are:

- Studies without a requirement for individual identification use one or two leg flags to mark the country. The flags are attached to the same leg as the metal band. On the other leg two colour leg bands is used to indicate year and site (site mark is optional). The system for marks on the legs is alternated between the first and second half of the year to enable northward and southward migration to be identified.
- Studies involving the need to recognise individuals are identified by the addition of a colour band to the leg with the colour flag(s). The bands on the other leg then refer to the identity of the bird rather then the site and year of marking.

This scheme provides countries with a framework in which national agencies maintain full control of colour marking approvals.

The colour marking scheme is part of the Pan American Shorebird Program (Myers *et. al* 1984). This program worked to coordinate the independent projects and to stimulate resighting of marked shorebirds. One of the goals of the scheme was to identify staging sites used during migration. This information could then be used to support the nomination of sites for the Western Hemisphere Shorebird Reserve Network (Morrison 1984).

In the US and Canada the program is now coordinated by Cheri Gratto-Trevor of the Canadian Wildlife Service. It is intended that all applications for colour marking of shorebirds in Canada and the US are directed to Cheri Gratto-Trevor. She then provides advice on the application to the US Bird Banding Laboratory or the Canadian Bird Banding Office.

2.2.2 Africa, Europe and the Middle East

The Wader Study Group (WSG) maintains a register of colour marking projects in Europe and west Africa (Marchant 1994). The WSG is a Specialist Group of Wetlands International and is an association of amateurs and professionals interested in shorebird research and conservation. In 1995 the register listed 432 schemes covering 35 species (Jane Marchant pers. comm.).

The register operates in close consultation with the British Trust for Ornithology which is responsible for bird banding in Britain. The register does not have formal links to national bird banding schemes. It relies on researchers registering proposed colour marks and responding to the advice of the coordinator of the register. Researchers are charged a registration fee and an annual fee. Registering a project minimises the chances of another researcher using the same colour marks. The register is maintained by a part time volunteer coordinator (Jane Marchant).

3.0 The Need for Increased Coordination

Coordination of the use of colour marks is essential because research will be compromised if the same marks are being used by another researcher and there is the possibility of the bird occurring in the study areas of both researchers. Even short term studies within one country have the potential to compromise research in other parts of the region because of the extensive and sometimes erratic migration of shorebirds.

The need for increased coordination has been formally recognised during the Japan-Australia Migratory Bird Agreement Meeting in Coolum, Australia in June 1996. The need is also specifically acknowledged in the Asia-Pacific Migratory Waterbird Conservation Strategy: 1996-2000 (Anon. 1996a).

In 1996 Environment Australia commissioned Wetlands International to develop a draft colour marking protocol for shorebirds in the East Asian-Australasian Flyway. The ABBBS is presently seeking involvement of banding schemes in other countries in the Flyway to develop agreement on a colour marking protocol.

4.0 References

Anonymous. 1996a. *Asia-Pacific Migratory Waterbird Conservation Strategy: 1996-2000*. Wetlands International - Asia Pacific, Kuala Lumpur, Publication No. 117, and International Waterfowl and Wetlands Research Bureau - Japan Committee, Tokyo.

Barter, M.A. and M. Rush. 1992. Leg-flagging waders in Australia - Why and How? *Stilt* 20: 23-26.

Cossee, R and Wakelin, M. 1991. *Report on Bird Banding in New Zealand 1989-1990.* Department of Conservation. Science & Research Series No.33.

Cossee, R. 1992. *Report on Bird Banding in New Zealand 1990-1991*. Department of Conservation. Science & Research Series No.49.

Cossee, R . 1993. *Report on Bird Banding in New Zealand 1991-1992.* Department of Conservation. Science & Research Series No.59.

Fletcher, A., Newman, M. and Park, P. 1982. Colour Dyeing of Palaearctic Waders at Hobart. *Stilt* 2: 11-13.

Howes, J and Parish, D. 1989. *New Information on Asian Shorebirds: A preliminary review of the INTERWADER Programme 1983-1989 and priorities for the future*. 2nd edition. AWB Publication No. 42. Asian Wetland Bureau, Kuala Lumpur.

Lane, B. 1987. *Shorebirds in Australia.* Nelson. Melbourne.

Marchant, J. 1994. Report of the WSG Register of permanent colour marks. *Wader Study Group Bulletin* 73: 8-11.

Minton, C. 1980. Sightings of Colour Marked Waders. *Victorian Wader Study Bulletin* 2: 11-12.

Minton, C. 1981. Further Sightings of Colour Marked Waders. *Victorian Wader Study Bulletin* 3: 10-11.

Minton, C. 1985. Results of Colour-dyeing Waders in Jan/Feb 1985. *Victorian Wader Study Bulletin* 9: 16-17.

Minton, C. 1987. Sightings of Colour-dyed Waders. *Victorian Wader Study Bulletin* 11: 10.

Minton C. and Pearce, R. 1986. Migration studies of Double-banded Plovers. *Stilt* 8:27.

Minton C. 1996. Comparison of Flag Sightings versus Recoveries for Waders Marked in Victoria. *Victorian Wader Study Bulletin 20 :37-38.*

Minton C. 1996. Analysis of Overseas Movements of Red-necked Stints and Curlew Sandpipers. *Victorian Wader Study Bulletin* 20 :39-43.

Morrison, R.I.G. 1984. A hemispheric perspective on shorebird migration in the New World. *Behav. Mar. Animals* 6:125-202.

Mundkur, T. 1992. Asia-Pacific Waterbird Banding Directory (Draft). Unpublished report. Asian Wetland Bureau, Kuala Lumpur.

Myers, J.P., Maron, J.C., Ortiz, E., Castro, G., Howe, M.A., Morrison, R.I.G., and Harrington, B.A.. 1981. Rationale and Suggestions for a Hemispheric Colour-Marking Scheme for Shorebirds : A Way to Avoid Chaos. *Wader Study Group Bulletin* 38: 30-32.

Myers, J.P., Castro, G., Harrington B.A., Howe, M.A., Maron, J.C., Sallaberry, M., Schick, C.T. and Tabilo, E. 1984. The Pan American Shorebird Program : A Progress Report. *Wader Study Group Bulletin* 42: 26-30.

Ozaki, K. 1995. *Report on the Japanese Bird Banding Scheme for 1995*. Yamashina Institute for Ornithology. (Japanese with English summary).

Riegen, A. and Davies, S. 1993. Formation of the New Zealand Wader Study Group (NZWSG). *Stilt* 23: 11.

Tomkovich, P.S. 1991. The Working Group on Waders in the USSR. *Stilt* 19:39-40.

Tomkovich, P.S. 1996 in press. Colour Marking in the CIS. *Wader Study Group Bulletin*.

Watkins, D., Barter, M., and Weaver, K. 1996. Shorebird Conservation in Australia. In Wells, D.R. and Mundkur, T. (eds.). *Conservation of Migratory Waterbirds and their Wetland Habitats in the East Asian - Australasian Flyway*. Proceedings of an International Workshop, Kushiro, Japan. 28 Nov-3 Dec 1994. Wetlands International-Asia Pacific, Kuala Lumpur, Publication No. 116, and International Waterfowl and Wetlands Research Bureau-Japan Committee, Tokyo.

Acknowledgments

This paper is a product from a project funded under the Migratory Waterbird Program of Environment Australia (Biodiversity Group) (Project No RAN04711). The project involves developing a draft colour marking protocol for migratory shorebirds in the East Asian-Australasian Flyway.

The foundation of this paper has been the colour flagging work conducted by researchers in Australia, New Zealand and Japan. The following people have been instrumental in this work: Clive Minton, Mark Barter, Peter Driscoll, Phil Straw, Adrian Riegen, Taej Mundkur, Kiyoaki Ozaki and Yoshimitsu Shigeta. Thanks are due also to the hundreds of people who give their time and energy to assist in flagging shorebirds and to looking for them during migration.

I would like to thank the following people for assisting me in the preparation of this paper by generously providing comments, information and research data: Cheri Gratto-Trevor, Mary Gustafson, Declan Troy, Ian Davidson, Bob Gill, Guy Morrison, Jim Corven, Pavel Tomkovich, Shin Ichi Hanawa, Tobai Sadayosi, Minoru Kashiwagi, Atsuo Tsuji, Cbu Guozhong, Chen Kelin, Chia-yang Tsai, Wen-yu Vicky Chen, David Melville, Clive Minton, Peter Driscoll, Phil Straw, Tom Scotney, Belinda Dettmann, Barry Baker, David Drynan, Adrian Riegen and Rod Cossee.

I also wish to thank Wetlands International staff, Brigitta Wimmer, Roger Jaensch and Taej Mundkur, for their assistance in the preparation of this paper.

Part V

East Asian-Australasian Shorebird Reserve Network

East Asian-Australasian Shorebird Reserve Network

Doug Watkins

Summary

Each year millions of shorebirds migrate between their breeding areas in the Russian Far East, northern China and Alaska to as far south as Australia and New Zealand. To complete this remarkable migration of up to 12 000 km, shorebirds are dependent on intermediate staging sites where they can replenish the fat reserves needed to power them further on their migration. As such, successful conservation of migratory shorebirds requires a coordinated multinational approach.

The East Asian-Australasian Shorebird Reserve Network has been developed under the Asia-Pacific Migratory Waterbird Conservation Strategy: 1996-2000. The Network aims to facilitate international recognition and management of a network of important sites for shorebirds. The Network will work as a co-operative environmental program, involving site management bodies and local communities, working for the conservation of wetlands of international importance for migratory shorebirds. The Shorebird Reserve Network is modelled on a very successful program that has been in operation in the Americas for the past 10 years called the Western Hemisphere Shorebird Reserve Network.

The Shorebird Reserve Network has been developed in response to an international workshop on the conservation of migratory waterbirds in the East Asian-Australian flyway held in Kushiro, Japan in December 1994.

The motivating feature of the Network is that it enables site owners, managers, participating organisations and local people to obtain international recognition for the importance of the site and their conservation efforts.

At the international level the Shorebird Reserve Network will be supported by a Shorebird Flyway Officer. An officer has been engaged by Wetlands International, with funding from Environment Australia, to work on the development of the Network. He works from the Oceania Office of Wetlands International which is co-located with Environment Australia in Canberra, Australia. A Shorebird Working Group will be established to oversee the development of the Network.

It is hoped that the East Asian-Australasian Shorebird Reserve Network, along with the Western Hemisphere Shorebird Reserve Network, will act as catalysts for conservation action for migratory species in other flyways.

The initiative is being made possible by the sponsorship and support of Environment Australia and the Environment Agency of Japan.

D. Watkins, Wetlands International - Oceania, Wetlands and Migratory Wildlife Unit, ANCA, GPO Box 636, Canberra, ACT 2601

1. Introduction

In December 1994 a workshop was held in Kushiro, Japan to discuss conservation of migratory waterbirds in East Asia - Australasia. The meeting was organised under the auspices of the Environment Agency of Japan and Environment Australia with assistance from the Wetlands International - Asia Pacific and the International Waterfowl and Wetlands Research Bureau - Japan Committee. The meeting was attended by 92 participants from 16 regional nations.

The workshop produced a summary statement called the "Kushiro Initiative". The statement calls for the:

- preparation of a conservation strategy for migratory waterbirds in the region (Asia-Pacific Migratory Waterbird Conservation Strategy)
- development of action plans for species-groups
- development of networks of internationally important sites for species-groups.

The "Kushiro Initiative" specifically calls for the establishment of a network of internationally important sites for migratory shorebirds. This network was to be based on the very successful Western Hemisphere Shorebird Reserve Network that has operated in the Americas since 1985 (*see box*). The shorebird reserve network will form part of an Asia-Pacific Migratory Shorebird Action Plan, itself an element of the Asia-Pacific Migratory Waterbird Conservation Strategy.

The Shorebird Reserve Network has been developed by Wetlands International - Asia Pacific, with funding from Environment Australia. Input has been provided by Wetlands for the Americas who coordinate the Western Hemisphere Shorebird Reserve Network.

The Western Hemisphere Shorebird Reserve Network

"The Western Hemisphere Shorebird Reserve Network (WHSRN) is a voluntary collaboration of government and private organisations that are committed to shorebird conservation. WHSRN gives international recognition to critically important shorebird sites and promotes cooperative management and protection of these sites as part of an international reserve network.

WHSRN was launched in 1985 in response to research which indicated significant declines in shorebird populations. It is currently managed through the Board of Wetlands of the Americas (an international non-government organisation) which also provides secretariate services.

During migration, shorebirds depend on a chain of critical wetland sites strategically located along their flyways extending from the Canadian high Arctic to Tierra del Fuego in southern Argentina. The diminished ecological function of just one of these critical sites could have disastrous affects on specific shorebird populations or even entire species. WHSRN identifies these areas and seeks to work together with wildlife agencies, land owners, private conservation groups and others to help ensure the conservation of shorebirds and shorebird habitats.

As of 1994, WHSRN has designated 25 internationally important reserves throughout the Western Hemisphere, offering protection for approximately 30 million shorebirds and over 4 million acres of wetlands. WHSRN uses shorebirds as a symbol of the intense conservation challenge facing wetlands and of the need for international cooperation in the protection of these areas."
(from Wetlands for the Americas Policy Paper 1995)

2. Principles of the East Asian-Australasian Shorebird Reserve Network

The following principles outline the philosophy for the operation of the Network:

- Wetlands and shorebirds are a natural heritage highly valued by societies worldwide.
- All uses of wetlands will be consistent with their long term protection and sustainable use.
- Involvement of local communities in decisions on the management of wetland resources will be encouraged.
- Maintenance of populations of migrant shorebirds requires long term planning, close co-operation and co-ordination of ongoing and future management activities by all nations in the shorebird flyway.
- Development and the appropriate management

of an international network of internationally important sites for shorebirds will greatly enhance the conservation of these and other species of waterbirds using the sites.
- The conservation of sites for migratory shorebirds will act as a catalyst for greater community appreciation of the natural environment.

Geographic coverage of the East Asian-Australasian Shorebird Flyway is shown on Map 1.

3. Nature of the Network

The East Asian-Australasian Shorebird Reserve Network will be a co-operative international program for conservation of shorebirds and their habitats. It involves collaboration of site management bodies and local communities. This mechanism is primarily aimed at assisting "on-site" personnel while providing opportunities for assistance from "off-site" conservation agencies and organisations.

An important feature of the Network is that it enables site owners, managers, participating organisations and local people to obtain international recognition for the importance of their site and their conservation efforts.

The Shorebird Reserve Network will be a network of both sites and people. Managers of Network sites will be encouraged to establish mechanisms to build community support for the conservation management of the site. All issues related to site management will continue to be the responsibility of the site management bodies.

It is not intended that the sites in the Network be limited to totally protected areas declared under national legislation. In developing the Shorebird Reserve Network concept it has been recognised that shorebird conservation can be achieved within the "wise-use" of a site without the site needing to be a totally protected area.

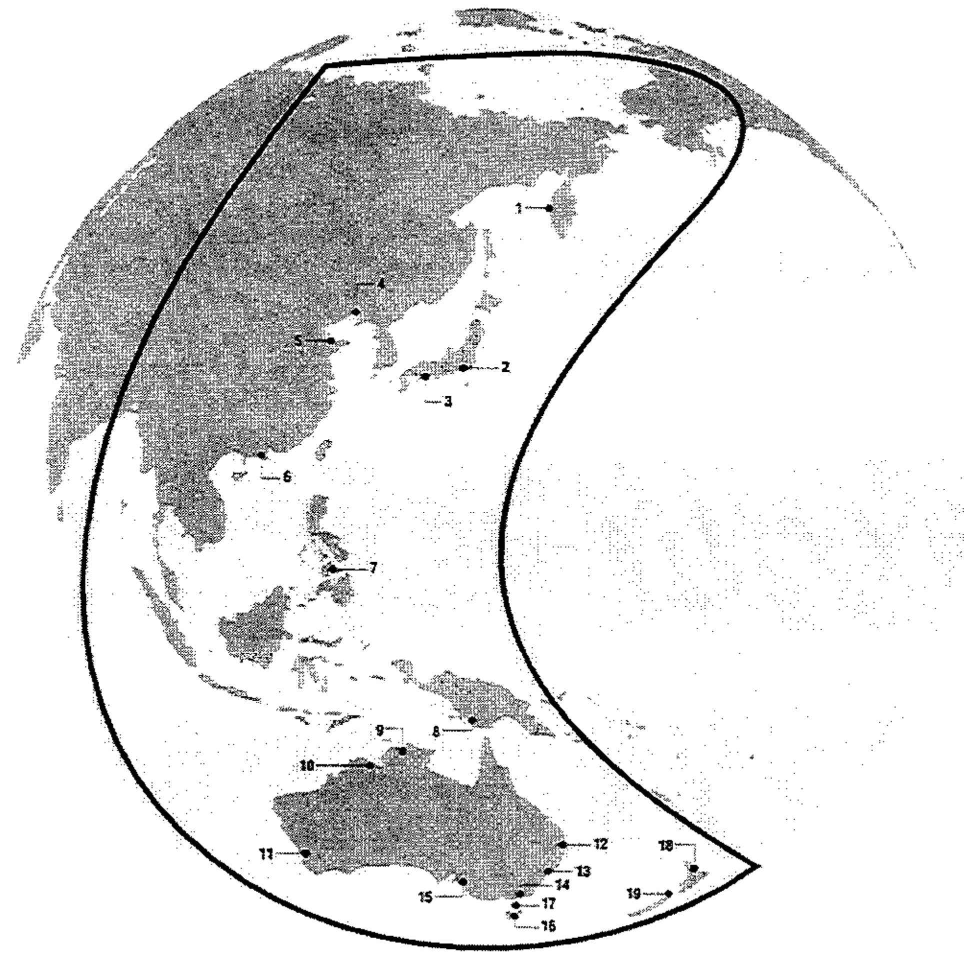
4. Goal of the Network

To ensure the long term conservation of migratory shorebirds in the East Asian-Australasian Flyway through recognition and appropriate management of a network of internationally important sites.

5. Activities of the Network

Site Management Bodies / National Agencies:
- Prepare nomination information for the site.
- Management of the site.
- Development of a site management plan.
- Promote the local recognition of the importance of the site for the conservation of shorebirds.
- Promote the establishment of mechanisms to build community support for the management of the site.
- Participate in exchange of information on the site with other sites in the Shorebird Reserve Network.
- Assist to promote, at a national level, the nomination of other internationally important sites.

Shorebird Flyway Officer:
- Assist in the identification of internationally important sites for the conservation of migratory shorebirds.
- Promote recognition of the importance of these sites for the conservation of migratory shorebirds.
- Provide information and advice to site management bodies on matters relating to shorebird management and other wetland issues.
- Maintain a database on sites in the Shorebird Reserve Network.
- Assist in providing training opportunities for site managers.
- Facilitate communication and information exchange between site management bodies, researchers and other relevant agencies in the Network and other global networks.
- Advise site management bodies on possible funding sources for the management of sites in the Shorebird Reserve Network.



Map 1 Geographic Coverage of the East Asian-Australasian Flyway

	Country	Network Sites	To be Nominated	Lat/Long	Status
1	Russian Federation	Moroshechnaya Estuary		56 21 156 15	Protected Area, Ramsar
	Korea, Republic of		Kychwa Jo Alyu Je	35 37 126 31	Protected Area (part)
2	Japan	Yatsu tidal flats		35 41 140 00	Protected Area, Ramsar
3	Japan	Yoshino Estuary		34 05 134 36	
4	China, P.R. of	Shuangtaizi Estuary		40 57 121 45	Protected Area, Ramsar
5	China, P.R. of	Yellow River Delta		37 50 118 50	Protected Area
	China, P.R. of		Chongming Island	31 30 121 45	
6		Mai Po - Inner Deep Bay		22 30 114 00	Protected Area, Ramsar
	Cambodia		Kaoh Kapik	11 05 103 03	Protected Area
7	The Philippines	Olango Island		10 16 124 03	Protected Area, Ramsar
8	Indonesia	Wasur National Park		8 35 140 45	Protected Area
	Papua New Guinea		Tonda Wildlife Reserve	8 45 141 23	Protected Area, Ramsar
9	Australia (NT)	Kakadu National Park		12 40 132 45	Protected Area, Ramsar
10	Australia (WA)	Parry Lagoons		15 15 128 22	Protected Area, Ramsar
11	Australia (WA)	Thomsons Lake		32 09 115 52	Protected Area, Ramsar
12	Australia (Qld)	Moreton Bay		27 20 153 10	Partly Protected Area, Ramsar
13	Australia (NSW)	Kooragang Nature Reserve		32 51 151 47	Protected Area, Ramsar
14	Australia (VIC)	Corner Inlet		38 45 146 32	Protected Area, Ramsar
15	Australia (SA)	The Coorong		35 40 139 00	Protected Area, Ramsar
16	Australia (Tas)	Orielton Lagoon		42 47 147 30	Protected Area, Ramsar
17	Australia (Tas)	Logan Lagoon		40 10 148 17	Protected Area, Ramsar
	Australia (WA)		Eighty Mile Beach	19 31 120 48	Ramsar
	Australia (WA)		Roebuck Bay	18 07 122 16	Ramsar
18	New Zealand	Firth of Thames		37 13 175 23	Protected Area, Ramsar
19	New Zealand	Farewell Spit		40 32 172 50	Protected Area, Ramsar

- Assist in the implementation of the Asia-Pacific Shorebird Action Plan and the Asia-Pacific Migratory Waterbird Conservation Strategy.

6. Joining the Shorebird Reserve Network

To become a site in the Shorebird Reserve Network involves the following:

- Preparation of nomination documents by site management body in consultation with the Shorebird Flyway Officer of Wetlands International - Asia Pacific.
- National Government proposal for the nomination.
- Review of the technical details of the nomination by the Shorebird Working Group and finalisation of site nomination with the site management body and national government.
- Wetlands International - Asia Pacific Council notes the site as part of the Shorebird Reserve Network.
- Network Reserve dedication ceremony.

Site management bodies are invited to consult with the Shorebird Flyway Officer of Wetlands International - Asia Pacific when considering the potential nomination of sites. This process will ensure that technical questions about the shorebird criteria can be satisfactorily addressed before a site is formally nominated. Site nominations will be reviewed by the Shorebird Working Group and will formally become part of the Shorebird Reserve Network following noting by the Wetlands International - Asia Pacific Council.

The Network Reserve dedication ceremony is envisaged as being organised by the site management body. It provides an opportunity to formally involve politicians, administrators and the local community in a celebration of the importance of the site.

7. Biological Criteria to Qualify as a Network Reserve

The Kushiro workshop agreed that the criteria for sites to qualify for inclusion in the Network should be modelled on the Ramsar Convention's "Special Criteria Based on Waterfowl for Identifying Wetlands of International Importance". This has been supported in subsequent discussions. As such the criteria for a site are:

- it regularly supports > 20 000 migratory shorebirds; or,
- it regularly supports > 1 % of the individuals in a population of one species or subspecies of migratory shorebird; or,
- it supports appreciable numbers of an endangered or vulnerable population of migratory shorebird.

During migration shorebirds stop at sites for brief periods to replenish their energy reserves and these sites are called "staging sites". A feature of staging sites is that the number of shorebirds supported is much greater than at any one count, because of movement of birds through the site. The guideline for applying the criteria to staging sites will be to use a multiplication factor of 4 for species that stage at these sites. That is, the site would need to support a total of 5 000 staging shorebirds or 0.25% of a staging shorebird species. Management bodies are urged to discuss these complex issues with the Shorebird Flyway Officer at any early stage.

It is anticipated that the Shorebird Working Group may re-evaluate the biological criteria as assessments are made of the adequacy of the Network. Consideration may be given to developing various categories of importance for sites within the Network

8. Shorebird Network Support and Administration

Wetlands International

Wetlands International was established in Malaysia in October 1995 through the integration of the Asian Wetland Bureau (AWB), the International Wetlands and Waterbird Research Bureau (IWRB) and Wetlands for the Americas (WA). Wetlands International has three regional councils: Asia-Pacific, Europe-Africa-Middle East and the Americas. The membership of the Councils comprises of representatives of Governments in the region and organisational and technical experts.

Wetlands International combines the regional expertise of AWB with the experience that WA has in the co-ordination of the Western Hemisphere

Shorebird Reserve Network. IWRB bring the skills they have developed in the areas of waterbird research, working with the Ramsar Bureau and the development of the Agreement on the Conservation of African-Eurasian Migratory Waterbirds. At the meeting of the Wetlands International - Asia-Pacific Council on 18 March 1996, the representatives from Australia and Japan proposed that the Asia-Pacific Council of Wetlands International establish a framework and mechanism for overseeing and managing the Network. This was approved by the Council and an Asia-Pacific Migratory Waterbird Conservation Committee and a Shorebird Working Group will be established to undertake this task.

Shorebird Working Group

Wetlands International - Asia-Pacific Council will establish a Shorebird Working Group to oversee the implementation of a Asia-Pacific Migratory Shorebird Action Plan which will include the development of the Shorebird Reserve Network. It is proposed that the working group have a membership drawn from Government, non-government organisations and experts actively involved in shorebird conservation.

It is proposed that the Shorebird Working Group meet once each year to review the activities of the Network, provide expert advise on Network development, review site nominations and forward plans. A Shorebird Flyway Officer will provide the administrative support for the Shorebird Working Group.

An annual report of the activities of the Network will be prepared and circulated to all participating countries and management bodies of Network sites.

Funding for projects initiated under the Network will need to be identified. It is anticipated that the projects will include activities such as newsletters, educational and awareness material, training courses, Network site management and personnel exchange between Network sites.

Shorebird Flyway Officer

Environment Australia is providing funding to Wetland International - Oceania for this position on a half time basis. The funding covers salary, travel and office expenses for up to six months work a year over three years. The Shorebird Flyway Officer works from the Oceania Office of Wetland International which is co-located with the Wetlands, Waterways and Waterbirds Unit of Environment Australia in Canberra, Australia.

Shorebird Use of the Moroshechnaya Estuary

N.N. Gerasimov & Yu.N. Gerasimov

Kamchatka Institute of Ecology, Prospect Rybakov 19a, Petropavlovsk-Kamchatsky, 683024, Russia

The West Kamchatka plain is the most important region of the Kamchatka peninsula for migrating shorebirds. The plain stretches along the sea coast for 800 km. Swamps or wet tundra are the most characteristic landscapes with 21 670 rivers and streams. The valleys contain more than 21 800 lakes with a total surface area of 735 sq. km. The area covered by wetlands totals over 20 000 sq. km. (The Surface Current Resources of USSR, 1972).

One of the main rivers of the West Kamchatka plain is the Moroshechnaya River with its associated swampy treeless plain and numerous lakes. The river has a 25 km long estuary which is separated from the Sea of Okhotsk by a sand spit. The mouth of the estuary is located 56°50'N and 156°10'E. The vegetation of the sand spit consists of grass, moss and berries: *Empetrum nigrum, Vaccinium vitis-idaea, Vaccinium uliginosum, Lonicera kamtschatica, Rubus chamaemorus, Chamaepericlymenum suecicum.* The estuary has vast mudflats and pebbly and sandy beaches exposed during low tide. These factors are the reason that the Moroshechnaya estuary area is a very important shorebird staging place in Kamchatka.

The data on the Moroshechnaya River shorebirds were collected in 1970-1990. The total observation time was more than 12 months. In May 1990 a count of migrating shorebirds was conducted on the sea coast near the mouth of the river (Yu. Gerasimov, 1991). It was part of the spring counts of migrating waterfowl conducted in Kamchatka in 1975-1995 (N. Gerasimov & Yu. Gerasimov, 1995).

About 30 shorebird species use the area as a staging site and more than 10 species breed in the low basin of the Moroshechnaya River.

The shorebird spring migration takes place from the middle of May to early June. Arrival date and total approximate number estimation are shown in Table 1. Dunlin, Red-necked Stint and Great Knot are the most numerous species of Moroshechnaya estuary shorebirds in spring (Yu. Gerasimov, 1991).

In June the spring migration time of shorebirds turns into the summer wandering period. Flocks of Eastern Curlew, Black-tailed Godwit, Dunlin and Red-necked Stint wander in the Moroshechnaya estuary all summer. For example, in June - July 1984, a concentration of 7,000 Great Knot stayed near the mouth of the Moroshechnaya River. On 9 July 1984, a concentration of 170 Eastern Curlew was observed in the estuary.

Flocks of Whimbrel and Bar-tailed Godwit appear on the sand spit in the middle of July after tundra berries have ripened. During August some of the flocks of Whimbrel leave the sand spit heading south, while other flocks arrive from the north. In August 1990, we conducted a count of the shorebirds in the sand spit. It showed that sometimes about 20 000 Whimbrel were feeding on the Moroshechnaya sand spit at the same time. Autumn migration of Whimbrel and Bar-tailed Godwit is finished by the middle of September.

Thousands of Dunlin, Red-necked Stint, Great Knot and Black-tailed Godwit and hundreds of Eastern Curlew and Oystercatcher feed on the mudflats and sandy beaches of the estuary in August and September (see Table 2).

The mouth of the Moroshechnaya River is used as a base by fishermen during this time of the year. In winter this area is use for reindeer-breeding.

In 1972 the state nature reserve (Zakaznik) was established on the lower section of the Moroshechnaya River. Zakaznik includes 1500 square kilometres of the important wetlands. This place meets the criteria for the determination of internationally important wetlands. Zakaznik now has Ramsar site status.

The Moroshechnaya River estuary is an important region for East Asian-Australasian Flyway shorebird conservation. But the difficult economic situation in Russia has a negative influence on nature conservation projects. Russian ornithologists and nature conservation services are no longer able to conduct meaningful wildlife research or conservation activities in the Moroshechnaya River area without international support.

Table 1
Shorebirds of Moroshechnaya River estuary in spring
(arrival date, approximate number estimation and breeding)

Species	Arrival date	Number estimation	Breeding
Pluvialis squatarola	17.05.90	hundreds	No
Pluvialis fulva	-	hundreds	Yes
Charadrius mongolus	10.05.76	1,000	No
Arenaria interpres	14.05.76	hundreds	No
Haematopus ostralegus	3-9.05	500	Yes
Tringa glareola	10-18.05	hundreds	Yes
T. nebularia	13-18.05	hundreds	Yes
T. guttifer	21-24.05	few	?
T. erythropus	23.05.76	tens	No
T. hypoleucos	-	tens	Yes
T. brevipes	-	tens	No
Xenus cinereus	-	hundreds	No
Phalaropus lobatus	14.05.75	hundreds	Yes
Eurynorhynchus pygmeus	29.05.90	500	No
Calidris ruficollis	18.05.76	100,000	No
C. subminuta	-	tens	Yes
C. temminckii	-	?	?
C. ferruginea	24.05.75	few	No
C. alpina	14.05	150,000	Yes
C. tenuirostris	15.05	40,000	No
C. canutus	-	3,000	No
C. alba	1.06.90	few	No
Gallinago gallinago	-	tens	Yes
Numenius madagascariensis	10.05	hundreds	Yes
N. phaeopus	17.05	1,000	No
Limosa limosa	18.05	1,000	Yes
L. lapponica	10.05.77	5,000	No
Total		300,000	

Table 2.
Shorebirds in the Moroshechnaya River estuary in autumn (approximate estimation)

Species	Number Estimation
Haematopus ostralegus	1,000
Calidris ruficollis	300,000
C. alpina	350,000
C. tenuirostris	100,000
Numenius madagascariensis	1,000
N. phaeopus	100,000
Limosa limosa	10,000
L. lapponica	50,000
Other species	?
Total	1,000,000

References

Gerasimov N. & Gerasimov Yu. 1995. Investigation of Waterfowl Migration in Kamchatka. Geese study. No.9, p.1-7, Wakayanagi, Japan.

Yu.Gerasimov, 1991. Spring shorebirds migration in the West Kamchatka. Materials of 10th ornithology conference of USSR. part 2 (1). Minsk. p.142-143.

The Surface Current Resources of USSR. 1972. Vol.20 (Kamchatka). Leningrad.

Wader Migration at north-eastern Sakhalin Island, based on Observations in Lunskiy Bay

Vladimir Zykov

V. Zykov, Director, Fauna, Komsomolskaya Str 241-A, 14, Yuzhno-Sakhalinsk, Sakhalin, Russia 693013

One waterfowl migration route passes along the north east-coast of Sakhalin Island. The shallow gulfs create favourable conditions for feeding and roosting during the migration period. Many species of birds spending the northern winter in Australia, Asia and Japan migrate along the coast of Sakhalin from their breeding grounds in the northern regions of Siberia and Far East.

The migration of waders on Sakhalin is only described briefly here. Some publications have stresses the importance of the coasts of Sakhalin for migration of waterfowl, as well as for waders. The spring migration is more intensive on the western coast of Sakhalin, because the Tatarskiy Strait is free from ice earlier. During summer and autumn the east coast of Sakhalin is more favourable for migration where there are some shallow bays, convenient for roosting and feeding for many species. Quantitative characteristics of migration, including detailed analysis in the changes in the number of species during season, have not been previously published.

Characteristics of the study area

On the north-east coast of Sakhalin there are some large shallow gulfs connected by a narrow sea strait. Extensive sand and mud-sand flats are found in these gulfs.

During spring (April-May) the prevailing weather can include some snowfalls and periods of drizzling rain. The main winds are from the north and south. The monthly average temperature in April is - 1° C, and in May + 3°C to + 6°C. Late melting ice during spring is typical of these gulfs, especially in shallow areas. At these sites the ice can remain until the beginning of June. Strong currents can be experienced at the mouth of these gulfs and in some places along the rivers in March - April, The ice conditions on the sea vary and are greatly influenced by winds. But by the end of May the ice on beaches has basically disappeared. The complete clearing of the gulfs and sea of ice occurs in June.

Summer (June-August) is cool and rainy. Monthly average air temperature is +14°C. The moisture precipitates in a kind of drizzling rain; winds are from the south-east and south directions. In the summer fogs are common, especially in July.

The autumn (September- October) is gloomy. Monthly average temperature in September is +12°C. The directions of winds during the autumn vary. Ice begins to form on the gulf at the beginning of November.

The Lunskiy Gulf is the southern most in the system of gulfs of north-east Sakhalin. Due to their small size they are convenient for surveys, however, they are typical for the region.

The coast of Lunskiy Gulf, on which the work was carried out, is a flat plain dissected by several small rivers and streams. The landscape of the coast is similar to tundra.

A narrow sand beach separates the gulf from the sea. The mudflats are characteristic of the river mouths and shallow zones of a gulf with weak currents. Width of littoral areas on some parts of the coast can be 100-200 metres. The gulf is shallow and in the second half of summer carries much water vegetation. On the gulf coast are the outlets of underground hot springs. These boggy swampy sites are clear of snow earlier in the spring and the first migratory birds stop here.

The research was conducted on the northeast coast of Sakhalin Island, on Lunskiy Bay (Fig.1) from April 10 to June 28 and from August 15 to November 9, 1989, from June 1 to October 10, 1990, from May 1 to July 16 and from September 20 to October 22, 1991. To study the variation in the number of waders, control sites were selected. These were places where roosting and feeding concentrations of waders occurred during the migration period. The sites were regularly monitored to determine the numbers of birds. Species identification was made using 12x binoculars. Several visits were made to control sites during the day; as result the maximum number of birds of a certain species or species group was obtained. More than 500 visits to control sites were carried out during the study.

Results

Fifty-two species of waders have been recorded on Sakhalin. On the north-east coast, where the majority of the work has been carried out, 33 species have been marked. Fifty-two thousand waders were counted of which 31 thousand (60%) were determined to species level. Data on species structure and numbers of birds counted are shown in Fig 2.

Species Accounts

Grey Plover (*Pluvialis squatarola*) (Fig. 2.1)

This species is occasionally encountered in the region. These birds are usually observed flying over the area without stopping.

Pacific Golden Plover (*Pluvialis fulva*) (Fig. 2.2)

The spring migration of this species is from the end of May to the beginning of June when birds fly along the coastline in small groups (less than 10 birds). This species is rare in the gulf, only occasionally stopping on the coast. The autumn migration is similar. This migration takes place from August to the first week in October.

Little Ringed Plover (*Charadrius dubius*) (Fig. 2.3)

Single birds were observed on migration during spring on mud areas of hot springs and on the Gulf shores.

Lesser Sand Plover (*Charadrius mongolus*) (Fig. 2.4)

This species makes up 7-9 % of the total number of waders recorded during migration. Spring migration is from the middle of May to first week of June. The peak of the autumn migration is in the first half of September when 30 % the total birds of this species were counted. At this time small concentrations form on the bays, and remain for several days. During migration birds form flocks on the shores of the gulfs, and on the coast. At other times this species prefers to stay on sand/mudflats of the bay during low water and during high tide on coastal sand banks, amongst small shrubs or grasses or on the sea coast.

Ruddy Turnstone (*Arenaria interpres*) (Fig. 2.5)

This species is seldom observed during spring migration. Some birds have been recorded at the end of May. The autumn migration is from middle of July to the middle of September. They are more usually seen in the second half of July - August. At this time the birds occur only on the sea coast.

Black-winged Stilt (*Himantopus himantopus*)

A single bird was recorded on mud flats near hot springs on 30 May 1991. This is the northern most known record of this species in Sakhalin area.

Eurasian Oystercatcher (*Haematopus ostralegus*)

This species was recorded twice on the gulf, one bird was recorded on 26 May 1989 and a flock of 60 birds was recorded 16 on September 1990.

Wood Sandpiper (*Tringa glareola*) (Fig. 2.6)

The spring migration of this species takes place in the third week of May. In July it stays on the shores of the gulf and on muddy and grassy sites near hot springs. Small numbers of this species arrive at the gulf to the middle of September.

Greenshank (*Tringa nebularia*) (Fig. 2.7)

During the spring migration period small numbers gather during the last ten days of May. The summer- autumn migration is from the beginning of July to the end of September. The peak is from the end of August to the beginning of September.

Spotted Greenshank (*Tringa guttifer*)

Single birds were recorded on the bay. On 19 May 1989 one bird was observed on the edge of an ice field, on the deep-water part of the gulf. On 7 June a single bird was observed feeding on the shores of the gulf in the company of two *Tringa brevipes*. In September 1989 one bird was feeding on the shores of the gulf in a group of 15 *Tringa nebularia*.

Redshank (*Tringa totanus*) (Fig. 2.8)

During migration this species does not congregate into large groups. The first birds arrive in the Gulf of Lunskiy in spring during the last ten days of May. This species has been breeding on the north east coast, including, in small numbers on the Lunskiy gulf. During the breeding season the numbers of *Tringa totanus* remain constant. The migration of this species from the territory starts in July, the last birds leave the gulf in September.

Spotted Redshank (*Tringa erythropus*)

During spring migration on the gulf only one bird in breeding plumage was recorded, 23 May 1991. In the middle of September the young birds gather in small flocks at the river mouths in the northern part of the gulf.

Grey-tailed Tattler (*Heteroscelus brevipes*) (Fig. 2.9)

Small numbers of birds occur along the shores of the Gulf. They occur in groups of 2 to 3 and up to 10 birds during migration on the shores, generally separate from other species. In spring they arrive in the middle ten days of May until the middle of June. In the summer- autumn period they occur from the second half of July up to the end of September.

Common Sandpiper (*Actitis hypoleucos*) (Fig. 2.10)

It is possible to see this species in spring from the last ten days of May to the middle of June. In the summer- autumn period they arrive from last ten days of July to end of August.

Terek Sandpiper (*Xenus cinereus*) (Fig. 2.11)

During the spring migration several flocks were observed on the shores of the gulf during the last ten days of May. Summer migration is much more active. Flocks of 10-20 birds are constantly seen on the coast of the bay during the latter two thirds of July. The migration of this species is completed on the gulf by the beginning of September.

Grey Phalarope (*Phalaropus fulicarius*)

A female of this species was recorded on 24 September 1990, on the central part of Lunskiy Gulf.

Red-necked Phalarope (*Phalaropus lobatus*) (Fig. 2.12)

During the spring migration small flocks (tens of birds) of this species were recorded from the end May to the middle of June. The summer-autumn migration is not obvious in the study area. Separate flocks of 10-20 birds periodically occur at sites with aquatic vegetation in the area of the gulf during most of September.

Spoon-billed Sandpiper (*Eurynorhynchus pygmeus*)

This species is very rare in the area. It was recorded only twice. One bird was feeding on the shore of the bay with a flock *Calidris ruficollis* and *Calidris alpina* (total about 200 birds) on 20 September 1989. Four *Eurynorhynchus pygmeus* were present on the sand-mud shores of Lunskiy bay in flocks of *Calidris ruficollis* on 22 and 23 August 1990.

Red-necked Stint (*Calidris ruficollis*) (Fig. 2.13)

This species represents an average of 51 % of all waders counted during migration. Spring migration on the northeast coast of Sakhalin is from the end of May to the beginning of June. The majority of birds pass through the area in concentrated flocks over several days in the middle of July. During this period Red-necked Stints make up more than 60 % of all waders, and the absolute numbers at control sites exceed a thousand birds for each. This is the migration of females after nesting. Females constitute more than 95% of records of this species. Moult starts at this time. About 1-5% birds have early body-moult. During the second-third of August the number of Red-necked Stint decreases, and the overall presence drops to 38% of all birds present. Few Red-necked Stints remain in September when the last birds are recorded.

Long-toed Stint (*Calidris subminuta*) (Fig. 2.14)

Small numbers of this species gather on Lunskiy Gulf during the first ten days of May or first ten days of June and during August. This species is only found in small groups of up to 5 birds. They prefer grassy bogs and rough meadow. On Lunskiy Gulf they tend to stay on mud flats of hot springs and in the mouths of the rivers.

Temminck's Stint (*Calidris temminckii*)

Observed once during the whole study period, on 28 May 1991, when three birds were recorded on the shore near the mouth of the bay.

Curlew Sandpiper (*Calidris ferruginea*)

A single bird was recorded by us on Lunskiy Gulf on 13 June 1991 and two in August 1990.

Dunlin (*Calidris alpina*) (Fig. 2.15)

Dunlins represent 26% of all waders on the north-east of Sakhalin during the migration period. Spring passage occurs in the second half of May. The number of Dunlins on spring migration is much lower than in the summer and autumn. The summer-autumn migration of this species, as well as Red-necked Stint, is in two waves. Of the Dunlins counted during migration in 1989, 30% passed through the area during the fist few days of July. The migration at the end of August and into September is basically comprised of young birds. At this time Dunlin represent 33 % of all waders congregating in the gulf.

Great Knot (*Calidris tenuirostris*) (Fig. 2.16)

One bird of this species was recorded during spring on 23 May 1989. During summer-autumn migration the number of this species on gulf increased in middle of July and from second ten days of August to first ten days of September.

Red Knot (*Calidris canutus*) (Fig. 2.17)

This species has been recorded only on autumn migration, beginning with the second ten days of August and until the first ten days of September, with numbers increasing towards the end of the migration period.

Sanderling (*Calidris alba*)

Two birds were recorded on the sand coast of Lunskiy Gulf on 28 May 1991. This species is more common on the northern most bays (about 150 km to north).

Broad-billed Sandpiper (*Limicola falcinellus*)

Some birds were regularly seen on grassland mudflats near hot springs during August and the beginning of September.

Common Snipe (*Gallinago gallinago*) (Fig. 2.18)

This species is usual but not numerous in the summer-autumn period. Birds stay on grassy areas at the mouths of the rivers.

Latham's Snipe (*Gallinago hardwickii*)

A young female was collected on 14 May 1989 on crude grassland. This is the most northern known record of this species on Sakhalin island.

Eastern Curlew (*Numenius madagascariensis*) (Fig. 2.19)

This species has been observed congregating in small numbers in the Lunskiy area in August and the beginning of September during transit.

Whimbrel (*Numenius phaeopus*) (Fig. 2.20)

Few Whimbrel occur in the area during the spring migration when some flocks may contain up to about 20 birds. Spring migration takes place during the last ten days of May. Summer-autumn migration of this species is from mid-July to mid-September. During this time birds have been observed largely in tundra, where they feed on berries. Sometimes it is possible to see them on the coast and shores of the bay. The flyway is basically along the sea coast.

Black-tailed Godwit (*Limosa limosa*) (Fig. 2.21)

This species represent about 2.3 % of all waders in the area. The spring migration of this species is variable, mostly in July, but occasionally during August and the first half of September. The preferred habitat is grassland on the lower reaches of rivers, with small lakes.

Bar-tailed Godwit (*Limosa lapponica*) (Fig. 2.22)

This species represent about 1.3 % of all waders in the area. Observations have only been made on the gulf during autumn migration. Birds stop only for a short time on mud flats of the gulf.

Discussion

The spring migration of waders in the gulf is largely during the third ten-day period of May. Extensive coastal regions of the gulf are very good for resting and feeding for the majority of *Calidris spp*, which are prevalent on migration. More convenient for the stopover of waders are the shores in the central part of the gulf, where 53% of all waders were counted on study sites with flocks in some places of 1000 to 2000 birds.

The first migrants arrive in the gulf in the middle of May (earliest 9 May 1989 - two *Calidris subminuta*). The main migration has been in last ten days of May to the beginning of June. In total the main spring migration last about two weeks. After this the number of waders decreases and only breeding species remain in the Gulf.

There is no migration of waders during the second two thirds of June. The summer and autumn migration of waders occurs from the start of July to October. The period of most intensive migration is during July and August. There are only small flocks by the beginning November, the latest record being Dunlin on 8 November 1990.

During the migration period the number of waders is not constant on control sites; there is a large variation in the number of birds (Fig. 2.1-2.22). The timing of concentrations of waders on the study sites depends on the character of floods. At times of double tides during a day (two high waters and two low waters), the littoral areas on the gulf open on some days. It is at this time that the maximum numbers of waders are recorded on control sites. The maximum duration of such conditions is five days.

Comparing number of birds recorded during spring migration with the aggregate number of waders during summer-autumn period shows that for most species the northeast coast of a Sakhalin is an important region for migration and stopping, primarily in the summer-autumn period.

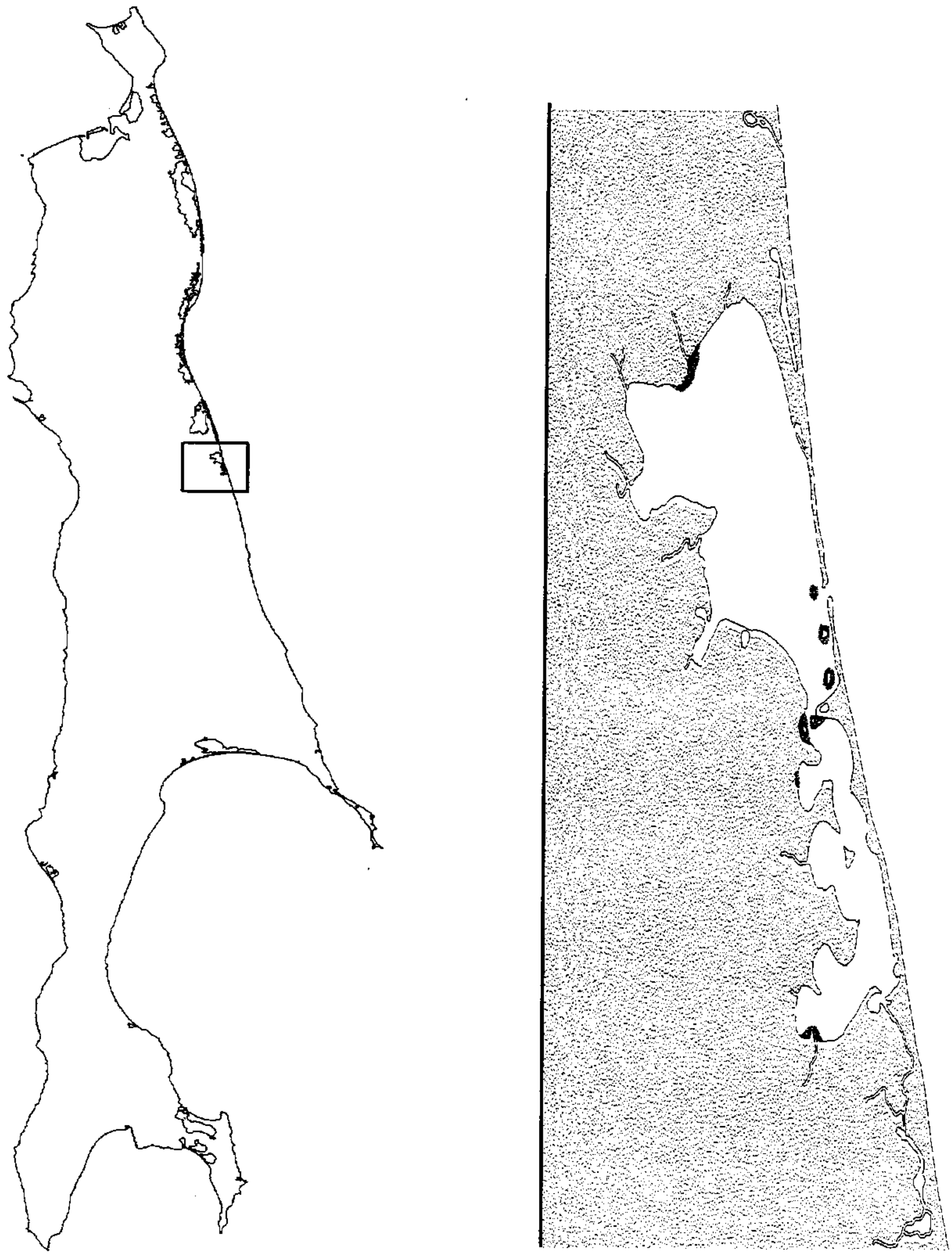
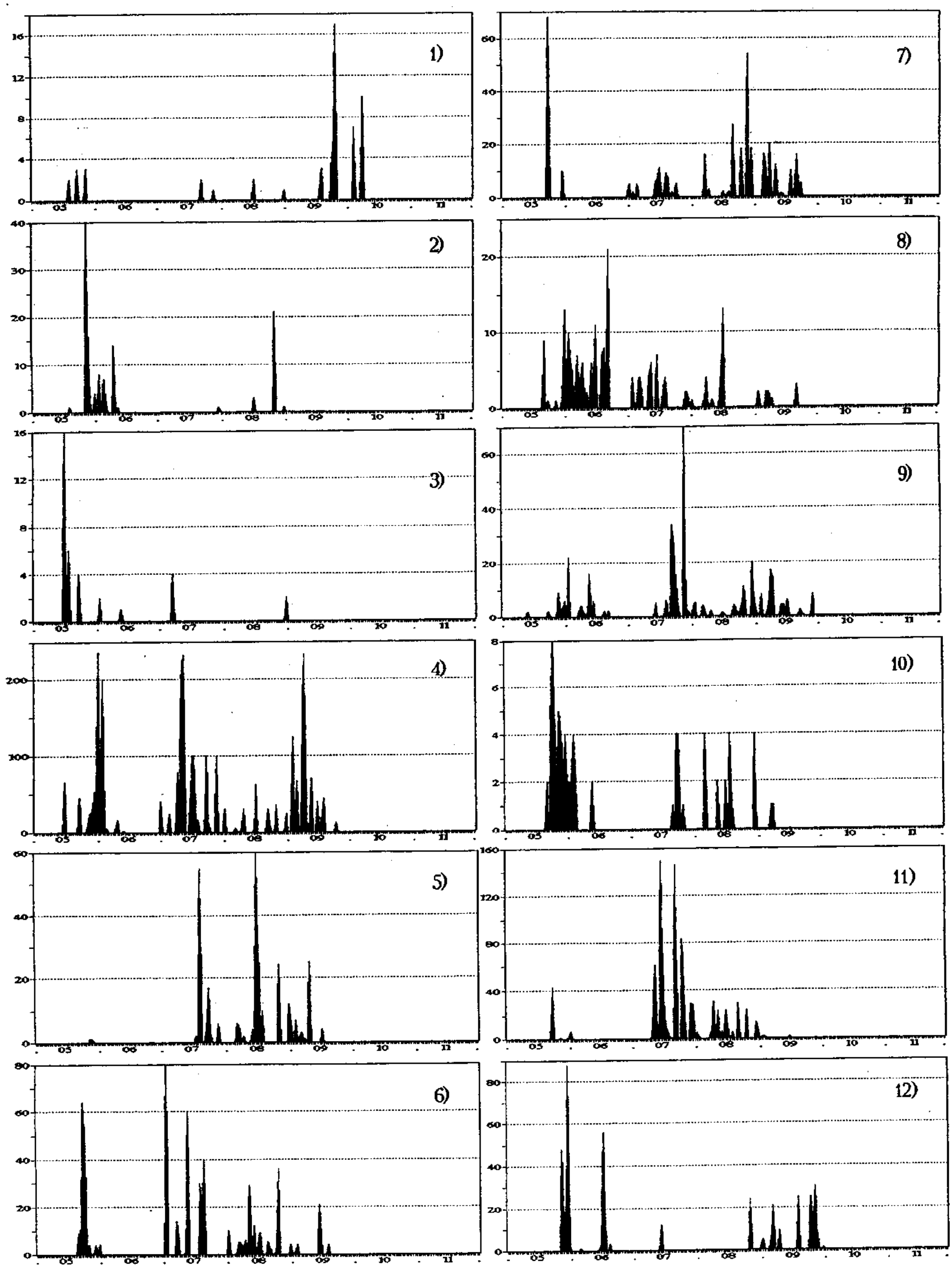


Fig 1.
Sakhalin Island

Lunskiy Bay showing wader concentrations


1)
2)
3)
4)
5)
6)
7)
8)
9)
10)
11)
12)

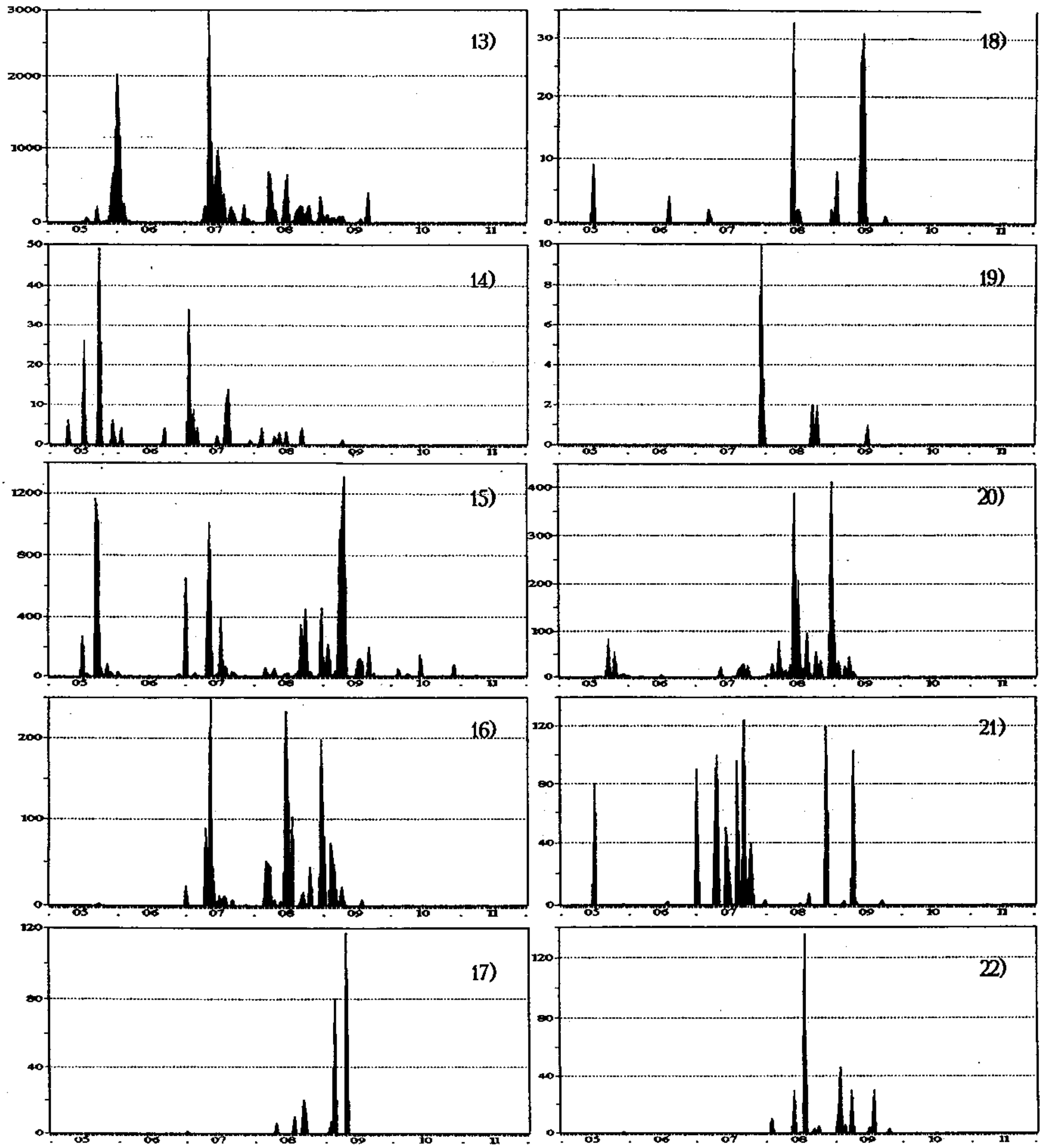


Fig. 2 Dynamics of wader numbers which have been observed in Lunski Bay between May and November (totals from 1989 to 1991): 1) Pluvialis squatarola; 2) Pluvialis fulva; 3) Charadrius dubius; 4) Charadrius mongolus; 5) Arenaria interpres; 6) Tringa glareola; 7) Tringa nabularia; 8) Tringa totanus; 9) Heteroscelus brevipes; 10) Actitis hypoleucos; 11) Xenus cinereus; 12) Phalaropus lobatus; 13) Calidris ruficollis; 14) Calidris subminuta; 15) Calidris alpina; 16) Calidris tenuirostris; 17) Calidris canutus; 18) Gallinago gallinago; 19) Numenius madagascariensis; 20 Numenius phaeopus; 21) Limosa limosa; 22) Limosa lapponica.

Shorebird use of Yancheng Biosphere Reserve China

Wang Hui

Abstract: Yancheng Biosphere Reserve is a very important international wetland for shorebirds. Over 80,000 shorebirds of 56 species use it as a stage point in spring and autumn. Over 20,000 shorebirds winter here, and 6 species breed, with Far Eastern Curlew and Asiatic Dowitcher reaching adulthood here in summer. YBR is the most important site for recommendation as a Ramsar wetland. Key words: Yancheng Biosphere Reserve Shorebird Survey Number.
W. Hui,

Introduction

Yancheng Biosphere Reserve (YBR) is situated on the coast of northern and central Jiangsu Province of China. It was established as a provincial reserve in 1983, and approved as a national class reserve by the State Council in 1992. It was approved as an international biosphere reserve under UNESCO's Man and Biosphere Program at the same time. The reserve extends 582 km along the coast of the Yellow Sea in Jiangsu and covers 5 counties from 33°38' - 34°31'N and 119°27' - 120°56'E, The total area is 453,000 ha, which comprises 17,400 ha of Core Area, 46,700 ha of Buffer Zone and 388,900 ha of Experimental Area. The reserve owns the Core Area only, other lands are locally owned. The reserve inludes the Huanghuai Plain by the Yangtze River, where the Old Yellow River once met. This river deposited much sand and silt to form a large mudflat 100 years ago. The northern boundary of the reserve has a mud sea wall from the north to the south, farmlands and mudflats are traversed, the eastern boundary is in water 3 meters below sea-level. Two saltworks are in the northern area of the reserve, in the Experimental Area, Sheyang saltworks is within the Buffer Zone, near the northern area of the Core Area. The administrative office of the reserve is located in the Xinyanggang town which is adjacent the Core Area. The vegetation of the coast is composed chiefly of herbage including *Phragmites australis*, *Imperta cylindrica* and *Aeluropus littoralis*. Salt-alkali-resistant species live in the high tidal zone such as *Suaeda salsa, S. yhauca* etc. Near the mudflat and the bare land adjacent the zero-level zone, local people plant some *Spartina anglica* to increase silt deposit. Yancheng Reserve has a monsoon climate, the temperature varies from -10°C in winter to 39°C in summer. The average annual rainfall is around 1000mm, with most of it occurring during summer and autumn, typhoon-related heavy rainstorms sometimes can bring very heavy rainfall and cause periodic flooding in the lower-lying areas of the reserve. There are 210-224 frost-free days and summers are hot and humid.

Method

Spring survey: In 1990 the survey area involved Guandong, Xintan, Sheyang saltworks and Sheyang river mouth, Core Area. In 1993 birds were counted in the Core Area and Sheyang Saltworks. In 1992 and 1995 birds were censused only in the Sheyang Saltworks, and in 1995 only one survey taken, on 17 April.

Summer survey: Birds recorded in 1993 and 1994, during Saunders' Gull *Larus sandersii* count.

Autumn survey: Only in 1990 was all the reserve surveyed. In 1992 birds were counted in the south of Core Area and adjacent area on 26 August. In 1989, '91, '93 to '95 birds were surveyed in the Core Area and the Sheyang saltworks. In 1995 the survey ran from August to the beginning of November, others mostly in October.

Winter survey: Shorebirds were surveyed during waterfowl censuses, from the end of November to the beginning of March. One to three persons using telescopes and binoculars did the counts. Bikes, motorbikes and minibus were used as transport from site to site; many large areas of mudflats could not be counted due to lack of boats.

Table 1. Spring counts data in Yancheng Biosphere Reserve

Species/Year	1990	1992	1993	1995
Oriental Pratincole	286	26	112	0
Painted Snipe	9	0	0	0
Oystercatcher	12	0	0	0
Black-winged Stilt	37	38	0	4
Grey-headed Lapwing	26	26	20	2
Asiatic Golden Plover	439	0	2	0
Long-billed Plover	33	1	0	0
Oriental Plover	1717	12	0	50
Grey Plover	672	434	446	0
Little Ringed Plover	0	2	0	255
Kentish Plover	3491	4165	1576	2
Mongolian Plover	1623	398	0	348
Great Sand Plover	142	2	0	0
Dotterel	440	1	0	3
Black-tailed Godwit	552	308	26	7
Bar-tailed Godwit	281	28	88	0
Godwits spp	0	246	0	0
Little Curlew	2	0	0	0
Whimbrel	255	90	0	0
Eurasian Curlew	139	80	31	9
Far Eastern Curlew	211	192	18	0
Spotted Redshank	570	215	235	70
Common Redshank	450	44	31	2
Marsh Sandpiper	157	418	569	4
Greenshank	839	38	955	11
Nordmann's Greenshank	35	1	0	0
Green Sandpiper	136	7	0	7
Wood Sandpiper	0	32	1	192
Common Sandpiper	1546	5	0	6
Terek Sandpiper	14	0	8	0
Grey-tailed Tattler	8	0	0	0
Ruddy Turnstone	850	220	0	30
Eurasian Woodcock	6	0	0	0
Pintail Snipe	124	0	0	0
Common Snipe	0	18	14	0
Swinhoe's Snipe	74	0	0	0
Great Knot	3271	1095	274	659
Red Knot	3169	340	33	30
Sanderling	3095	0	0	1
Red-necked Stint	4166	2122	675	97
Temminck's Stint	1638	480	16	0
Long-toed Stint	384	0	0	9
Little Stint	0	0	0	3
Sharp-tailed Sandpiper	1365	220	365	0
Dunlin	22678	8001	3735	510
Spoon-billed Sandpiper	8	0	0	0
Asiatic Dowitcher	2	182	14	40
Red-necked Phalarope	7	0	0	23
Curlew Sandpiper	502	0	2	0
Broad-billed Sandpiper	38	717	14	7
Unidentified shorebirds	6420	0	9534	6548
Total	61889	29832	18795	9286

Table 2. Summer counts data in 1993 and 1994, Yancheng Biosphere Reserve

Species/Year	1993	1994
Oriental Pratincole*	2	18
Oystercatcher*	81	14
Black-winged Stilt*	14	8
Grey-headed Lapwing*	43	4
Grey Plover	0	12
Little Ringed Plover	3	0
Kentish Plover*	205	47
Black-tailed Godwit	72	10
Bar-tailed Godwit	6	0
Godwits spp	5	7
Whimbrel	6	4
Eurasian Curlew	0	7
Far Eastern Curlew	510	1718
Spotted Redshank	0	2
Common Redshank*	275	104
Greenshank	30	0
Wood Sandpiper	9	0
Common Sandpiper	0	20
Dunlin	0	10
Asiatic Dowitcher	4	27
Unidentified shorebirds	57	18
Total	1322	2030

Table 3. Autumn counts data in Yancheng Biosphere Reserve

Species/Year	1989	1990	1991	1993	1994	1995
Oriental Pratincole	2	370	40	0	42	61
Painted Snipe	0	0	0	0	0	2
Oystercatcher	4	0	0	0	3	10
Black-winged Stilt	5	93	327	17	84	217
Avocet	128	0	23	0	0	2
Northern Lapwing	21	0	1	0	0	6
Grey-headed Lapwing	542	8	18	2	0	10
Asiatic Golden Plover	1	42	13	0	0	60
Long-billed Plover	0	6	5	0	1	16
Oriental Plover	0	389	107	17	2	131
Grey Plover	66	118	627	37	81	410
Little Ringed Plover	29	4658	1533	788	174	1211
Ringed Plover	120	5	7	1	1	21
Kentish Plover	1622	1447	4890	1358	287	3249
Mongolian Plover	57	1787	1232	115	113	862
Great Sand Plover	5	100	94	0	0	103
Black-tailed Godwit	74	626	1201	252	69	1686
Bar-tailed Godwit	7	168	634	110	35	981

continued next page....

Species/Year	1989	1990	1991	1993	1994	1995
Godwits spp	0	0	244	0	0	0
Little Curlew	6	5	2	17	0	76
Whimbrel	10	0	533	0	68	410
Eurasian Curlew	50	1	379	51	61	40
Far Eastern Curlew	3	0	14	0	59	328
Spotted Redshank	430	241	6484	348	272	7150
Common Redshank	134	547	256	262	25	135
Marsh Sandpiper	960	4229	3044	1998	637	6022
Greenshank	99	1740	1682	0	2	2325
Nordmann's Greenshank	2	170	27	0	0	210
Green Sandpiper	3	49	87	148	1	160
Wood Sandpiper	52	6	166	0	0	0
Common Sandpiper	12	519	33	4	5	16
Terek Sandpiper	2	81	166	148	1	322
Grey-tailed Tattler	7	146	2	0	5	4
Ruddy Turnstone	9	919	277	0	175	360
Eurasian Woodcock	4	1	1	0	0	0
Pintail Snipe	220	1	0	0	0	6
Common Snipe	7	1	0	1	0	41
Swinhoe's Snipe	0	3	0	0	0	1
Great Snipe	52	0	0	0	0	65
Snipes spp	0	300	0	0	0	510
Great Knot	5	3199	1303	11	44	1100
Red Knot	230	851	30	4	1	1006
Sanderling	250	362	0	0	0	14
Red-necked Stint	1550	2276	5822	1957	811	4128
Temminck's Stint	8	336	379	0	1	203
Little Stint	0	0	7	0	0	18
Long-toed Stint	0	1167	184	0	0	112
Sharp-tailed Sandpiper	126	1771	627	22	34	1233
Dunlin	2170	14454	16074	3650	337	18559
Spoon-billed Sandpiper	14	8	0	0	3	18
Asiatic Dowitcher	105	46	137	1	65	285
Red-necked Phalarope	0	46	0	0	0	187
Long-billed Phalarope	0	20	0	0	0	1
Red Phalarope	0	2	0	0	81	6
Curlew Sandpiper	7	0	0	1	5	1
Broad-billed Sandpiper	8	196	119	14	544	806
Ruff	0	71	0	0	0	0
Unidentified shorebirds	0	17778	33699	8370	5782	6280
Total	9217	61163	82438	21070	10155	60387

Table 4. Winter counts data in 1989-95, Yancheng Biosphere Reserve

Species/Year	1989	1990	1991	1992	1993	1994	1995
Oystercatcher	0	0	0	0	0	0	14
Black-winged Stilt	24	0	0	0	0	0	2
Avocet	279	595	775	0	700	120	523
Northern Lapwing	0	0	241	15	0	350	480
Grey Plover	0	58	94	20	16	64	180
Little Ringed Plover	0	1	0	0	0	0	0
Kentish Plover	3220	3937	1451	528	19	388	435
Mongolian Plover	0	64	12	0	0	0	0
Little Curlew	1	0	0	0	0	0	0
Eurasian Curlew	314	697	367	231	30	334	427
Far Eastern Curlew	0	1	0	0	0	0	0
Spotted Redshank	49	6	186	4	34	0	1511
Common Redshank	71	2	0	0	1	1	0
Marsh Sandpiper	0	0	34	9	0	0	557
Greenshank	0	0	0	0	2	0	803
Green Sandpiper	200	0	1	0	2	1	0
Wood Sandpiper	3	0	0	0	0	0	0
Common Sandpiper	0	0	4	0	0	0	12
Ruddy Turnstone	120	0	12	0	0	0	0
Eurasian Woodcock	0	0	1	0	1	0	0
Common Snipe	0	0	2	0	0	0	0
Great Knot	0	1	0	0	0	0	0
Sanderling	1102	67	631	0	0	264	2
Dunlin	3700	2999	4975	401	1137	2485	5700
Curlew Sandpiper	0	1245	2	0	104	180	1231
Unidentified shorebirds	0	9372	8658	740	300	350	15304
Total	9083	17924	17446	1948	2346	4537	27189

Results

Spring counts are given in Table 1.
35 Nordmann's Greenshank, 8 Spoon-billed Sandpiper, 2 Asiatic Dowitcher, 22,678 Dunlin, 440 Dotterel, 286 Oriental Pratincole and total 61,889 birds were counted in 1991. 1 Nordmann's Greenshank, 182 Asiatic Dowitcher, 192 Far Eastern Curlew, 4,165 Kentish Plover and total 29,832 birds were noted in 1992. 14 Asiatic Dowitcher, 112 Oriental Pratincole and total 18,795 birds were counted in 1993. 40 Asiatic Dowitcher and total 19,728 shorebirds were counted 17 April in 1994.

Summer counts are given in Table 2.
There were 81 Oystercatcher, 510 Far Eastern Curlew, 4 Asiatic Dowitcher and 14 species of total 1,322 birds summering. Oystercatcher, Grey-headed Lapwing, Black-winged Stilt, Kentish Plover, Redshank and Oriental Pratincole were breeding on high tide mudflat or waste saltpans, others were almost all young birds ,e.g. Far Eastern Curlews, Asiatic Dowitchers. 14 Oystercatcher 1,718 Far Eastern Curlew, 27 Asiatic Dowitcher, 7 Whimbrel and total 2030 birds of 15 species were recorded in 1994; of them 6 species were breeding as in 1993; others mostly were young birds.

Autumn counts are given in Table 3. 14 Spoon-billed Sandpiper, 2 Nordmann's Greenshank, 105 Asiatic Dowitcher, 542 Grey-headed Lapwing and total 9,217 shorebirds were counted in 1989. 170 Nordmann's Greenshank, 8 Spoon-billed Sandpiper, 46 Asiatic Dowitcher, 20 Long-billed Phalarope, 77 Ruff, 14,454 Dunlin total 61,163 birds were noted in 1990. 137 Asiatic Dowitcher, 27 Nordmann's Greenshank, 6,484 Spotted

Redshank, 5,822 Red-necked Stint, 7 Little Stint, and total 82,438 birds were recorded in 1991. There were 15 species of total 4,670 birds recorded on 26 August in 1992, and 21,070 shorebirds counted in 1993, 10,155 birds and 1 yellow-legged flagged Broad-billed Sandpiper, 1 banded Dunlin were noted in 1994. 2 Painted Snipe, 328 Far Eastern Curlew, 210 Nordmann's Greenshank, 1 Swinhoe's Snipe, 18 little Stint 806 Broad-billed Sandpiper, 285 Asiatic Dowitcher, 18 Spoon-billed Sandpiper, 18,559 Dunlin total of 60,387 birds counted in 1995.

Winter counts were taken from winter 1989 to 1995 (Table 4). Main wintering species were Dunlin, Grey Plover, Kentish Plover, Avocet, Curlew Sandpiper, Eurasian Curlew and Northern Lapwing. Eurasian Woodcock and Common Snipe mostly roosted in forest with short shrubs, others mostly were young birds or injured birds. Wintering census population numbers over 10,000 were in 1990-91,1991-92, 1995-96, (17,924, 17,446 and 27,189 birds respectively). See table 4.

Discussion

Yancheng Biosphere Reserve is a Ramsar wetland with the following characteristics:

- It is a main roosting site for shorebirds in the East Asian-Australasian Flyway. Over 80,000 shorebirds of 56 species migrate here to forage and roost, especially Dunlin whose population was over 10,000.
- Many rare shorebirds roost here, e.g. Nordmann's Greenshank, Asiatic Dowitcher, Spoon-billed Sandpiper.
- Some birds breed in Yancheng, e.g. Grey-headed Lapwing, Oystercatcher. Some birds grow to adulthood e.g. Far Eastern Curlew, Asiatic Dowitcher. Some birds winter in Yancheng, e.g. a large number of Dunlin(>5,000).
- The roosting site for birds on the tidal mudflats is enlarged up to 660 ha annually.
- Yancheng Reserve has undergone habitat conservation for many years. Details of a wetland protection plan will soon be available.

Spring migration of birds is less than the Autumn migration in 7 years' watching. It seems that most birds pass through Yancheng in Autumn, but in Spring, there are two flyways for migration, one along Yancheng Coasts, another from the Chongming Island to Japan.

Acknowledgments

I would like to thank: Dr. Liu Xiping, Mr. Du Jinjin, Chen Hao, Chen Weihua, Dr. Taej Mundkur, Roger Jaensch, David Melville, Lew Young, Wang Tianhou, Geoff Carey, Mark Barter, Doug Watkins, for all their friendly help.

References

1. Bakewell D.N. and L. Young 1989 Report on Ornithological Observations from Hangzhou Bay and Yancheng Nature Reserve, East China, AWB Publication No.58 Kuala Lumpur.

2. Wang Hui. 1993. A Primary Study on Waterfowl Resources in Sheyang Saltworks Chinese Journal Zoology 28(4):21-24. (In Chinese)

3. Wang Hui and Liu Xiping. 1994. Survey Data on Shorebirds and other Waterbirds, Coastal Wetlands of Jiangsu Province, CHINA. 1990-92 AWB report 1-62, Kuala Lumper

4. Wang Hui. 1992. Surveys of migratory Shorebirds at Sheyang Saltworks, Jiangsu, China Autumn 1991. The Stilt No.20:48-50.

Bangladesh: A Case Study On Shorebird Conservation Network

Anisuzzaman Kahn

A Kahn, Executive Director, Anisuzzaman, Nature Conservation Movement, GPO Box 3413, Dhaka-1207, Bangladesh

Introduction

Bangladesh is at the crossroads of two major shorebird migration flyways in the Asia-Pacific region. Precisely, the country has been considered to be on the western edge of the East Asian-Australasian Flyway and at the eastern edge of the Central Asian Flyway. The vast stretch of coastal wetlands at the Bay of Bengal and the Ganges-Brahmaputra-Meghna (GBM) rivers floodplains play a key role for nearly 73 species of shorebirds in resting, roosting, feeding, refueling and as a staging ground during the winter quarter. The congregation of shorebirds on the coast ranges from 200,000 to 300,000 individuals which includes the commonest species: Mongolian Plover, Asiatic Golden Plover, Black-tailed Godwit, Kentish Plover, Eurasian Curlew, Terek Sandpiper, Curlew Sandpiper, Ruff, etc. as well as the rarest: Crab Plover, Oystercatcher, Great Stone Plover, Spotted Redshank, Nordman's Greenshank, Asiatic Dowitcher and Spoon-billed Sandpiper. A total of about 95 species of waterbirds have so far been recorded from the Bangla coast during the last ten years of Asian Waterfowl Census.

Background

During the early eighties, a group of young biologists headed by the author and Dr Ali Reza Khan, the pioneer field ornithologist in Bangladesh, took the initiative to explore the avifauna in remote coastal mudflats and for the first time indicated the potential of the coast as an internationally important staging ground for globally threatened migratory birds. This pioneering work has further been strengthened by a coordinated voluntary network among the birdwatchers and the bird conservation organisations from all around the globe. Important roles played by various individual scientists and organisations to co-ordinate the effort are:

At individual level:

- Mr John Howes, Mr David Makewell, Mr Faizal Parish, Dr Nathern Khan, Dr Taej dukar and Ms Susan Wang from the then Interwader/Asian Wetlands Bureau (AWB)
- Dr Derek Scott from International Waterfowl and Wetlands Research Bureau (IWRB)
- Mr Mark Barter from Australasian Wader Studies Group (AWSG)
- Dr Jim Harris, International Crane Foundation (ICF)
- Dr Noritaka Ichida & Mr S A Hussain from Birdlife International (BLI)
- Dr Paul Thompson from Oriental Bird Club (OBC)
- Dr David Johnson, Mr Enamul Haque as individual naturalists from Bangladesh
- Mr Mokhlesur Rahaman, Mr Abdul Wahab Akonda from the Govt. Forest Department

At Organisational Level:

- Bombay Natural History Society (BNHS), India
- Asian Wetlands Bureau (AWB) Malaysia
- International Waterfowl and Wetlands Research Bureau (IWRB), UK
- WWF- Switzerland, WWF - USA
- Royal Society for Preservation of Birds (RSPB), UK
- Australasian Wader Studies Group (AWSG), Australia
- Ashoka: Innovators for the Public, USA
- Nagao Natural Environment Foundation (NEF), Japan
- Canadian International Development Agency (CIDA)
- Wild Bird Society of Japan
- Malayan Nature Society, Malaysia
- Dhaka Zoo, Bangladesh
- Forest Department, Government of Bangladesh

The Asian Waterfowl Census (AWC) acts as the focal point for the informal network of individual ornithologists and organisations dealing with wildlife, nature and shorebird conservation. AWC in Bangladesh has been organised for the last ten years and is established as one of the important bird conservation programs in Bangladesh.

Shorebird Habitats

Wetlands, forests and Ganges-Brahmaputra-Meghna (GBM) floodplains are the major habitat for the migratory shorebirds in Bangladesh. Approximately 720 km long, the Bangladesh coastline between Myanmar in the southeast and India in the southwest is characterised by three distinct geomorphologic regions:

- the East coast, along the Chittagong is regular and unbroken and protected along the sea by mudflats and submerged sands.
- the West coast supports a deep sedimentary basin covered with very old mangrove forests.
- the Central coast is characterised by heavy sediment input, formation of huge charlands and bank erosion as the region is located at the mouth of the confluence of three megha rivers Ganges-Brahmaputra-Meghna.

Habitat diversity in the Bay of Bengal is very rich. Other than the main sea marine ecosystem, the coastal zone supports a number of micro-habitats. These are: Intertidal mud and sand flats, sandy beaches, sand dunes and bars, low-lying islands, intertidal canals and creeks, grass and reed lands, strand vegetation, mangrove plantation, paddy fields, coastal floodplains, coral islands, rivers, channels and estuaries, etc.

In addition to the coastal wetlands, the inland wetland also provides important habitats for the shorebirds. These habitats are:

Haor: large depression between two or more rivers. This wetland is generally bowl-shaped, deeply flooded permanent freshwater wetlands having freshwater swamp. The Northeastern region of the country is dominated by this Haor system and is known as a haor basin. A vast haor basin lies at the foothills of Garo and Meghalaya hills of India.

Baor: Oxbow lakes and the dead arm of rivers situated in the moribund delta of the Ganges.

Beel: Saucer-like depressions which generally retain water throughout the year. GBM floodplains are dominated by this vast beel system.

Important Shorebird Areas and their Species Account

Area	No. of Species	Average no. birds	Rare birds	Remarks
Nijhum Dweep (includes Char Osman & Char Bahauddin)	42	20,000	Grey-headed Lapwing, Spotted Redshank, Nordman's Greenshank, Asiatic Dowitcher, Spoon-billed Sandpiper	An island in the Bay of Bengal, mangroves at centre surrounded by mudflats, sand beaches and grassland, crisscrossed by tidal canals
Dhal Char	37	30,000	Grey-headed Lapwing, Asiatic Dowitcher, Nordman's Geenshank	A cluster of three islands (Moulavir Char, Ghasiar Char & Dhal Char) with mangroves, grassland and intertidal mudflats. Important site for Indian Skimmer, Bar-headed Geese and Greylag Geese.
Urir Char	30	20,000	Spoon-billed Sandpiper, Grey-headed Lapwing	Deep intertidal mudflat, grasslands supports, Indian Skimmer, Spoonbill, Pied Avocet, Broadbill

Area	No. of Species	Average no. birds	Rare birds	Remarks
				Sandpiper, Bar-headed Geese
Sonarchar	35	15,000	Spoon-billed Sandpiper, Red-necked Stint, Broad-billed Sandpiper	Mangrove, grassland, mudflats and sandy beaches support big flocks of Common Shelduck, Pied Avocet.
East Dhal Char	20	10,000	Spoon-billed Sandpiper	Ruddy Turnstone, Long-toed Stint, Little Stint, Broad-billed Sandpiper. **Important site for Spoon-billed Sandpiper.**
Char Dighal	15	7,000	Long-toed Stint, Asiatic Dowitcher	Lesser Adjutant Stork, 8 species of heron, Ruddy Shelduck
Char Zamir	20	10,000	Nordman's Greenshank, Asiatic Dowitcher	Lesser Adjutant Stork, Bar-headed Geese
Kuakata	30	20,000	Spoon-billed Sandpiper	Herring Gull, Black-bellied Tern
Undderchar			Crabplover, Great Stone Plover, Grey-headed Lapwing	Breeding ground of Terns and Redwattled Lapwing.

Waterbird Species Account

Family	No. of Species	Abundance	Comments
Jacanidae	2	VC	Haor basin, Northeast Region
Rostratulidae	1	C	
Dromadidae	1	R	Naf estuary, East coast
Hematopodidae	1	R	Naf estuary, East coast
Recurvirostridae	2	C	Pied avocet in Central coast and Black-winged stilt at Haor basin Northeast
Burhinidae	2	R	Western coast
Glareolidae	2	C	Central coast and charlands in Padma
Charadidae	16	C	Both coastal and inland wetlands
Scolopacidae	32	-	Do
Laridae	13	-	Do
Rhyncopidae	1	C	Eastern and Central coasts
Total number of species	73		

Discussion

A wide variety of foods are found in abundance in different habitats. Marine invertebrates are very rich in both terrestrial and aquatic habitats. At low tide, birds were seen dispersed in larger areas for feeding and during high tide they congregated at a few high tide roosts. Maximum concentration of shorebirds was seen at the mudflats. Geese are always seen in the grasslands far away from high tide mark. Occasionally they are seen at the creeks. Highest numbers are seen at Bayer Char, Dhal Char and at Char Bahauddin. In a few cases they were seen close to the Ruddy Shelduck. Northern Shoveller were seen in big numbers at the water edges close to the low tide mark as the muddy areas are their most favoured habitat. Northern Shoveller are seen in large numbers in between Monpura and Agunmukha areas. Widgeon and Common Shelduck were seen floating at the mid channel of Shabajpur near Sonar Char and Kalkiny Island in Monpura. There is another important concentration of these two ducks seen at Char Bahauddin and Char Jonak. Common Shelduck were also seen at the sand flat during roosting and resting.

Highest concentration of birds in terms of their rarity, species diversity and individual numbers were seen at Char Bahauddin, named after the ex-Chief Conservator of Forests. Char Bahauddin in the Northeast coast of Nijhum Dweep is a unique staging ground for the migratory birds moving both north and south during the winter quarter. Before the long southern flight, birds use this small island as a refueling station and a roosting place. The sand flats of Char Bahauddin, after joining with Nijhum dweep in the southwest coast, extend nearly 25 km down to the Bay of Bengal. These newly accreted mudflats and sandflats are inundated at high tide and form a continuous sheet of sandy land during the ebb tide and are suitable feeding ground for large numbers of sandpipers and plovers.

The Island (Char Bahauddin) has also several micro-habitats, viz: 2 to 3 meter deep mudflats, elevated sand dune, sandy beaches, creeks, canals, intertidal mud and sand flats, lagoons, reed lands, grass lands, mangrove formations and channels. All these habitats are rich in marine, estuarine and coastal biological resources ranging from zoo-plankton and phytoplankton to huge algae and lower invertebrates. Birds with diverse food and feeding habits choose these islands as the best refuge when the vast low lying islands flood during high tide. According to the local fishermen, the channels around Char Bahauddin and between Nijhum Dweep and Char Muktaria are also rich in coastal fisheries. Marine turtles and marine dolphin populations close to Char Bahauddin and Nijhum are also rich. We have encountered 5 schools of dolphin at the confluence of Hatiya and Shahabajpur Channel near Char Muktaria and Bahauddin Area.

Important Bird Areas (IBA) in the coastal zone are: Urir Char, Bayer Char, Dhal Char, Char Bahauddin, Nijhum Dweep, Sonar Char, Kalkiny Dweep, East Dhal Char, Char Dhigal and Char Jamir. All these areas are important staging grounds and stop-overs for long distance migratory birds and lie in the East Asia-Australasian flyways.

Areas between Hatiya and Nijhum Dweep have been described as some of the internationally important wetlands and fulfill at least three criteria of the Ramsar convention.

Human disturbance is one of the main threats to the migratory birds at the coast. Excepting new island and mid-channels in almost all the islands, people were seen collecting fry of crustaceans, specifically the shrimp fry. Islanders of all age groups engaged themselves in fry collection activities both day and night. This conflicts with the feeding, resting, roosting, swimming, floating and wading grounds of shorebirds.

The rate of hunting and trapping of birds in the coastal wetlands is lower in comparison to the inland wetlands.

The practice of shrimp fry collection is detrimental and suicidal as the collectors destroy the future stock of other estuarine fish species. This is unconsciously done. Other than the targeted fry species, all other bycatch are thrown away as debris and unwanted catch. Therefore, the large volume of shorebirds is deprived of its predatory role in the coastal fisheries and biological foodchain. This would undoubtedly create an adverse impact on the prey population of marine biological productivity.

Unplanned mechanisation of local and sea going boats discharging unburned oil is one additional source of coastal water pollution and is identified as a potential threat.

One of the major loopholes in the existing coastal zone development plan is the total blockage of tidal inundation by the construction of a high embankment. Introduction of freshwater dependent agriculture will follow in the coastal saline and brackish water environment, instead of an agriculture, horticulture and aquaculture based on salt-tolerant species. As a result of these high embankment and channel training the islands are eroding at a faster rate.

Impact

AWC in Bangladesh has played a key role in the Government of Bangladesh signing the Ramsar Convention.

A number of voluntary bird conservation clubs/groups resulted from the AWC network in Bangladesh. They are simple civic pressure groups and birdwatching/naturalist clubs, organising a wide variety of popular programs in favour of bird and nature conservation.

Ten years of AWC results form the baseline of information for the people and organisations involved in research, policy formulation, etc. Important among them are:

- Northeast Regional Water Resources Management Project
- Tangail Compartmentalisation Pilot Project
- Third Forestry Nature Conservation Management
- Forest Resources Management Project
- National Conservation Strategy - Implementation Phase I
- Development of Wildlife Conservation and Management Project

Action Proposed

Based on the author's personal experience, the following action for Bangladesh is proposed:

- National Shorebird Conservation Action Plan needs to be developed
- There is a need to build an inventory of shorebirds and their habitats and coastal biodiversity.
- Newly accreted islands in the Bay of Bengal need to be kept as is for at least ten years for natural succession of both biotic and abiotic components. If the accreted land is encroached and occupied earlier for human habitation, it would definitely be detrimental to the stabilization of the fragile ecosystem ; the erosion process would be enhanced and the settlers would definitely be exposed to the direct threat of cyclonic storm and tidal surges and other natural calamities.
- Training and education with emphasis on bird banding and recovery, ecological studies and monitoring techniques to be organised.
- Site and Species Management Plans for the shorebirds to be developed and implemented.
- Nijhum Dweep under the Hatiya Police Station should be developed as a Shorebird Observatory

Recommendations

I. Central Coastal Region of Bangladesh should be declared as the country's first Shorebird Reserve.

II. To learn more about the globally threatened shorebirds such as Nordman's Greenshank, Spotted Redshank, Asiatic Dowitcher and Spoon-billed Sandpiper for their practical management purpose, there needs to be an international project with an urgent basis.

III. Regional and international cooperation and support needed to enhance the institutional capacity to monitor shorebirds and their flyways management in Bangladesh.

IV. At national level, the proposed offshore oil exploration and other coastal development projects should have proper Environmental Impact Assessment compatible with the national environmental laws.

V. Bangladesh should become a party to the global migratory animals convention - the Bonn Convention.

APPENDIX I - LIST OF PARTICIPANTS

Agnew, Lindsay, 5 Davina Street, Tarragindi, QLD 4121
Anderson, Mr E.R, PO Box 5545, Rockhampton, QLD 4702
Arnold, Don, PO Box 204, Boyne Island, QLD 4680
Baker, Barry, Executive Officer, Aust. Bird & Bat Banding schemes, GPO Box 8, Canberra, ACT 2601
Baker-Gabb, Dr David, RAOU, 415 Riversdale Road, East Hawthorn, VIC 3123
Barter, Mark, AWSG, 21 Chivalry Ave, Glen Waverley, VIC 3150
Bielewicz, Mr Julian, Redcliffe City Council, PO Box 66, Redcliffe, QLD 4020
Boere, Gerard, International Wader Study Group, Voorstraat 7,4153 AH Beesd, The Netherlands
Borsaru, Ms Ruzandra, 59 Moordale Street, Chapel Hill, QLD 4069
Boulton, Alan, Redcliffe City Council, PO Box 66, Redcliffe, QLD 4020
Bowden, Ms Leanne, 60 Lydia Street, Kalinga, QLD 4030
Chamberlain, Jill, PO Box 5748, Maroochydore, QLD 4558
Charley, David, NSW National Parks & Wildlife Serv., PO Box 91, Alstonville, NSW 2477
Chatto, Ray, Wildlife Research Unit Parks & Wildlife Unit, PO Box 496, Palmerston, NT 0831
Clancy, Greg, PO Box 63, Coutts Crossing, NSW 2460
Clancy, Val, PO Box 63, Coutts Crossing, NSW 2460
Coffey, Dr Felicity, Dept of Environment & Heritage, 61 Gold Creek Road, Brookfield, QLD 4069
Cooper, Melissa, Brisbane City Council - Parks North, GPO Box 1434, Brisbane, QLD 4001
Cornelius, John, PO Box 526, Gordonvale, QLD 4865
Crimp, Ms Olwyn, Div. Conservation, Dept Env., PO Box 155, Brisbane Albert St, Brisbane, QLD 4000
Cromarty, Pamela, Species Protection Div Dept of Cons, PO Box 10-420, Wellington, New Zealand
Custodio, Carlo, DENR, Manila, Philippines
Davidson, Ian, Wetlands International - Americas, 7 Hinton Ave, N Suite 200, Ottawa, Ontario, Canada
Dennett, Xenia, 100 Mountain View, Rosanna, VIC 3084
Denning, Jill, 5 Piat Place, Beerwah, QLD 4519
Dettmann, Ms Belinda, ANCA, ABBBS PO Box 8, Canberra, ACT 2601
Driscoll, Peter, QWSG, Fahey Road, Mt Glorious, QLD 4520
Filippich, Dr L.J., Dept of CAMS Veterinary School, University of Queensland, St Lucia, QLD 4067
Fisher, Keith, PO Box 2209, Cairns, QLD 4870
Fleming, Dr Mike, NSW NPWS, PO Box 1007, Dubbo, NSW 2830
Ford, Lisa, Coastal Mgt Qld Dept Env & Heritage, GPO Box 2771, Brisbane, QLD 4001
Fry, Graham, NSW WSG, 46 Whitfield Pde, Hurstville Grove, NSW 2220
Geering, Dr Andrew, QWSG, 28 Peppertree Street, Sinnamon Park, QLD 4073
Geering, Margaret, 28 Peppertree Street, Sinnamon Park, QLD 4073
Gerasimov, Dr Yuri, Kamchatka Inst of Ecology, Prospect Rybakov 19a, Petropavlovsk-Kamchatsky, 683024 Russia
Goeij, Ms Petra de, c/- Netherlands Ins. Sea Research, PO Box 59, 1790 AB Den Burg, Texel, The Netherlands.
Graham, Doris, VWSG, 14 Falconer Street, Nth Fitzroy, VIC 3065
Guard, Dr Frances, 214 Maleny-Mountford Rd, Maleny, QLD 4552
Guozhong, Chu, National Bird Banding Centre, Beijing, China
Hanawa, Shin-ichi, WWF-Japan, Shiba 3-1-14, Minato-Ku, Tokyo 105, Japan
Harding, Sandra, AWSG, 336 Prout Road, Burbank, QLD 4156
Harnett, Ian, 2-5-10 Tsutsui Cho, Higashi Ku, Nagoya, Japan
Harris, Gordon, 6 Quaver Court, Bridgeman Downs, QLD 4035
Harris, Mr Leigh, Coastal Management, S.E. Region, Dept. of Environment, GPO Box 2771, Brisbane, QLD 4001
Hoskin, Paul, 27 Trafalgar Drive, Victoria Point, QLD 4165
Hotaka, Ms Shinko, Japan Wetland Action Network, 4-31-2-305 Nishi Gotanda Shinagawa-ku, Tokyo, Japan
Howie, Barbara, 26 Dawson Ave, Thornleigh, NSW 2120
Hulsman, Dr Kees, ENS Griffith University, Nathan, QLD 4111
Husk, Mark, 5 Morgan Street, Botany, NSW 2019
Hutchison, Dr Michael, Qld Dept of Primary Industries, 13 Beach Rd., Deception Bay, QLD 4508
Ihara, Mr Tatsuo, Wildlife Div. Nature Cons, Environment Agency, 1-2-2 Kasumigaseki, Chiyoda-ku, Tokyo, Japan
Ingham, Ms Debbie, 18 Edgecliffe Road, Woolwich, NSW 2110
Ishikawa, Toshio, Japan Wetlands Action Network, 468-6 Sonno-cho, Inege-ku, Chiba-shi, Japan

Jaensch, Roger, Wetlands International - Oceania, GPO Box 636,Canberra, ACT 2601
Johnson, Nancy, 12 Queen Street, Scarborough, QLD 4020
Johnson, Richard, 21 Murry Street, Gatton, QLD 4343
Jones, A, Redcliffe City Council, PO Box 66, Redcliffe, QLD 4020
Ju, Ms Min Eun, 3a Ja/4-1 Jung-ang Dong, Jung District, Pusan, Korea
Kashiwagi, Minoru, Japan Wetland Action Network, 3-18-1 105 Higashi-Toyoda, Hino-shi, Tokyo 191, Japan
Khan, Executive Director, Anisuzzaman, Nature Conservation Movement, GPO Box 3413, Dhaka-1207, Bangladesh
Kikkawa, Prof. Jiro, Zoology Dept, University of Qld, St Brisbane, QLD 4072
Lake, Barbara, Nambucca Valley Birdwatchers, 1/1 Warrigal Ave, Nambucca Heads, NSW 2448
Lane, Brett, Ecology Australia Pty Ltd, 272-276 Heidelberg Rd., Fairfield VIC 3078
Lane, Jim, Dept Cons & Land Management, 14 Queen Street, Busselton, WA 6280
Litz-Tyne, Lynda, 24 Rokeby Terrace, Taringa, QLD 4068
Mackay, Ms Moragh, 40a George Street, Frankston, VIC 3199
Macwhirter, Dr Pat, 23 Barrington Drive, Ashwood, VIC 3147
Mangan, Ms Janet, 53 Beulin Ct, Brisbane, QLD 4000
Marr, Noela, 259 Bunneys Lane, Kin Kin, QLD 4571
Matsui, Ms Kaori, TB Miyashita Bldg, 1-22-10, Shibuya, Shibuya-Ku, Tokyo, Japan
McNamara, Deb, 11 Maritime Court, Victoria Point, QLD 4165
McNamara, Dr Owen, 11 Maritime Court, Victoria Point, QLD 4165
Melville, David, WWF Hong Kong, GPO Box 12721, No.1 Tramway Path, Central, Hong Kong
Miller, Greg, 60 Lydia Street, Kalinga, QLD 4030
Milton, Dr David, 336 Prout Road, Burbank, QLD 4156
Moffat, Bob, NSW National Parks & Wildlife Ser., PO Box 91, Alstonville, NSW 2477
Moores, Niall, Maison Torianon 101, Kashi 6-Chome, 3-27, Higashi Ku, Fukuoka, Japan 810
Mundkur, Taej, Wetlands International - Asia Pacific, IPT University of Malaya, Kuala Lumpur 50603, Malaysia
Murohashi, Ms Ariko, IWRB Japan Committee, TB Miyashita Bldg, 1-22-10, Shibuya, Shibuya-Ku, Tokyo, Japan
Ngamane, Ms Liane, New Zealand.
Noor, Yus Rusila, Wetlands International - Indonesia, Jl Arzimar III No 17, Bogor 16152, Indonesia
O'Connor, Ms D.E., QWSG, 55 Nestor Ave., Bardon, QLD 4065
O'Neill, Paul, Qld Dept of Environment & Heritage, PO Box 3130,Rockhamton Shopping Fair, QLD 4700
Okuda, Naohisa, Wildlife Div. Nature Cons Bureau, 1-2-2 Kasumigaseki, Chiyoda-Ku, Tokyo, Japan
Ozaki, Kiyoaki, Yamashima Institute of Ornithology, 115 Tsutsumine, Konoyama, Abiko-shi, Chiba-Ken, Japan
Paterson, Iain, NSW WSG, 2/33 Stokes Street, Lane Cove, NSW 2066
Phillipps, Hugo, Birds Australia, 415 Riversdale Road, East Hawthorn, VIC 3123
Pidcock, Stephanie, ANCA Migratory Wildlife Program, GPO Box 636, Canberra, ACT 2601
Pienkowski, Dr Mike, Royal Society for the Protection of Birds, 102 Broadway, Peterborough, UK
Piersma, Dr Theunis, Netherlands Inst. Sea Research (NIOZ), PO Box 59, 1790 AB Den Burg, Texel, Netherlands.
Redhead, David, 17 Brisbane Street, The Gap, Brisbane, QLD 4061
Reigen, Adrian Charles, NZ WSG, 231 Forest Hill Road, Waiatarua, Auckland, New Zealand
Reviakina, Ms Zoja, c/- Fauna, Komsomolskaya Str 241-A, 14, Yuzhno-Sakhalinsk, Sakhalin, Russia 693013
Richards, Roger, 114b Winmalee Road, Balwyn, VIC 3103
Roberts, Nigel, 59 Cracknell Rd, Annerly, QLD 4103
Rohweder, David, 4/25 Tamar Street, Ballina, NSW 2480
Russell-French, Alison, ANCA, GPO Box 636, Canberra, ACT 2601
Schulz, Martin, PO Box 749, Grafton, NSW 2460
Silvius, Marcel, Wetlands International - Asia Pacific, IPT University of Malaya, Kuala Lumpur 50603, Malaysia
Smith, Coral, 5 Morgan Street, Botany, NSW 2019
Sonnenburg, Roy, QOSI, 81 Woondaree Street, Bracken Ridge, QLD 4017
Speechley, Brian, 9 Meehan Place, Kirrawee, NSW 2232
Stewart, David, 64 Almeida Street, Indooroopilly, QLD 4068
Stewart, Sue, Brisbane City Council - Parks North, GPO Box 1434, Brisbane, QLD 4001
Stokes, Mr Tony, Great Barrier Reef Marine Park Auth, PO Box 1379, Townsville, QLD 4810
Stone, Richard, 39 Wahcumba Street, Dutton Park, QLD 4102
Straw, Phil, AWSG, 15 Kings Road, Brighton-Le-Sands, NSW 2216
Stroud, David Alan, Joint Nature Conservation Comm., Monkstone House, City Road, Peterborough, UK
Suzuki, Maggie, FoE - Shikoku, 279-1 Kureha, Hiketa-cho, Okawa-gun, Kagawa-ken, Japan

Syroechkovski, Dr Eugeny, Inst of Ecology & Evolution, Russian Academy of Sciences, Leninski Ave 33, Moscow V-71, 117071 Russia
Tagi, Koji, Box 366, The University of Qld, Gatton College, Lawes, QLD 4343
Taylor, Dr Iain, Charles Sturt University - Murray, PO Box 789, Albury, NSW 2640
Thompson, Dr Jeremy, Dept of Environment & Heritage, PO Box 155, Brisbane, QLD 4002
Thornton, Dr Tim, PO Box 80, Howard, QLD 4659
Tobai, Sadayosi, WWF Japan, Shiba 3-1-14, Minato-Ku, Tokyo, Japan
Tomkovich, Dr Pavel, Dept. of Ornithology, Zoological Mu, Herzen St. 6,103009 Moscow, Russia
Tonkinson, Dale, 2a Macaulay Court, Eltham, VIC 3095
Troy, Declan, Troy Ecological Research Associates, 2322 E 16th Ave, Anchorage, Alaska, USA
Tsuji, Atsuo, Save Fujimae Association, 2-212 Yshirodai Maito-ku, Nagoya 465, Japan
Ushino, Ms Kumiko, Save Chiba Tidal Flats Association, 6-11-13 Sodegaura, Narashino-shi, Chiba-ken, Japan
van Gessel, Fred, 1/38 Priestman Ave, Umina, NSW 2257
van Vessem, Dr Janine, Wetlands International, Slimbridge, Gloucester, UK
Venables, Ian, 7 Aberfoyle Street, Kenmore, QLD 4069
Wang, Hui, Yancheng Biosphere Reserve, Xinyanggang, Sheyang, Yancheng, Jiangsu Province, 224333 China.
Wang, Ms Luan Keng, Sungai Bulah Nature Park, Neo Tien Crescent, Singapore
Ward, Joan, 11 Kilamajare Drive, Suffolk Park, NSW 2481
Watkins, Doug, Wetlands International - Oceania, ANCA, GPO Box 636, Canberra, ACT 2601
Weaver, Karen, Environment Officer, Aust. Fisheries Management Authority, Burns Centre, Barton, ACT 2600.
Weston, Michael, AWSG, 415 Riversdale Road, East Hawthorn, VIC 3123
Wettenhall, Dr Norman, 14 Lascelles Avenue, Toorak, VIC 3142
Whyte, Ivell, QOSI, 37 Grosvenor Crt, Munruben, QLD 4125
Wieneke, Jo, 22 Bishop Street, Belgian Gardens, QLD 4810
Woodley, Keith, Miranda Naturalists Trust, R.D.1, Pokeno, New Zealand
Young, Lew, Mai Po Marshes Nature Reserve, Mai Po, Yuen Long, NT., Hong Kong
Zykov, V., Director, Fauna, Komsomolskaya Str 241-A, 14, Yuzhno-Sakhalinsk, Sakhalin, Russia 693013

Environment Australia

AWSG

Birds Australia