

10th International Waterfowl Ecology Symposium and Wader Study Group meeting, Aveiro

Edited by Barbara Ganter

1995 WSG MEETING: ABSTRACTS OF TALKS

Status, population dynamics, and habitat selection by Black-winged Stilts *Himantopus himantopus* in the estuarine environment of Cádiz Bay: influence of human management

G.M. Arroyo, A. Pérez-Hurtado, & M. Castro, Dpto Biología Animal, Vegetal y Ecología, Facultad de Ciencias del Mar, Puerto Real (Cádiz), Spain.

Estuaries and coastal wetlands constitute suitable habitats for a great number of waders, both to obtain food and for reproduction. Nevertheless, these coastal zones have been suffering during the last decades different alterations, mainly due to human activity, which may have notable repercussions on wader populations (Dugan 1987; Goss-Custard *et al.* 1990; Pérez-Hurtado *et al.* 1993).

Cádiz Bay is possibly the most important Spanish wetland for both wintering and breeding Stilts (Martínez Vilalta 1991; Pérez-Hurtado 1993; Pérez-Hurtado in press). This species depends mainly on supratidal coastal zones, chiefly salines, in order to obtain food and to breed. Hence, it is especially sensitive to the changes that are produced in this type of habitats. In the present paper recent changes in Black-winged Stilts populations in Cádiz Bay are discussed.

We have noted a strong decline, by more than 50%, in Stilt numbers. Habitat selection plays an important role in this decline. Salines are the most preferred habitat for Black-winged Stilts in Cádiz Bay, but these salines have been transformed into fishfarms during the last decades. Other factors, such as predation pressure and nest site competition in breeding areas could influence the reduction in breeding Black-winged Stilts. It would be necessary to compare the trend in Cádiz Bay birds with fluctuations in other southern wetland bird populations.

Site fixation and homing of wintering Dunlins

N. Bacetti, G. Cherubini, A. Magnani, L. Serra & A. Talamelli, INFS, Via Ca Fomacetta 9, 40064 Ozzano Emilia BO, Italy.

Experiments based on the displacement of Dunlins *Calidris alpina* have been carried out in N Italy at a rate of one per year since 1992. The aim is to get a reliable picture of the timing of fixation to the wintering site by juvenile birds; the reason of our slow schedule is that bird movements are detected visually and only one type of dye mark (Picric) can reliably be used over a long period, so that different groups of birds could not be tested during the same season. Experiments were performed always in the same pattern, with groups of 50 adults or juveniles being displaced from a wintering area to another one located 133 km to the south.

In birds tested after ca. two months from site occupation, adult and juveniles returned home in a similar way (experiments performed around 1 December 1992 and 1993), most birds between 16 and 25 days from release, the effect of displacement disappearing after 50 days. Juveniles tested earlier in the season, ca. 1 month after the bulk of the wintering population had settled (experiment of 4 November 1994) homed in smaller numbers, 38% of them even remained at the release site until spring (vs. 14% of later displaced juveniles). These results suggest that site fixation and consequent homing behaviour are developed as soon as suitable wintering areas are first visited by juveniles.

Counting Britain's non-estuarine shorebirds

Stephen Browne, Habitats Advisory Unit, British Trust for Ornithology, The Nunnery, Thetford, Norfolk IP24 2PU, UK.

The United Kingdom's over-wintering population of waders is in excess of 1.5 million individuals, making the UK an important part of the East Atlantic Flyway. The majority of these waders are found on estuaries, but

non-estuarine coasts also support a significant number of waders and are the primary habitat for some species (e.g. Turnstone *Arenaria interpres* and Purple Sandpiper *Calidris maritima*). In winter 1984/85, a BTO/WSG survey covered 90% of the UK's 1,200 km of non-cliff coastline. This one-off survey counted almost 300,000 waders of 19 species. However, non-estuarine coastlines remain under-counted and currently WeBS only covers about 50 non-estuarine sites. This clearly leaves a gap in our current population estimates of over-wintering waders in the UK.

In recognition of the importance of surveying the UK's non-estuarine coastline, WeBS initiated a pilot survey of waterfowl on Britain's non-estuarine coastal sites in winter 1994/95. In future the aim will be to include Winter Shorebird Counts from a proportion of the UK's non-estuarine coastline to produce reliable national wader population estimates.

This paper reports on an appraisal of the validity of the results obtained by the 1984/85 survey. The suitability of the data, currently being collected by WeBS and the WeBS pilot survey, for producing population estimates was assessed. Simulations of sampling regimes for planned future surveys were also carried out. The data from 1984/85 survey were re-sampled using bootstrapping methodology in order to give confidence limits for the wader totals derived from that survey. This allowed the accuracy of population estimates of each species to be assessed.

As logistics and limits on expense make it unlikely that the 1984/85 survey will ever be completely repeated, estimates from a smaller survey will have to be used. Simulations in which various proportions of the UK coastline (5% to 80%) were sampled from the 1984/85 survey data were used to produce a wide range of population estimates with confidence limits. The confidence limits were large when only a small section of coast was sampled, but reduced with increasing coastline length. These results enable an assessment of the degree-of-accuracy for species estimates, for a range of sampling strategies. Using results derived from the simulations it was possible to assess the accuracy of species totals calculated from data currently collected by WeBS and by the pilot study.

Wader population recovery following large-scale mortality

Jacquie Clark, BTO, The National Centre for Ornithology, The Nunnery, Norfolk IP24 2PU, UK.

The paper compares the results of an empirical study following large-scale wader mortality caused by severe weather in February 1991, with theoretical predictions of recovery of populations. Although the mortality was caused by a natural short-term change the study provides useful information for those trying to predict the effect of mortality following habitat loss or change. Count data were examined to indicate the extent of population loss. Data on age ratios from trapped birds were used to show that more juveniles than expected were present in the affected areas in the winter following the severe weather mortality but this effect did not occur through the rest of Britain. The biometrics of birds caught before and after the cold weather were compared to those found dead.

Organochlorines in Avocet eggs

Sabine Dietrich, Am Helgehaus 12, 35274 Kirchhain, Germany; & Hermann Hötter, Forschungs- und Technologiezentrum, Univ. Kiel, Hafentörn, 25761 Büsum, Germany.

The pattern of pcb-congeners in Avocet *Recurvirostra avosetta* eggs differs from those of other wader species. An explanation might be the contamination at different wintering sites (Becker 1991). Individually colour-ringed Avocets were controlled both at the breeding site near Husum and in their main wintering sites in France and Portugal. We collected eggs of those females whose past wintering site was known. Samples of typical Avocet food organisms were taken at each of the three study sites. Twenty eggs of 14 individuals and 46 samples of benthic organisms were analysed using a new method described by A. Bütke & E. Denker in 1995.

In the eggs, 35 congeners with an average of 5.7 cl-atoms represented each less than 1% of the total PCB-content and 33 congeners with an average of 6.5 cl-atoms at least represented more than 1% each. Only ten of them covered more than 60% of the total PCB content. Low chlorinated biphenyls were hardly found. A peculiarity in Avocet eggs is the high amount of octo-CBs. With 7% it is five to seven times higher than in other wader eggs. Congeners with nine and ten cl-atoms had not been analysed in former studies so no comparison is possible. They covered about 1.5% of total PCBs. The mean quantity of total PCB in the eggs was 0.7 mg/kg areas the food samples differed

significantly in total pcb and in the degree of chlorination. Congeners specific for the food on the breeding grounds were characterized by a high content of cl-atoms. They appeared less in the food but in a high quantity in the eggs, possibly because of bioaccumulation. The birds usually feed four weeks in the breeding area before laying the first egg. The low chlorinated congeners (typical for the food organisms from France) are eliminated or metabolized very fast. Most of the congeners found in the eggs (average cl-degree of 5.8) were present in the food at every feeding site. Therefore the contamination can happen at any time. Even if the birds are able to metabolize these congeners very fast, there is a permanent input.

Twice we were able to measure the first and the second clutch of the same female. Between the clutches there was a decrease in total PCB of 31% and 43%, respectively. Laying eggs thus seems to be a suitable way to get rid of xenobiotics.

Supported by Stifterverband für die Deutsche Wissenschaft.

How attractive are Wadden Sea mudflats for Golden Plovers?

Christiane Ketzenberg & Klaus-Michael Exo, Institut für Vogelforschung, An der Vogelwarte 21, 26386 Wilhelmshaven, Germany.

Like millions of other waders, Golden Plovers *Pluvialis apricaria* use the Wadden Sea as staging and fattening site on spring and autumn migration. However, in contrast to other waders Golden Plovers prefer to feed on inland marshes; mudflats are used only to a lesser extent.

During the last years the number of Golden Plovers feeding on mudflats seems to have increased. Therefore, investigations about the annual occurrence and spatial distribution of Golden Plovers were carried out at the east Frisian Wadden Sea coast and the adjacent inland areas in 1993/94. To estimate the importance of different feeding habitats, behaviour patterns, especially time budgets, were established by scan sampling during daylight.

In addition, energy intake was estimated by observation of individual birds. Golden Plovers fed on mudflat areas exclusively during autumn migration. Particularly in August/September up to 80% of the birds fed on mudflats during low tide. There the intake rate was as high as on inland meadows.

To analyse behaviour patterns and habitat use during day and night, Golden Plovers were marked with motion-sensitive radio

transmitters. First analyses indicate that feeding activity at night was higher than during the day. Differences between spring and autumn migration as well as the daily activity patterns will be discussed in relation to food availability.

(Supported by the Federal Ministry of Research and Technology).

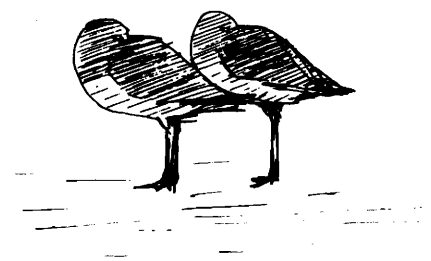
Taimyr wader distribution: map analysis

Elena G. Lappo, Department of Biogeography, Institute of Geography, Russian Academy of Sciences, Staromonety 29, Moscow 109017, Russia.

The Taimyr Autonomous District (862,100 km²) is the area of one of the highest diversities of waterbird fauna in the Russian Arctic. A total of 34 species of waders breed there.

Data on wader distribution on Taimyr have been collected for decades, and have now been transferred to maps and analysed. 98 descriptions of concrete local wader faunas and information from more than ten additional points form a basis for creation of a series of maps of species breeding ranges. More than 35% of these data were collected during last decade by the International Arctic Expedition of the Russian Academy of Sciences under supervision of Prof. E.E. Syroechkovski and are now stored in the expedition database. The GIS programme Mapinfo was used for creation of some of the distribution maps. Distribution maps were compiled for all breeding wader species.

For many of them range borders are more precise in comparison with existing zoogeographical overviews for Siberia. For several widely distributed tundra waders (Grey Plover *Pluvialis squatarola*, Turnstone *Arenaria interpres*, Dunlin *Calidris alpina*, Curlew Sandpiper *C. ferruginea*, Little Stint *C. minuta*, Grey Phalarope *Phalaropus fulicarius* etc.) a series of the following maps were prepared: (1) map of all breeding records; (2) breeding range map based on landscape extrapolation; (3) map of the spectrum of breeding habitats; (4) map of breeding range structure based on population estimate. The maps are compared to each other. Problems of methodology of mapping of bird ranges and population and creation of atlases in the arctic and subarctic areas are discussed.



A new hypothesis concerning why Palearctic waders oversummer in the tropics

Raymond McNeil, *Dépt. de Sciences Biologiques, Université de Montréal, CP 6128, Succ. A, Montréal, Québec H3C 3J7, Canada*; Marcos Tulio Diaz, *Inst. de Investigaciones en Biomedicina y Ciencias Aplicadas, Universidad de Oriente, Cumaná, Sucre, Venezuela*; & Alain Villeneuve, *Dépt. de Pathologie et Microbiologie, Faculté de Médecine Vétérinaire, Université de Montréal, C.P. 5000, St-Hyacinthe, Québec J2S 7C6, Canada*.

A few hypotheses have been proposed to explain why some boreal-breeding shorebirds oversummer, i.e., stay on the wintering grounds in the southern latitudes during the boreal summer instead of migrating north for breeding. The main hypothesis proposes that oversummerers are sexually immature first-year birds. Most oversummerers are actually juveniles but, in some species, adult individuals were also reported as summering. In addition, many boreal shorebirds of the species known to oversummer in the southern latitudes do return to the breeding grounds and, in many cases, start breeding at the end of their first year.

Why do some individuals, first-year birds and older, oversummer in southern latitudes while other members of the same species and age classes do return to the Holarctic region and breed?

In oversummering shorebirds, premigratory moult and fattening either do not take place or are delayed, the birds acquiring an alternate plumage and getting fat by the end of June and the beginning of July. The reasons for absent or delayed moult and fat accumulation are reviewed. The possible relationship between trematode infestation and oversummering was explored in Greater Yellowlegs *Tringa melanoleuca*.

Birds were collected throughout the year in coastal Venezuela to examine seasonal and age-related variations in digenean trematode infestations. Yellowlegs were infested with eleven digeneans. The digenean faunas of adult and juvenile Yellowlegs were dissimilar, with only four genera common to both age classes. Adults recently arrived on the wintering grounds were more infested with trematodes than juveniles. By spring, this relationship changed and juveniles tended to contain more trematodes than adults. Also, the percentage of individuals infested by digenean trematodes increased almost steadily from November to April/May.

The detrimental effects of trematode infestation and the reasons for the age difference in digenean infestation are discussed. It is concluded that in addition to causing enteritis, anemia and death of some

individuals, trematode infestation may prevent or delay normal premigratory moulting and fat accumulation in some shorebirds, particularly in the juveniles, and therefore be an important factor responsible for their oversummering.

Changes in the population size and spatial distribution of wintering Knots in NW Europe in the period 1969-1994

Jaap van der Meer & Theunis Piersma, *Netherland Institute for Sea Research, PO Box 59, 1790 AB Den Burg, The Netherlands*.

Monthly count data of Knot *Calidris canutus islandica* from Ireland, the UK, France, The Netherlands, Germany, and Denmark from the period 1969-1994 have been compiled using among other things the BTO and IWRB databases. Log-linear models were used to handle missing and incomplete counts. Population trend and changes in the spatial distribution are described, and related to changes in food supply, as far as the limited data on macrobenthos abundance permitted.

Factors influencing mortality of Redshank *Tringa totanus* during severe winter weather

P. Ian Mitchell, I. Scott & P.R. Evans, *Durham University, Dept. of Biological Sciences, Durham, DH1 3LE, UK*.

During five of the last sixteen years prolonged severe winter weather has led to substantial incidents of high mortality amongst waders and seabirds along the east coast of Great Britain. Of the wader species, Redshank appear to suffer the most. Two breeding populations over-winter on British estuaries, the British-breeding race *T. t. britannica* and the larger Icelandic sub-species *T. t. robusta*. It is unclear from previous work whether these two races show differential mortality during severe weather. In both races we investigated factors which would contribute to their survival during severe weather.

Nutritional preparation for winter was similar in both races, in that they accumulated proportionately the same fat and protein reserves (total lean mass and mass of fat were estimated in live Redshank at Teesmouth, NE England using TOBEC).

Destructive analysis of Redshank which died on the Wash in February 1991 showed that virtually all storage fat had been depleted and half the protein mass in the breast muscles had been utilized. The severe depletion of protein reserves in the breast muscles indicated death from starvation since protein

from the gut is normally drawn on first in fasting birds. The British Redshank had proportionately larger breast muscles at death than the Icelandic Redshank. Larger energy reserves remaining at death may indicate a greater energy demand.

Standard metabolic rate (SMR) was determined in both races at temperatures 25° C to -5° C by measuring oxygen consumption using open-flow respirometry. Basal metabolic rate when controlled for body mass (mass-specific) was similar in each race. However, at low temperatures, mass-specific SMR was higher in Icelandic Redshank. This difference in energy consumption in the cold was attributable to lower insulation provided by the skin and feathers of Icelandic Redshank and was not attributable to any difference in body size and surface area.

The higher energy expenditure of Icelandic Redshank under standard conditions would suggest that they would have higher energy demands during severe weather and hence, be more likely to die than British Redshank. However, the condition of the British Redshank at death suggested energy demand prior to death was in fact higher in this race. Further work (time and energy budget analysis and measurements of thermostatic costs using heated taxidermic mounts) is being undertaken to determine whether the high energy demand of Icelandic Redshank under standard conditions does translate to field conditions.

Intertidal mudflats as critical habitats for migratory waders in Bahrain

Saeed A. Mohamed, *Biology Department, University of Bahrain, P.O. Box 32038, Bahrain*.

The archipelago of Bahrain consists of more than 33 islands located in the southwestern waters of the Arabian Gulf. The majority of these islands are surrounded with vast areas of sand and mudflats. The tidal regime is semi-diurnal with a maximum annual tidal range of about 2.5 m. Large intertidal areas are exposed during low tide in the eastern sheltered regions of most islands which provide good size areas of sand and mudflats available for thousands of migratory wading birds. The richness of sand and mudflats is reflected by a high biomass value (35.4 g/m² dry wt.). A high density of macrofauna, in particular crabs *Metopograpsus*, *Scopimera*, and *Macrophthalmus*, and buried polychaetes *Perinereis* is present in the intertidal area and represents a valuable diet for many waders.

Migrant waders on passage normally spend 2-3 weeks feeding actively on available food in the intertidal area in order to gain enough energy that allows them to continue their

migration. Some birds (e.g. Little Stint *Calidris minuta*) gained two to three times their initial arrival weight before they continued their long trip.

From 1991-1994, a continuous ringing programme for waders was conducted. More than 3,000 birds were ringed, representing 22 different species of waders. The main species are Little Stint, Dunlin *Calidris alpina*, Curlew Sandpiper *C. ferruginea*, and Kentish Plover *Charadrius alexandrinus*. The study revealed a high recovery turnover of marked birds, reaching 5% in some periods. Regional and long distance recoveries were also recorded.

The sheltered intertidal areas are under continuous threat from human activities. Apart from the direct effect due to oil spills, the most serious impact is the ongoing land filling. However, the National Committee for Wildlife Protection, which has been recently established, is concentrating on effective legislation and regulations to protect and reduce the loss of some critical and important wetlands present around the islands of Bahrain.

Successive use of feeding sites by a flock of Purple Sandpipers *Calidris maritima* wintering in Tromsø, northern Norway

Stein Nilsen, NINA, Norwegian Institute for Nature Research, 9006 Tromsø, Norway.

Norway holds by far the largest part of the winter population of Purple Sandpiper *Calidris maritima* in Europe with probably several hundred thousand birds. The Purple Sandpiper is the only wader wintering in northern Norway in great numbers. The main origin of the birds in Tromsø is Russian, but three recent findings of birds ringed at Spitsbergen, Svalbard archipelago, show that there is a mixture of at least two populations.

Since 1989 170 birds have been ringed with individual colour-rings in Tromsø. A total of 27 of the birds were ringed before 1990, and 13 of these were observed in the area in 1995.

The main arrival time in autumn is during the first two weeks of October, and the birds stay in the study area until the last week of April. A small flock of about 40-60 birds stays until mid May. These late birds may well be Svalbard birds who have to migrate nonstop from Norway to their destination point in the Arctic.

The Purple Sandpipers in Tromsø are mainly feeding in the intertidal zone of rocky shores, but in spring at least some of the birds switch to use sandy mudflats. During the first 2.5 months after their arrival the birds stay in the

northern parts of the Tromsø Island, roosting at Skattøra. They feed extensively on *Littorina* spp. and *Mytilus edulis* on the rocky shores in this area. During late December or early January, the whole flock moves about 6-10 km further north to the mainland. In this area the feeding habitat is also rocky shores. The communal high tide roost, Vagnes, is situated 5-7,5 km to the north of the new feeding areas. During winter the birds utilize totally about 22 km of coastline.

Waders can markedly deplete their stocks of invertebrate prey, and this could be the reason why they change feeding sites in December/January. In March or early April the birds return to the Skattøra area, where they feed on rocky shores. They stay in this area until they leave for their breeding grounds in late April or mid May. Of the all the colour-ringed birds, 60% have been observed in 1995, and 26% of these returning to Skattøra in April/May 1995.

The breeding biology of the Lapwing *Vanellus vanellus*: the incidence of polygamy, double-brooding and polyterritoriality

Dave Parish, Pat Thompson and John Coulson, Durham University, Dept. of Biological Sciences, Durham, DH1 3LE, UK.

Lapwings have been ringed in Upper Teesdale, northern England since the late 1980s, by fieldworkers from Durham University. This resulted in around 250-300 individually recognisable Lapwings available during the study period of 1993-1995.

Lapwings have, until recently, been regarded as socially monogamous birds (one male breeding with one female in a season), with only rare occurrences of polygyny (one male breeding with more than one female). On average 30% of territorial males in this study were paired with more than one female: 45% when unpaired males are excluded.

Polyandry (one female breeding with more than one male in a season) has not been reported for the Lapwing before. In 1995 one female (1% of those studied) paired sequentially with two different males, the second mate chosen after the failure of her first clutch.

Four percent of the females studied were also double-brooded (i.e. produced more than one batch of young during the season, without the loss of the preceding batch). However, each case differed from the only other report of double-brooding in the Lapwing from Sweden (Blomqvist & Johansson 1994). In this study, the birds seemed to be laying a second clutch in response to severe, early, partial losses of their first broods: i.e. they did not appear to

be *a priori* attempts to increase reproductive output.

Polyterritoriality (one male defending multiple breeding areas in the same season) has not previously been reported for the Lapwing. In 1995 two males (2% of territorial males) were found defending two discrete territories, one male attracting a female to settle on this second territory.

This study illustrates the flexibility of the Lapwing's breeding biology, and raises the possibility that populations which experience different selection pressures may have higher incidences of these events. It also shows how studies of marked individuals reveal events often overlooked.

Fragmentation of salt-pan habitat: consequences for the breeding population of Black-winged Stilt

Rui Rufino & Renato Neves, CEMPA/ICN, R. Filipe Folque 46, 5º, 1050 Lisboa, Portugal.

The breeding population of Black-winged Stilt *Himantopus himantopus* of the Sado estuary (Portugal) has been studied during four years. Data were collected in order to understand the effect of abandonment and transformation of salt-pans upon the breeding population of the Black-winged Stilt, both in terms of immediate habitat loss and overall habitat loss.

Results show that virtually the whole area of each salt-pan group is used throughout the year and, as a consequence, the fragmentation of these groups causes a redistribution of the Stilt's breeding population.

Nest aggregation, egg size and hatching success in Lapwing *Vanellus vanellus*: differences between two breeding sites with different proportions of suitable habitats

Miroslav Sálek, Czech Agricultural University, Department of Ecology, Faculty of Forestry, 165 21 Praha 8, Czech Republic.

Differences in nest aggregation, egg size and hatching success in the Lapwing were studied in arable land and a river floodplain (671 and 346 ha) in South Bohemia, Czech Republic (49° 13' - 49° 18' N and 14° 05' - 14° 13' E) between 1988 and 1994. The river floodplain was characterized by higher proportions of meadows and wet fields in comparison with arable land which was dominated by crop fields and drier habitats.

An aggregated pattern of nests was confirmed in both sites; however, higher breeding density, some larger aggregations (at least ten nests) and slightly larger eggs were found in the river floodplain.

Predation was the main factor of nest failures in both sites. Higher probability of nest survival was found in large aggregations in the floodplain and similarly in groups of nests in arable land. High predation risk occurred in smaller groups of nests in the river floodplain. Results indicate that the total nest survival rate in a Lapwing population breeding in higher density is positively influenced by the actual portion of nests situated in large aggregations and that hatching success in small aggregations depends on population density resulting probably from density dependent predation pressure.

The Importance of coastal Guinea-Bissau to waders

Jacob Christian Salvig, Ministry of Environment and Energy, Danmarks Miljøundersøgelser, Grenåvej 12, Kalø, DK-8410 Rønne, Denmark; Alqueia Quadé, Gabinete de Planificação Costeira, Aportado 23, Codex 1031-Bissau, Guinea-Bissau; Sten Asbirk, Ministry of Environment and Energy, National Forest and Nature Agency, Haraldsgade 53, DK-2100, Copenhagen, Denmark; Jørgen Peter Kjeldsen, Palle A.F. Rasmussen, John Frikke & Erik Christophersen.

Coastal Guinea-Bissau is one of the most important wetland areas in West Africa for waders. Past surveys during winter in those parts of the coastal zone where the present survey was undertaken, have estimated that about one million waders winter in the area. The purpose of the 1994 survey was:

- i) to survey the entire coastal zone covering areas which have never been visited;
- ii) to examine the extent to which coastal Guinea-Bissau is used as a spring and autumn refuelling station by migratory waders wintering further south of Guinea-Bissau; and
- iii) to estimate the proportion of over-summering birds.

During January 1994, the coastal zone was surveyed by aircraft, and 564,000 waders were counted. On the basis of this number, it is confirmed that about one million waders were wintering in coastal Guinea-Bissau. From monthly counts at selected sites in the Bijagós Archipelago, the size and composition of wader populations are presented during both the migratory season and in summer. The phenology of waders in coastal Guinea-Bissau showed rather constant numbers during summer, although the proportion of migrant wader populations

varied with species, a bimodal pattern being evident during autumn with an influx of birds in September and another in November.

During spring, waders were present until May when most birds left the area. Individual species showed considerable variations in the pattern of seasonal distribution. From the observed annual occurrence it can be concluded that coastal Guinea-Bissau is important for waders throughout the year.

Growth and energetics of Knot chicks in Taimyr, Siberia

Hans Schekkerman, I. Tulp, T. Piersma, P. de Goeij, J. van de Kam & J. Jukema, IBN-DLO, P.O. Box 23, 6700 AA Wageningen, The Netherlands, and Zoological Laboratory, P.O. Box 14, 9750 AA Haren, The Netherlands.

Growth, energy expenditure and time budgets of Knot *Calidris canutus* chicks, as well as the availability of surface arthropods were studied at Cape Sterlegova, NW Taimyr, Siberia, in the summer of 1994. Families were located for observation and recapture by means of radio transmitters mounted on the male. Energy expenditure of growing chicks was measured using the doubly-labelled water method and proved very high. Daily metabolized energy was 30-40% higher than in wader chicks of similar mass growing up in temperate (Dutch) grasslands, most measurements exceeding empirical allometric predictions of maximum ME. Average daily metabolized energy over the 20-day fledging period was twice as high as the interspecific prediction derived by Weathers (1992). Nevertheless, Knot chicks grew fast in comparison to other waders elsewhere, but growth rate was correlated with the availability of arthropods, which in turn showed a marked weather dependence.

The high energy demands of Knot chicks could be met by a) having a long work day, either as a result of the 24-hour daylight period or by increased cold-hardiness reducing the time spent being brooded, or b) through a higher intake rate due to high availability or large size of surface arthropods. Time budget observations showed that at similar ages and environmental temperatures, Knot chicks require less brooding than wader chicks in temperate (Dutch) grasslands. This would give a Knot chick a 40% increase in feeding time compared with a similar-sized Redshank *Tringa totanus* chick at 5° C. Sampling of surface arthropods using identical methods in Taimyr and Sterlegova indicated that both abundance and size distribution of arthropods were very similar in the two areas. These observations suggest that, at Sterlegova in 1994, it was the continuous daylight and the high cold tolerance of Knot chicks, rather than a superabundance of

food, which allowed successful reproduction under the prevailing arctic conditions.

New population estimates for waders in Atlantic Europe: closer and closer to the numbers actually present?

C.J. Smit & M. Purmer, IBN-DLO, P.O. Box 167, 1790 AD Den Burg, The Netherlands; N.C. Davidson, JNCC, Monkstone House, City Road, Peterborough PE1 1JY, UK; & P. Rose, IWRB, Slimbridge, Gloucester GL2 7BX, UK.

Agreements resulting from the last Ramsar Conference of the Contracting Parties (Kishiro, Japan, 1993) indicate that population estimates of waders and waterfowl will have to be re-examined every three years, preceding each Ramsar Conference. At the same time the 1% thresholds will be re-evaluated every nine years. The last exercise to evaluate wader numbers wintering on the East Atlantic Flyway dates from 1989. However, in this case mostly data from the first half of the 1980s were used. The conclusion is obvious: there is a clear and urgent need for new population estimates.

Regrettably, no new counts have become available from the major west African wintering site: the Banc d'Arguin in Mauritania. Consequently we cannot compare the whole East Atlantic Flyway population with figures from the past decade. At the same time, however, a very promising amount of data on wader number wintering along the European Atlantic coast has now been stored in the IWRB Wader Database. These considerations, and the availability of recently developed trend-analysis computer programmes following the "Underhill technique", have led to a full re-appraisal of population estimates for the European Atlantic coast, combined with a first trend-analysis of wader numbers wintering in that area. In this contribution we present the first results of this analysis. Additionally we compare the results of the current totals with earlier population estimates (Prater 1976; Smit & Piersma 1989).

The influence of lemming cycles on breeding success of waders and waterfowl on the Taimyr peninsula, Siberia

Eugene E. Syroechkovski Jr., Institute of Ecology and Evolution, Russian Acad. Sci., Moscow, Russia.

The role of lemming cycles as a basis for changes in Arctic Fox *Alopex lagopus* predation pressure on tundra birds has been widely discussed in the ornithological literature. Most of these papers were based

on indirect analysis without the support of long-term observations in the tundra. The activities of the International Arctic Expedition of Russian Academy of Sciences in Taimyr since 1988 gave us the possibility to contribute to in the analysis a good set of concrete observations made in the tundra.

The Taimyr peninsula is the biggest arctic region in Russia (more than 400,000 km²), with a high diversity of tundra landscapes. Lemmings and foxes are irregularly distributed on this territory. For the North Siberian Lowland - the biggest plain in the centre of Taimyr, the three-year cyclicity in numbers of both foxes and lemmings was described for a period of more than 30 years. The data were collected on seven different stations for three year periods and more, and in addition on 27 different locations in the tundra in different parts of the peninsula from forest-tundra to polar deserts. A total number of more than 60 situations in which both the stage of the lemming cycle and the level of predation on breeding waders and waterfowl were estimated in one season are involved in the analysis. For the standardisation of information and to avoid difficulties of comparison of different methods, four levels of scale were used in the analysis.

The following subjects are raised for discussion based on the analysis of observations in Taimyr: (1) how homogeneous are fox and lemming abundance and predation intensity in a relatively small tundra region? (2) the role of predators other than foxes on bird populations, in different stages of the lemming cycle and in different tundra subzones; (3) the role of fox migration for distribution of predation pressure; (4) which year in the three-year cycle is the best and which is the worst for breeding waders and waterfowl in the tundra?; (5) some ideas about the role of the weather in the dynamics of breeding success of waders and waterfowl.

Main results of research activities on Black-winged Stilt in Italy

Roberto Tinarelli, Via Savena Inferiore 9, Bologna 40061 Minerbio, Italy.

The breeding population of Black-winged Stilt *Himantopus himantopus* in Italy has been monitored since 1978. In particular, accurate counts have been carried out at every breeding site between 1983 and 1987 in the framework of a national research project (1983-1988), which was aimed also at the collection of data on laying dates, egg size, colony and nest description, and breeding success in different habitats. After 1988 the collection of data on breeding biology continued mainly on breeding success in selected breeding sites and habitats.

Since 1988 accurate estimates of population size can be produced by means of censuses of the most important breeding areas. After a marked decrease, recorded in 1984 and 1985, the breeding population showed a general increase, especially since 1989 and 1990, when new breeding sites were recorded in areas never reported in the last century.

Ringling activities with colour rings have been carried out since 1984, mainly on chicks and in wetlands of north-eastern Italy, allowing some conclusions on fidelity to birth site and region, breeding site fidelity, post-breeding dispersion, and connections between populations of the western Palearctic. In the framework of a research project on wintering biology, information on the location of winter quarters has been gathered by means of observations of colour marked individuals.

Social organization of Sanderling *Calidris alba* at Taimyr, Siberia

Pavel S. Tomkovich, Zoological Museum, Moscow State University, Herzen Str. 6, Moscow 103006, Russia.

According to studies in 1990-92 in the Knipovich Bay area, Northern Taimyr, a considerable portion of the Sanderling population arrive to the breeding grounds already in pairs. Patterns of spacing behavior change during a season in accordance with current demands at a given stage of breeding.

No resource defending territoriality was found, and spacing behaviour is probably similar between different populations. Of 22 nests, 18% were incubated by both parents, while others were attended by single males or females. Only single birds were observed with young. Birds attending broods from earlier clutches were mainly males, while females dominated among adults with later broods. These observations support the possibility of a double-clutch breeding system in part of the Taimyr population, though a direct evidence is lacking. No delay in start of incubation by males was found, in contrast to Canadian Sanderlings and other double-clutching species.

This finding contrasts the double-clutch system of the Taimyr population to the classic one and permits to suggest that only one third of the population (most probably less than 20% of birds) attempts to mate twice a season. This breeding system is different not only from the Canadian one, but also from the Greenlandic system of monogamy in Sanderlings. No benefits of double-clutching were found in our study, as late broods have little chance to survive. Nevertheless, the polymorphism in mating behaviour found at Taimyr can be

advantageous, allowing the evolution in any direction in case of environmental changes.

Use of arctic saltmarshes by shorebirds in northern Alaska

Declan M. Troy, Troy Ecological Research Associates, 2322 E. 16th Ave., Anchorage, Alaska 99508, USA.

In temperate and tropical portions of the world, saltmarshes are important to breeding, staging, or over-wintering shorebirds. The importance of saline tundra (arctic saltmarsh) for shorebirds has received relatively little investigation due to its inaccessibility and restricted availability. This study compares shorebird use of saline tundra near Prudhoe Bay, Alaska with use of other types of tundra that are not influenced by salt. The types of tundra examined included saline tundra, nonsaline tundra (areas adjacent to saline tundra but not influenced by salt), and noncoastal tundra (areas up to 6 km from the coast).

The importance of saline tundra relative to other tundras varied over the course of the summer. Semipalmated Plover *Charadrius semipalmatus* and Ruddy Turnstone *Arenaria interpres*, two species sparsely distributed in the Prudhoe Bay area, exhibited a strong affinity to saline tundra throughout the summer, but even here were a minor component of the avifauna. Shorebird nest densities in general were lower in saline tundra than most other tundra types. High nest densities of Red-necked and Red Phalaropes *Phalaropus lobatus* and *P. fulicarius*, and Semipalmated Sandpiper *Calidris pusilla* were found in nonsaline areas adjacent to the saline tundra, perhaps indicating that these birds foraged in saline habitats but nested in slightly more upland areas. The diversity of nesting species was greatest farther inland.

Saline tundra achieves its greatest importance to shorebirds during mid-summer when densities in saline tundra averaged more than twice that in nonsaline tundra. At this time Lesser Golden Plover *Pluvialis dominica*, Semipalmated Sandpiper, Stilt Sandpiper *Micropalama himantopus*, and Red-necked Phalarope reached their highest densities in saline tundra. Some migrants, such as Black-bellied Plover *Pluvialis squatarola* remained primarily in noncoastal habitats. During late summer all tundras studied received influxes of shorebirds. Many species exhibited higher densities in saline tundra than in the other areas. This was particularly true of Semipalmated Sandpiper, Dunlin *Calidris alpina*, Long-billed Dowitcher *Limnodromus scolopaceus*, Red-necked Phalarope, and Red Phalarope.

Overall saline tundra was shown to receive

considerable use by shorebirds throughout the summer but to be relatively unimportant for nesting. In comparison to other types of tundra, use of saline tundra was the most seasonal, exhibiting more distinct waves of shorebird use. Shorebird use of saline tundra was most pronounced during mid-summer, at the time of adult migration of many species.

The Black-winged Stilt *Himantopus himantopus* in southern Africa

Les G. Underhill & H.D. Oschadleus, Avian Demography Unit, Department of Statistical Sciences, University of Cape Town, Rondebosch, 7700 South Africa.

The Black-winged Stilt increased in abundance in southern Africa during the twentieth century, benefitting especially from the construction of farm dams, sewage works and salt works. The paper reviews available information on the distribution of the Black-winged Stilt, with historical information based on literature sources and the current distribution provided by the Southern African Bird Atlas Project. Preliminary information on numbers is obtained from the Co-ordinated Waterbird Counts. Information on breeding biology, derived from nest record cards, includes an analysis of regional changes in breeding phenology.

Populations of waterbirds at Langebaan Lagoon, South Africa: trends over two decades 1975-1995

Les G. Underhill, Rene A. Navarro & M. Waltner, Avian Demography Unit, Univ. of Cape Town, Rondebosch 7700, South Africa.

The Western Cape Wader Study Group has undertaken summer and winter surveys of waterbirds at Langebaan Lagoon since winter (= June) 1975. The 40th survey took place in summer 1995, producing the longest

unbroken time series of counts for any major wetland in the southern hemisphere. The paper examines trends in population sizes over the 20-year period. Because many first-year waders do not migrate from southern Africa to the breeding grounds, the austral winter counts provide information about breeding productivity in the preceding boreal summer.

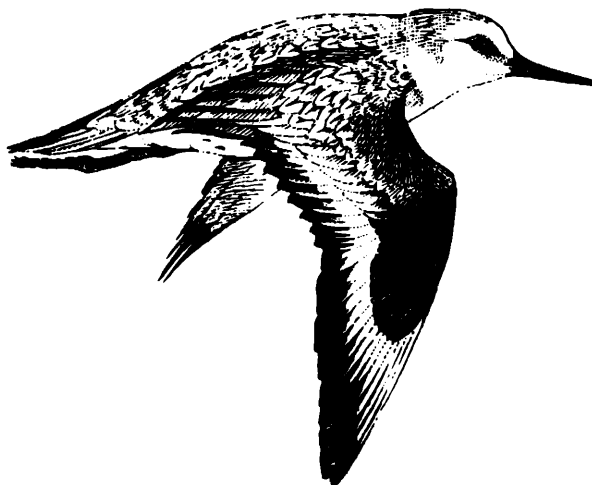
Spring migration of radiomarked Western Sandpipers along the Pacific Flyway: 1995

Nils Warnock, ERS/186, University of Nevada, 1000 Valley Rd., Reno, Nevada 89512, USA; & Mary Anne Bishop, Copper River Delta Institute, U.S. Forest Service, Cordova, Alaska, USA.

In April 1995 we radio-marked 30 Western Sandpipers *Calidris mauri* at San Francisco Bay, California (SF), 19 at Honey Lake, California and 20 at Grays Harbor, Washington. We monitored the northward migration of 61 of these birds at 14 sites from SF to the Yukon-Kuskokwim Delta, Alaska (YK).

Fifty-two birds (84%) were detected north of their banding locations, up to 4,200 km away. The Copper River Delta, Alaska (CR) was the single most important stopover site with 61% of the Western Sandpipers detected there.

Male Western Sandpipers were significantly more likely to be detected before the CR and females on or after the CR. Length of stay of Western Sandpipers at stopover sites other than their banding locations was correlated to distance from the Copper River Delta. No significant difference in length of stay between sexes was detected. Mean migration time, measured in terms of day last seen at the banding site to day first detected at the CR, varied significantly between banding sites. Significant differences between males and females in mean migration time were detected.



**WSG KENTISH PLOVER
WORKSHOP,
18 SEPTEMBER 1995,
AVEIRO, PORTUGAL**

ABSTRACTS OF TALKS

Apparent two phase breeding in the Kentish Plover population on the Alvor Estuary, (Southern Portugal)

M. Felgueras, "A Rocha", Cruzinha, Mexilhoeira Grande, 8500 Portimão, Portugal

The study of breeding populations of Kentish Plover *Charadrius alexandrinus* on the Alvor Estuary, initiated in 1991, was continued in 1993 in order to investigate apparent two phase breeding. The presence and status of nests on the salinas of Odeáxcre were assessed by visits every 4-6 days between March and August, and two peaks in egg laying were detected. The catching of adults at the nest revealed no evidence of birds having more than one brood per season, and so the hypothesis that the two peaks represent two breeding populations, one resident and the other migrant, is put forward. More data are needed to test this hypothesis.

Portugal: paradise for Kentish Plovers?

R. Freudenthal, Nederlands Inst. v. Oecolog. Onderzoek, P.O. Box 40, 6666 ZG Heteren, The Netherlands

The breeding behaviour of Kentish Plover *Charadrius alexandrinus* was studied in a saltpan in Parque natural da Ria Formosa, Portugal, from March to July in 1992 and 1993.

Throughout this period nests were checked daily, 103 adult birds were individually colour ringed, 20 chicks were caught before fledging, and behavioural observations were performed during the pre-laying, laying and fledging period. The aim of this talk is to describe the breeding success of Kentish Plovers by presenting the following data:

- description of the breeding habitat;
- size of breeding population;
- site fidelity and mate fidelity, both within and between seasons;
- parameters of breeding success: egg size, laying interval, clutch size, number of clutches per season, hatching and fledging success, and chick growth.

The Kentish Plover in the Baltic region - former and present breeding status, threats and conservation measures

P.E. Jönsson, Dept. of Ecology (Animal Ecology), Lund University, 223 62 Lund, Sweden

The breeding distribution of the Kentish Plover *Charadrius alexandrinus* reaches its northern limits around the south-western Baltic Sea and southern Scandinavia. In the late 19th century the species bred in most suitable places in Denmark, SW Sweden, along the German Baltic coast and even in south-westernmost Norway. The total population in this area around the turn of the century is estimated at 300-500 pairs. Following a continuous decline during most of the 20th century, the species is now restricted to 4-5 breeding pairs in SW Sweden and 20-30 pairs in SW Denmark, having disappeared totally from the rest of the Baltic.

Main causes of decline in the Baltic region are believed to be habitat change due to altered agricultural use of coastal wet meadows, disturbance from tourism, and ultimately high predation pressure on nests and chicks from man-favoured predators like Red Fox *Vulpes vulpes*, American Mink *Mustela vison* and Hooded Crow *Corvus corone cornix*. The role of the Ringed Plover *Charadrius hiaticula* as a possible competitor for the northern breeding Kentish Plovers is also discussed.

A 14-year study of the small Swedish population has revealed nest predation as the single most important factor affecting population size. However, low chick survival in cold/wet years and decreasing return rates of Swedish born first-breeders (rather staying in the Wadden Sea than flying a further 300 km to the north) have added to the picture of decline in recent years. The link between the small group of Swedish breeders and the bigger population in the Wadden Sea has been demonstrated by records of breeding by Swedish-born birds in Germany.

In both Sweden and Denmark conservation measures have been taken to protect the few remaining breeding colonies. These have included the creation of strictly protected bird sanctuaries, fencing around breeding areas to exclude tourists, dogs and Red Foxes, and active predator-control (e.g. trapping of minks and crows).

Kentish Plover as a breeding bird in the Netherlands during the 20th century

P.L. Meininger & F. Arts, National Institute for Coastal and Marine Management / RIKZ, P.O. Box 8039, 4330 EA Middelburg, The Netherlands

Based on an extensive survey of literature, files and unpublished notes, an attempt was made to "reconstruct" the numbers of Kentish Plover *Charadrius alexandrinus* breeding in The Netherlands. Between 1900 and 1950 the population size varied between 900 and 1,000 pairs, then the population decreased to a level of c. 600 pairs in the 1960s. During the 1970s there was a temporary increase again to over 800 pairs. Since then the population has been continuously declining to just over 400 pairs in 1994. The most dramatic decrease occurred in the Wadden Sea area: from 500 pairs around 1900 to less than 50 nowadays.

The population in the Netherlands was able to maintain a relatively high level due to a huge series of human activities during this century: creation of large polders, building of dikes, damming of estuaries, etc. There will be no comparable infrastructural projects in the near future, and therefore the Kentish Plover population is likely to continue its decline. The remaining breeding sites in marine, dynamic areas deserve extra attention!

Breeding success and dispersal strategy of Kentish Plover in relation to predation and tourism

R. Schulz, Tiroler Ring 500, 24147 Kiel, Germany

From 1989 to 1995 the breeding success of Kentish Plover *Charadrius alexandrinus* was studied at several mainland breeding sites of the German Wadden Sea coast. Additionally H. Rittinghaus' data from Oldeog Island (1946-1972) could be examined.

First or second year birds regularly disperse over a range of 5 to 50 km around their place of origin. Maximum distances between place of birth and breeding site were 120 km and 418 km. Adult birds, however, are very site faithful if conditions allow.

Kentish Plovers often are the first birds breeding in early primary dunes. Here nests may be flooded but risk of predation is low (about 30%). During further development of dunes the density of vegetation, number of breeding birds, and hence activity of predators increase. If conditions get worse (development of dense vegetation or, often more important, increase of predation) Kentish Plovers can change breeding sites immediately (max. distance recorded: 265 km within the same season).

Today this natural strategy to avoid predators is inhibited because most suitable early dune habitats are used by tourists. Kentish Plovers are restricted to some sanctuaries with an unnaturally high density of birds. Here the rate of predation may be

extraordinarily high (clutch losses up to and exceeding 90%). To overcome this problem a flexible strategy of declaring temporary sanctuaries seems promising. During my study two beach areas were closed for tourists immediately after the first Plovers tried to settle there. Compared to older sanctuaries in the vicinity (90-97%) the rate of predation was low (30-40%).

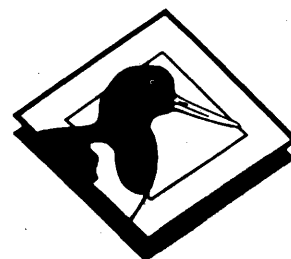
Migration of Kentish Plover *Charadrius alexandrinus* along the East Atlantic flyway

R. Schulz, Tiroler Ring 500, 24147 Kiel, Germany; & P.L. Meininger, National Institute for Coastal and Marine Management / RIKZ, P.O. Box 8039, 4330 EA Middelburg, The Netherlands

In the Wadden Sea and the Rhine Delta most adult Kentish Plovers stay near the breeding sites until the end of the primary moult. An exception are Baltic birds moving to the Wadden Sea just after fledging of chicks. In the north-western European population primary moult begins in late June or early July and lasts for about 8 weeks. Breeding birds weigh about 50 g whereas moulting birds maintain an average level of 46 g. In the following period of fattening about 0.6 g per day are gained until a mean departure weight of 63 g is reached. An important staging area for northern birds is the French Atlantic coast. Wintering birds are found around the Iberian peninsula and in Guinea Bissau. Western Africa is probably the main wintering site.

Birds from Austria and Hungary seem to moult in the northern Adriatic. Their further migration is not clear. Recoveries from Morocco as well as from Sardinia or Sicily indicate a wide range of wintering sites. High numbers of wintering birds in Italy (2,200-3,200) and Spain (7,000) probably result from resident parts of the population. On the other hand recoveries in Morocco and Senegal indicate that some parts of the Mediterranean population are connected with the East Atlantic flyway and probably winter in western Africa. But as shown by a bird ringed in Kazakhstan and wintering in Spain many connections are not known yet.

Data of birds ringed during migration are difficult to interpret because the origin of these individuals is unknown. Consequently future (colour-) ringing activities should concentrate on breeding sites.



Status of Kentish Plover in Hungary

T. Székely, School of Biological Sciences, University of Bristol, Bristol, BS8 1UG, UK

In this paper I present data on population size, distribution and reproductive success of Kentish Plovers *Charadrius alexandrinus*. The breeding population of Kentish Plover in Hungary is about 105-140 pairs. More than half of the population breeds in Miklapusztá (Central Hungary). The number of breeding pairs has declined in the last decades due to the reduction of suitable breeding habitats. Reduction in the number of breeding pairs coincided with a decrease in grazing livestock, particularly sheep.

I investigated the reproductive success of Kentish Plovers between 1988 and 1994. The predation rate of both clutches and broods were high. I show that reproductive success is not adequate to provide enough recruits for maintenance of the population. I suggest several measures such as the improvement of hatching success by nest-protective enclosures and the preservation of insect-rich feeding areas by maintaining grazing pressure by sheep flocks on the breeding sites of Kentish Plover.

Female desertion in Kentish Plover: a state-dependent life-history model

J.N. Webb & J.M. McNamara, School of Mathematical Sciences, University of Bristol, Bristol, BS8 1TW, UK; T. Székely & A.I. Houston, School of Biological Sciences, University of Bristol, Bristol, BS8 1UG, UK

Female desertion is uncommon in birds and one of the few species in which it occurs is the Kentish Plover *Charadrius alexandrinus*. Her deserting time varies: some females desert right at hatching whereas others stay with the brood until the chicks fledge. Here we investigate the decision of females whether to continue parental care or desert the brood and possibly remate. This decision is investigated theoretically using a state-dependent dynamic optimisation model.

The optimal decision is determined by the trade-off between the reward from her current brood and future reproduction where the reward from her current brood may vary according to the age and number of offspring. We investigate various forms of this trade-off.

For a given trade-off we show that the decision of a female should depend on body condition and the age of her brood. Females with low body reserves are expected to desert the brood in order to improve their body condition. The reward from future mating also affects the female's decision: when the operational sex ratio (OSR) is male biased

female desertion is predicted to be more common than when the OSR approaches unity. This study suggests that state-dependent life history models can be a powerful tool for predicting reproductive decisions of individuals.

POSTER ABSTRACTS

Effects of human activity on beaches on the behaviour of Kentish Plovers *Charadrius alexandrinus* during the breeding period: preliminary results

J. Dominguez, E. Rego & F. Arcos, Dpto. de Biología Animal, Facultad de Biología, Universidad de Santiago de Compostela, 15706 Santiago de Compostela, Spain

The breeding population of the Kentish Plover *Charadrius alexandrinus* in Galicia (north-west Spain), estimated at 66-72 pairs (Souza 1993) is largely restricted to a very small number of beaches. In parallel with increasing spring/summer recreational use of these beaches, the number of nesting pairs has declined substantially over recent decades.

Here, we present the preliminary results of current research aimed at evaluating the effect of human activity during the breeding season on the behaviour of Kentish Plovers. Monitoring was carried out in different conditions. Specifically, we compared behaviour in the presence and absence of people and dogs, and monitored both diurnal and nocturnal activity. In all cases air temperature and windspeed were also recorded. In particular, we aimed to test the hypothesis that high levels of human activity during the day force birds to become active at night, with possible consequent effects on prey ingestion rates.

Population tendencies and distribution of the Kentish Plover in industrial salines of Cádiz Bay, south-western Spain

F. Hortas, Dpto. de Biología Marina, Vegetal y Ecología, Universidad de Cádiz, Apdo. 40, 11510 Puerto Real (Cádiz), Spain

The Bay of Cádiz is the most important wintering area of Kentish Plover *Charadrius alexandrinus* in Iberia, with 4.7% of the individuals of the East Atlantic flyway (Perez-

Hurtado & Hortas 1994). Since 1986 until 1991 this species has declined by approximately 33% in the Bay (Perez-Hurtado *et al.* 1993). The population trend is analysed based on data obtained in an industrial saline of the Bay during the winters of 1985 to 1995. Also data about the distribution in relation with nearby intertidal mudflats are presented.

A gradual increase in wintering birds was observed, which is apparently due to a redistribution caused by transformations of intertidal zones into bivalve culture areas, and of salines into aquaculture inside the Bay (Perez-Hurtado & Hortas 1993). For the remaining seasons of the year a similar increase is observed.

The phenology of the species was obtained using monthly average data from approximately five years. A marked pre-nuptial migration is observed in May and the post-nuptial one begins in July, remaining more or less stable until November. It seems probable that a less numerous resident population exists. During the winter period, censuses during low tide revealed that 59% of the birds remain in the salines, 27% feeding. Moreover, 36% continue feeding during high tide, confirming what was suggested by Perez-Hurtado & Hortas (1993). Finally, during winter, the following densities could be observed: 5.10 ind/ha in intertidal mudflats and 0.69 ind/ha in salines, resulting in a total of 1.07 ind/ha.

Kentish Plover breeding population in two beaches of Spanish Levante

C. Oltra Martínez & M. A. Górez Serrano, C/ Almirante Cervera 4, 12100 Castellón, Spain

Parts of the results about breeding Kentish Plover *Charadrius alexandrinus* in Spanish Levante (Castellón and Valencia) since 1990 are presented. Both study areas, Serradal Beach in Castellón and La Punta in Valencia, are beaches with sand dunes subjected to different degrees of protection.

The study focuses on human disturbance on reproductive processes of Kentish Plover. Development of the breeding population since 1990 and different breeding parameters (nest site, breeding success) are described. Many notes about human disturbance related to breeding success and nest and chick losses were taken.

The study about the correlation between sand dune regeneration and the size of the breeding population shows that the quality of habitat is one of the limiting factors for density and distribution of the Kentish Plover. Human disturbance is the main factor for brood and chick losses. Natural factors (predation, weather, *etc.*) are less important.

Does the transformation of salines into fish farms affect the reproductive parameters of the Kentish Plover?

A. Perez-Hurtado, M.I. Gil & M. Castro, Dpto. de Biología Marina, Vegetal y Ecología, Universidad de Cádiz, Apdo. 40, 11510 Puerto Real (Cádiz), Spain

The destruction or transformation of natural habitat is considered one of the principal causes of the decline that Kentish Plover *Charadrius alexandrinus* populations are suffering in almost all of Europe (Jönsson *et al.* 1990). Cádiz Bay, SW Spain, lodges a population of 2,545 wintering individuals (Perez-Hurtado, 1993) and 770 breeding pairs (Perez-Hurtado *et al.* in press). However, the Bay has been suffering various alterations in its habitats during the last decade. These transformations principally consist in the change of salines into aquaculture installations, with a reduction of available habitats for waders.

Perez-Hurtado (1992) demonstrates the negative effect that these transformations have had on the wintering populations. Nevertheless, no study exists that evaluates the influence of these alterations during the reproductive time. The objective of this work is to contribute information about the influence of human use of the habitat on the reproductive ecology of the Kentish Plover.

Rates of hatching, density of nests, predation rate, as well as an index of chick condition (Beintema 1991) are analysed in three types of habitats: abandoned salines, salines in use and piscicultures, with data obtained during the springs of 1993-1995. On the basis of our results some measures for the conservation of this species in the study area are proposed and discussed.

Effects of tourism and industrial management of wetlands on Kentish Plover nesting habitat in the Mar Menor Lagoon (Murcia, SE Spain)

F. Robledano, Sección de Espacios Naturales, Conserejía de Medio Ambiente, C/Luis Fontes Pagán, s/n, 30071 Murcia, Spain; J.C. Blanco & F.J. Palazon, Equipo Seguimiento Proyecto LIFE-Humedales Conserejía de Medio Ambiente, C/Luis Fontes Pagán, s/n, 30071 Murcia, Spain

Since 1988, studies of nesting Kentish Plovers *Charadrius alexandrinus* have been conducted in different wetlands and other sedimentary ecosystems of the Mar Menor Lagoon complex, focusing on population size, breeding distribution and habitat characteristics of the nesting areas and nest sites. Kentish Plovers use a wide range of nesting habitats, ranging from natural beaches, dunes and saltmarshes to

agricultural fields, industrial salt pans and other man-made wetlands (irrigation ponds, sewage treatment plants). A non-negligible part of the total population occupies unprotected sites like derelict salt pans, refuse-filled basins, and marginal dune patches where reclamation is ongoing or planned, mostly for estate building and other tourism facilities.

Active industrial salt pans and natural ecosystems belong to protected areas (Regional Parks and Protected Landscapes). The latter, however, are usually adjacent to tourism complexes and thus suffer great pressure from recreational activities. On the other hand, industrial salt pans, which are relatively safe from human disturbance, undergo dramatic habitat changes through maintenance and reconstruction works.

Present studies aim basically at establishing a management model for the species and its habitats, to be able to preserve or reconstruct enough nesting space inside protected areas, and to reduce disturbance to the species in order to compensate for the reclamation of unprotected habitats. Mitigation procedures for industrial salt pan operation should also be developed.

FEEDING ECOLOGY SYMPOSIUM AND WSG MEETING ABSTRACTS OF POSTERS

HABITAT LOSS AND HABITAT CHANGE

Effects of wetland loss, management and disturbance on the availability of habitats for waterbirds in coastal southeastern Spain

Juan C. Blanco, Fernando J. Palazon & Francisco Robledano, Monitoring Programme - LIFE Wetlands Project, Consejería de Medio Ambiente (Sección de Espacios Naturales), Avda. Teniente Flomesta, s/n, 30001 Murcia, Spain.

In recent times, coastal wetlands of the Murcia region (SE Spain) have suffered important losses in area and function from drainage, silting, ploughing and filling. Land claim for estate building has been especially severe since the touristic boom of the 1960s.

Now, most coastal wetlands have some form of legal protection, and direct land claim has been much reduced. Some areas, however, have development plans which, in the short term, will eliminate good quality waterbird habitats. Moreover, protected wetlands are subject to several types of background threats, and receive a number of human uses, in particular various forms of recreation.

This suggests that only a fraction of the potentially available wetland surface is actually used by waterbirds. In man-made sites (particularly in industrial salinas), wetland hydrology, dictated by the needs of the managing companies, may further reduce the extent of habitat available to some taxa for feeding, roosting and breeding. On the other hand, the closure of small salt factories can cause the disappearance of flooded surfaces supporting important bird populations. Although uses like traditional fishing, salt harvesting, and some forms of outdoor recreation can be considered as compatible with wetland conservation, the intensity that they reach in some areas has greatly exceeded the regulation potential.

A monitoring programme started in 1994 and aims at quantifying bird use of coastal wetlands placed under different protection and management regimes, and submitted to various intensities of human use. Its results will be used to determine the proportion of habitat rendered unusable by inadequate management and disturbance, and the loss of habitat expected from reclamation of unprotected sites. It is expected, also, to derive guidelines for habitat improvement and restoration, to compensate for these losses by enhancing the carrying capacity of remaining wetlands.

A large-scale approach to predicting the effects of habitat loss

Richard Caldow, ITE, Furzebrook Research Station, Furzebrook Road, Wareham BH20 5AS, Dorset, UK.

The increasing need to forecast the consequences of policy decisions and natural processes requires ecologists to predict to new circumstances. Two constraints limit their ability to do so. First, empirical demographic relationships established in the current environment may not apply in new circumstances. Second, processes that occur at a local and relatively easily studied scale do not necessarily translate directly to larger scales. In migratory birds, for example, models that predict the effect of removing habitat on one site on the local rate of mortality or emigration tell us little about the wider consequences for the global population. Thus, we have developed an approach to modelling the distribution of predators in a large-scale patchy

environment, in which consideration is given to the physical and behavioural constraints that influence the movement of individuals between sites.

The modelling approach is spatially explicit, physiologically-structured and individual-based. A two dimensional model world is simulated within which lie patches of habitat that correspond to breeding, staging and wintering sites. The model allows birds to feed on each site and keeps track of the intake rate, body condition and location of each individual in the population as they migrate between breeding and wintering grounds. Individuals' movements between sites are made according to empirically derived, body-condition based, decision rules and the energetic cost of travel is calculated from the theory of flight mechanics. Individuals die either from starvation while on the ground or as a result of running out of fuel while flying between sites.

The model generates density-dependent mortality functions and a wide range of more readily testable quantitative predictions, for example, the timing of migratory movements of entire populations, breeding sub-populations and of different classes of birds. These predictions can be made for a variety of simulated environmental changes ranging from widespread habitat loss at all wintering sites, to a reduction in the quality of one staging site. The predicted consequences of a range of such simulated environmental changes for model species with differing foraging and migratory strategies are compared.

Human disturbance and waders on the Ria de Arousa (Ramsar site, NW Spain)

Jesus Dominguez, Francisco Arcos & Enrique Rego, Dept. Biol. Animal, Univ. Santiago, 15706 Santiago de Compostela, Spain.

The Ria de Arousa, an estuarine bay in the Spanish region of Galicia, is the most important site for wintering waders in the northwest Iberian Peninsula. The mean winter wader count for the period 1989-1993 was 9,600. However, both the intertidal and infralittoral zones of the site are subject to heavy pressure as a result of shellfish gathering, fishing and recreational activity. Here we report the preliminary results of research aimed at characterizing the effects of human activity on the spatial distribution and behaviour of waders, both in intertidal feeding areas and supralittoral resting areas.

In the winters of 1993/94 and 1994/95, we selected feeding and resting groups of Oystercatcher *Haematopus ostralegus*, Curlew *Numenius arquata*, Black-tailed Godwit *Limosa limosa* and Bar-tailed Godwit

L. lapponica. For each group monitored, we recorded variables including species composition, presence of gulls or other bird species within 25 m, distance from the high-tide mark, distance from the closest track/road, presence of people or boats within 300 m, nature of disturbances leading to flight (including distance of disturbing agent from group, and measured sound intensity), and nature of response to disturbance (flying time, distance flown). Windspeed and air temperature were also recorded. Monitoring was carried out on both working and nonworking days.

Effects of habitat loss on meadow birds nesting in Galicia (NW Spain)

Jesus Dominguez, Francisco Arcos and Rafael Salvadores, Dept. Biol. Animal, Univ. Santiago, 15706 Santiago de Compostela, Spain.

In Galicia, six species of meadow birds are known to breed. These are Oystercatcher *Haematopus ostralegus*, Lapwing *Vanellus vanellus*, Common Snipe *Gallinago gallinago*, Curlew *Numenius arquata*, Black-tailed Godwit *Limosa limosa* and Redshank *Tringa totanus* (but note that Oystercatchers breed on small islands off the coast, while breeding by Black-tailed Godwit and Redshank is sporadic).

Most of Galicia's major inland wetland sites have undergone radical transformations over the last 40 years, and it seems likely that this has led to severe declines in the breeding populations of many species. Unfortunately, almost no data are available on former breeding populations.

Of the above six species, Snipe currently has the largest breeding population, basically continuous with that in northern Portugal. The survival of this population is dependent on the adequate conservation of a very limited number of small wetland sites. These sites are currently used by low-intensity traditional farmers, but in most cases there is an imminent threat of change to high-impact modern agricultural land uses. Indeed, land-use changes of this type (encouraged by the regional government) have already led to significant losses of Snipe breeding habitat.

By contrast, the Galician breeding populations of Curlew (about 1-5 pairs) and Lapwing (about 15-25 pairs) are largely located in areas already subjected to high-intensity agricultural uses. The medium- and long-term prospects for survival of these populations are thus poor.

We present historical data on the shrinkage of inland wetland habitats in Galicia, and report on the current status of breeding populations of Common Snipe and Curlew in

the region. Lapwing will be considered in a separate poster.

Threats and habitat degradation of waterfowl

Phillip K. Gitahi, Wild Life Clubs of Kenya, Rift Valley Regional Office, P.O. Box 33, Nakuru, Kenya.

Species of migratory waterbirds share many characteristics which pose a special challenge for their conservation at a whole network of sites. Their dependence on wetlands means that they often congregate in very large numbers at particular sites, making them vulnerable to habitat loss and degradation; and they are also a prized quarry of sport and subsistence hunters, making them vulnerable to non-sustainable hunting activities.

Kenya's indigenous avifauna comprises 860 species of birds, of which 484 species are passerines and the other 376 are non-passerines. The above figure excludes Palearctic or Eurasian migratory bird species and pelagic species off the coast of Kenya except those species which breed on coastal islands.

A total of 138 species, or 16% of indigenous birds found in Kenya, are in imminent danger of extinction due to continuous and relentless encroachment by man on their habitats. There is mounting concern over the issue among local conservationists. Of the 138 species currently endangered 42 species nest in colonies. Their breeding sites are known and some have been in use for decades. However, one of the major worries of conservationists is that only one of the known colonies falls within a protected area. They have appealed to the government to protect more such areas as breeding birds are liable to disturbance and are therefore vulnerable.

Conservationists realize that no matter how numerous a species is, the danger of its extinction still looms if there is no concern and proper protection. Due to mass activities many species are being gradually squeezed out of their habitats as man moves into wetlands and bushland plains for agriculture and other purposes, making some species endangered and vulnerable. As a result many species must now be considered rare and requiring protection of their habitat. One such bird is the White-winged Apalis, which may now be extinct as it has not been recorded since 1961. Another rare bird is the Papyrus Gonolek which is restricted in Kenya to a small area of Papyrus around Yala Swamp in Western Kenya.

Consequences of habitat loss for waterfowl populations in the Loire estuary

Gilles Leray, Massereau Reserve, Office National de la Chasse, La Bonnefillaie, 44320 Frossay, France; Sophie le Drean Quenec'Hdu & Roger Maheo, Laboratoire d'Évolution des Systèmes Naturels et Modifiés, Campus de Beaulieu, Université de Rennes I, 35042 Rennes Cedex, France.

The Loire estuary has been much altered during the 20th century. Its populations of wild birds were equally modified, in particular because of an important decrease in the waterfowl population. This decrease is related to habitat loss of both feeding and roosting areas. This habitat loss has three causes:

1. *Loss of traditional habitat.* The progressive land claim of the Loire bed for harbour construction has led to the loss of many mudflats. At the same time, the wader (*Charadrii*) and Shelduck *Tadorna tadorna* populations, species feeding mainly on those mudflats, have either decreased significantly or have not increased as their numbers did nationwide. The filling of wet fields is a second cause of habitat loss: wet meadows are becoming places where sediments from Loire-bed dredging are deposited. As a consequence, the feeding areas of many ducks, in particular Teal *Anas crecca* have been decreasing.
2. *Modification of habitat use.* A decrease in agricultural practices, which were important in this area of extensive breeding, has led to less extensive use of pasture and mowing areas. Meadows are now laying fallow or are sold to hunters, who are managing them for Mallards *Anas platyrhynchos*. In either case, they have lost their feeding potential and are deserted, particularly by Back-tailed Godwit *Limosa limosa*, Common Snipe *Gallinago gallinago* or Teal.
3. *Increase of pressure on the birds due to disturbance by human activities.* During 'civelle' (Eel *Anguilla anguilla* alevin) fishing, numerous boats are much disturbing the duck flocks. Because of factors described above, these disturbances are all the more important as habitats are decreasing.

For waterfowl, the consequences of habitat loss have entailed a higher frequentation of certain sites, in particular the Banc de Bilho, the Corsept area and hunting reserves. These sites have a relatively small surface and their feeding potential is not extensible. With such extremely high concentrations, birds are searching for alternative sites.

Therefore Avocet *Recurvirostra avosetta* populations have much decreased in the Loire estuary while at the same time their numbers rose in adjacent sites like Bourgneuf Bay, Vilaine Bay and Traicts du Croisic.

Fish Ponds - a disappearing resource for waterbirds in Hong Kong

Lew Young & David Melville, WWF Hong Kong, GPO Box 12721, Hong Kong.

Freshwater fish culture has been a feature of South China for hundreds of years. In Hong Kong it became widespread in the 1970s and by 1983 there were 2,000 ha of ponds in the Territory. Most ponds are operated with a carp polyculture system, or for mullet *Mugil*. Ponds are drained during the winter (November to March) and the fish harvested. The sequential draining of ponds results in the provision of feeding habitat for regionally important populations of egrets, herons and the globally endangered Black-faced Spoonbill *Platalea minor*, which are attracted to feed on waste fish of no commercial value (mostly *Oreochromis spp.*), and prawns *Macrobrachium sp.* Ponds are reflooded in spring, when lime is added to counter acid soil conditions, and stocked with fry. Chironomids are abundant in spring and their emergence appears to be of importance in providing a food resource for migratory *Acrocephalus* warblers, hirundines and swifts.

Over 700 ha of ponds have been lost to industrial and residential development and for open storage over the past 20 years. Much of the remaining fish-pond area is in private ownership and there is increasing pressure to infill the ponds for residential housing, and golf courses. Some 40% of the remaining pond area is expected to be lost within the next 10 years. Egretries are evenly distributed, reflecting an average feeding range for breeding birds of 3 km. There is evidence of birds abandoning breeding sites following loss of nearby feeding habitats. Further loss of fish ponds is likely to result in a reduction of both breeding and wintering populations of piscivorous birds.

NUMBERS AND DISTRIBUTION

Migration of Spoonbills *Platalea leucorodia* via the middle basin of the Guadiana River (Extremadura, Spain)

E. Costillo & C. Corbacho, Animal Biology Department, University of Extremadura, Av. Elvas, 06071 Badajoz, Spain.

The migration of breeding populations of

Spoonbills from the north of Europe has been studied by Poorter (1982, 1990), and details have been provided concerning their routes, dispersion areas and roosts in France and on the coasts of the Iberian Peninsula. However, little is known of migration over inland Spain, where numerous wetlands of both a natural and artificial nature exist. In order to provide further details on this aspect, a survey of 89 river stretches and 355 wetland areas in the middle basin of the Guadiana River (southwest Iberian Peninsula) was carried out between 1992 and 1994.

A total of 97 birds was counted in 28 observations. Two maxima were noted: one in March, already reported by Galarza (1986), and another in July, previously unreported. The latter may refer to non-breeding birds roosting in areas with a high food availability.

The number of observations of migrating birds was greater at the pre-nuptial stage (61% of those observed), although the total number of birds counted was similar at both the pre-nuptial and post-nuptial stages.

Finally, with regard to the size of the groups, on only one occasion were there more than ten birds and 35% of the observations correspond to single birds.

Portuguese national censuses of heronries from 1991-1995

João Carlos Farinha, ICN, Rua Filipe Folque 46, 3º, 1050 Lisboa, Portugal.

Great efforts have been made in the last years to assess the numbers, size and species composition of the heronries in Portugal. Up to 37 heronries were recorded, and the total number of breeding pairs of herons from five species was estimated: Cattle Egret *Bubulcus ibis*; Little Egret *Egretta garzetta*, Grey Heron *Ardea cinerea*, Night Heron *Nycticorax nycticorax* and Squacco Heron *Ardeola ralloides*. Species like the Purple Heron *Ardea purpurea*, the Little Bittern *Ixobrychus minutus* and the Bittern *Botaurus stellaris* were not included in this study. Most heronries were located in trees and on islands in rivers, while others were on salt marshes and rocky stacks close to the seashore. The major threats to these species are identified, given special attention to the Cattle Egret, the most persecuted species from this group.



The Spoonbill in Portugal - status and distribution

João Carlos Farinha, ICN, Rua Filipe Folque 46, 3^a, 1050 Lisboa, Portugal.

The status and geographical distribution of the Spoonbill *Platalea leucorodia* in Portugal is analysed. Since 1988, the species has been breeding regularly with success in the Boquilobo colony (Ribatejo), and new breeding sites have recently been found. The recoveries of metal-ringed birds and resightings of birds marked with coloured leg-rings are also analysed, and a first attempt is made to describe possible movements and origin of the Portuguese population.

Seasonal variations of wader numbers at the Odiel Marshes (Huelva, Spain)

Francisco Hortas, Departamento de Biología Animal Vegetal y Ecología, Facultad de Ciencias del Mar, Apartado 40, Puerto Real, Universidad de Cádiz, Spain.

Waders were counted monthly in the Odiel Marshes Natural Park, Huelva (7,185 ha) during 1992.

Two peaks of approximately 10,000 birds were detected in January and September; numbers during wintering and autumn migration were particularly high as it was observed in Cádiz Bay (Hortas 1990). Spring migration started in February and ended in May. Knot *Calidris canutus* was particularly numerous during this time. Autumn migration ranged from June to October and included the following species: Spotted Redshank *Tringa erythropus*, Black-tailed Godwit *Limosa limosa*, Little Stint *Calidris minuta*, Ringed Plover *Charadrius hiaticula*, Kentish Plover *C. alexandrinus*, Stilt *Himantopus himantopus* and Redshank *Tringa totanus*.

Wintering included December and January when Bar-tailed Godwit *Limosa lapponica* and Avocet *Recurvirostra avosetta* were most abundant.

The migration of 21 species over the south-western coastal fringe is compared to the Odiel Marshes.

Survival and movements of Northern Pintails instrumented in Louisiana

Clinton W. Jeske & Paul C. Chadwick, Southern Science Center, 700 Cajundome Boulevard, Lafayette, Louisiana 70506, USA; & Mary C. Finley, Johnson Controls World Service, 700 Cajundome Boulevard, Lafayette, Louisiana 70506, USA.

Northern Pintails *Anas acuta* are thought to be highly nomadic with frequent long-distance movements to utilize ephemeral habitats. Our study was initiated to determine movement patterns and environmental factors influencing movements of Pintails wintering in Louisiana, USA. Pintails were captured with bait traps and rocket nets at Catahoula Lake in late November and early October 1992, 1993, and 1994. Physical measurements and measures for lead exposure were recorded.

Totals of 152 after-hatch year and 123 hatch-year females were instrumented with backpack radio transmitter packages with a mortality sensor and 180 day expected lifespan. Instrumented females were located weekly from aircraft. Weekly flights covered southwest, central and northeastern Louisiana, and eastern Arkansas. In late winter, aerial coverage included western Mississippi. Irregular flights covered southeastern Louisiana and western Texas. In March, flights extended into southern Missouri and western Tennessee. Altitude for most flights was from 4,000 to 6,500 feet AGL. At this altitude, reception distance was up to 40 miles.

Adult female Kaplan-Meier survival estimate for the 21 weeks starting in mid-October through early March ranged from 0.65 to 0.84. The 21 week survival rate estimate for immature females ranged from 0.84 to 0.86. Overall, 18 after-hatch year females and 31 hatch year females were killed by hunters and eight adult and seven juvenile females died of "natural causes".

Pintails remained in the vicinity of Catahoula Lake until mid-November when waterfowl hunting season opened and more wetland acreage became available. Most movements were in a northward direction to northeast Louisiana, where the instrumented birds primarily used flooded rice fields. In late December, when fields flooded in Arkansas, further northward movements were observed. A gradual northward movement in Arkansas was observed until mid-March, when increased ambient temperatures thawed wetlands north of Arkansas.

Description of the waterfowl community in the ricefields of 'Las Vegas Altas del Guadiana' (Extremadura, Spain)

A. López-Gallego, C. Fuentes & J.I. Ruiz de la Concha, Biología Animal, Universidad de Extremadura, Spain.

In the present study an analysis was made of the waterfowl community of the area located in the centre of Extremadura (centre-west of Spain). The information which exists on this community is very scarce and is limited to qualitative or semiquantitative descriptions

and some studies on specific species. Censuses were taken of the 10,540 ha of this wetland from April 1991 to May 1994 (although no censuses were taken from April 1993 until January 1994 because of drought). The winter censuses corresponding to 1990 and 1991 have also been used.

The most important populations of international importance existing in this area are those of the following species:

Common Crane *Grus grus* - censuses taken in January gave an average number of 3,105 birds. The size of the wintering population of this species has increased gradually in this area.

Common Pratincole *Glareola pratincola* - several colonies exist of which the largest has approximately 30 pairs. The average of the population peaks recorded over the years of study is 130 birds at the end of the breeding period.

Black-tailed Godwit *Limosa limosa* - this species uses the inland water as a wintering area and, more importantly, as a stopover on its pre-nuptial migratory route, with average numbers of 8,837 birds.

Other important wildfowl populations are: Cattle Egret *Bubulcus ibis* (1,100), Little Egret *Egretta garzetta* (136), White Stork *Ciconia ciconia* (189), Northern Shoveler *Anas clypeata* (864), Black-winged Stilt *Himantopus himantopus* (228) and Common Snipe *Gallinago gallinago* (707). Five 'vulnerable' species can be said to have made use of the area (Common Crane, White Stork, Marsh Harrier *Circus aeruginosus*, Common Pratincole and Gull-billed Tern *Gelochelidon nilotica*) as well as two 'rare' species (Avocet *Recurvirostra avosetta* and Eurasian Curlew *Numenius arquata*).

Based on the winter censuses of the years 1992, 1993 and 1994, the total population of waterfowl in the area was 11,401 birds. The most important taxonomical groups were Charadrii (6,799), Gruiformes (2,534), Anseriformes (1,120), Laridae (688), Ardeidae (195) and Ciconiidae (64). The richness of the wintering community for the years studied was 23 species; mean diversity (Shannon index) was 1.865; and equitability (Pielou index) was 0.599.

Based on the size of the wintering populations, this area could, as a preliminary evaluation, be situated in twelfth place amongst Iberian wetlands. According to an analysis of the wintering communities considered the 19 best in Spain, this area would occupy the tenth position.

Wader numbers at 'Ria de Aveiro'

A. Luís, Department of Biology, University of Aveiro, Portugal; C. Fradoca & R. Vaz, ICN, Reserva Natural das Dunas de S. Jacinto, Aveiro, Portugal.

Wader counts have been undertaken at "Ria de Aveiro" during recent years. The results of the last mid-winter counts are presented, showing that there is little variation and that the numbers of Avocets *Recurvirostra avosetta* and Ringed Plovers *Charadrius hiaticula* exceed the 1% threshold adopted for the use with the Ramsar Convention.

High densities of waders feeding in intertidal mudflats of the Cádiz Bay Natural Park (SW Spain)

J.A. Masero, G.M. Arroyo & A. Perez-Hurtado, Dpto Biología Animal, Vegetal y Ecología, Facultad de Ciencias del Mar, Puerto Real (Cádiz), Spain.

Densities of waders feeding in intertidal mudflats along the East Atlantic Flyway reach their maximum in the Banc d'Arguin, Mauritania, with an average of 40 birds/ha during winter (Zwarts *et al.* 1990), although 186.7 birds/ha could be registered in *Zostera* fields (Nome 1982).

In Cádiz Bay Natural Park (SW Spain) very high densities have been found, both during migration and throughout the winter, with numbers which do not drop below 100 individuals/ha in intertidal mudflats adjoining salines. These results are discussed in relation to scale effect, available invertebrates, thermoregulation and the presence of supratidal feeding resources.

Distribution patterns of wintering waterfowl in Europe

Jesus Olivero, J. Mario Vargas and Raimundo Real, Dept. Animal Biology, Malaga University, 29017 Malaga, Spain.

Usually, studies of waterfowl ecology only take into account the characteristics of the localities the birds normally inhabit. In the present study we show a different approach, in which we interpret waterfowl distribution based on the macro-environmental characteristics of the river basins where their habitats are situated.

We studied the distribution of 142 wintering waterfowl species in the main 55 river basins of Europe. The species belong to the orders Gaviiformes, Podicipediformes, Procellariiformes, Pelecaniformes, Ciconiiformes, Phoenicopteriformes,

Anseriformes, Gruiformes and Charadriiformes. We began with a presence-absence matrix of the species in the river basins. The river basins were grouped by a method of classification into 'biotic regions'. The biotic regions are areas characterized by having a particular fauna, significantly different from the rest of the continent. The species were grouped in 'corotypes' constituted of species with a significantly similar distribution.

We used the similarity index of Baroni-Urbani and Buser for the analysis of classification. This index has a significance table associated with it. The groupings were made by the UPGMA method. Then, we verified the significance of the groups obtained. Thus we were able to determinate the corotypes and biotic boundaries that resulted from the classifications. In this way we arrived at 19 corotypes and six biotic regions.

The distribution of each corotype and the biotic regions were characterized by logistic regression. We explained them in terms of several environmental factors: climatic stability, energy availability, water availability, simultaneous energy and water availability and climatic stress. The result was that water availability in Europe is not by itself a relevant factor for any of the European waterfowl corotypes. Instead, the factor that has most influenced corotype distribution is energy availability.

Expansion of Oystercatcher *Haematopus ostralegus* from coastal habitats to farmland in Latvia

Otars Opermanis, Museum of Zoology, University of Latvia, Kronvalda bulv. 4, Riga 1842, Latvia.

For more than 100 years until the 1980s the Oystercatcher was a rare breeding bird, having traditional nesting grounds on islands of lower waters of several Latvian larger rivers flowing into the Gulf of Riga. During the 1980s and until now the population has increased from 30 to more than 100 breeding pairs. As the area suitable for breeding at the coast was very limited, the increase in numbers was only possible by occupying other habitats. There were two distinct stages of this expansion: 1) moving inland by utilising coastal lakes and the whole length of the valley of Daugava until the border with Belarus, and 2) utilising farmland along the largest rivers mainly in their lower reaches.

During 1989-1994 comparative studies of Oystercatcher breeding biology were carried out in all these habitat groups. At the coastline typical breeding habitats are mostly sand or gravel patches without vegetation, with little disturbance and an area of at least 0.5 ha. Of nests, 29% were situated on

small islands or banks in river mouths. The highest density of nesting pairs recorded here was 0.6 pairs per km of coastline.

Inland breeding habitats are islands and sand banks of lakes along the coastline of the Riga gulf and two large rivers, flooded gravel or dolomite pits along the river valley and other artificial habitats. 65% of nests were located on islands. The maximum density observed here was 0.3 pairs per km of river valley. The number of breeding pairs here depends upon water level and upon overgrowing of islands and sand areas.

In farmland, 61% of nests were situated on unplanted fields with permanent cultivation. 26% of nests in cereals, 10% in furrow crops, 3% in fallow. Density of nesting pairs may reach up to 10 pairs/km². There were no significant differences in nesting phenology among habitats, except that laying appeared later with increasing distance from the Baltic Sea coast. Mean clutch size in farmland was significantly lower than in coastal and inland habitats. Mean egg volume in farmland was significantly larger than at the coast and inland. Hatching success was estimated as 19.3% at the coast, 47.2% inland and 6.2% in farmland. In all three habitat groups repeated clutches were recorded; they occurred more often where hatching success was low.

Resources for waterfowl in Turkmenistan: cartographic analysis of wintering areas and their protection

Eldar A. Rustamov, Institute of Zoology, Acad. of Sciences of Turkmenistan, Stepnaya St. 21, 744006 Ashgabat, Turkmenistan.

Many years of special research of the composition, distribution, population and biomass of waterfowl in wintering areas in Turkmenistan have resulted in the cartographic analysis and conception of the organization, ecological structure and development of waterfowl populations.

The following factors have been taken into consideration in the assessment of the transformation of reservoirs: feeding capacity, protection, regime of filling, pollution, air temperature, poaching and other problems. The status of 15 wintering areas which include 46 reservoirs has been examined.

Numbers of birds in the reservoirs in Turkmenistan have been decreasing. They reached their peak with an average of not less than 750,000 in the 1960s; there were years when the total waterfowl number reached 1 million. The first decrease in numbers took place in 1969, and a steeper decrease began in 1977. The reason for

such a decrease in the population of waterfowl in the territory of the former USSR are the cold winters of those years. At present there are on an average 489,000 individuals of waterfowl in all the wintering areas (on average 68 species/km²); their biomass is approximately 500,000 tons (66 kg/km²). Of the 34 species present, the following are dominating: Coot *Fulica atra* (25%, biomass 22%); Mallard *Anas platyrhynchos* (24%, biomass 30%); Teal *Anas crecca* (19%); Red-crested Pochard *Netta rufina* (17%, biomass 20%).

The greatest numbers of waterfowl are found on the lakes in the Amu-Darya riverbed: Dengizkul Lake, Soltandag Lake, Kelifski Lakes. Other important areas are the mouth of the Etrek River, the shallows of the south-east Caspian Sea, and the Khauzkhanski reservoir.

The results of these cartographic analyses are insights into ecological peculiarities of waterfowl wintering areas in Turkmenistan, into resources for waterfowl, and the numbers and distribution of birds. This includes existing wetlands as well as those which have already disappeared and those which will be generated in the future (as the result of irrigation of the Kara-Kum desert). This knowledge should provide the basis for protection and reasonable treatment of birds in Turkmenistan, above all the maintenance of feeding capacity and strict regulation of hunting in the reservoirs (not more than 20-25%).

The author is very grateful to the Macarthur Fund for supporting his attendance of the conference.

Trend in numbers and conservation of Lapwings *Vanellus vanellus* in Galicia (NW Spain)

Rafael Salvadores, Portanet 23-2^B, 36210 Vigo (Pontevedra), Spain; Francisco Arcos, Dept. Biología Animal, Fac. Biología, Univ. Santiago de Compostela, 15706 Santiago de Compostela (A Coruña), Spain; & Ramon F. Ramón, Grupo Habitat, Apdo. 805, 15080 A Coruña, Spain.

During 1992-1995, a census was carried out of the breeding population of Lapwings in Galicia (NW Spain). Data were compiled in relation to the habitat type used for nesting and feeding of chicks.

The results indicate a considerable decrease in the number of Lapwings compared to the estimate of 40-70 pairs in 1989. The data compiled with regard to the use of habitat suggest that agricultural intensification and drainage of wetlands in the area of A Limia, which is the main reproductive site, have influenced the decrease of the population.

While the effect which other factors such as predation or human disturbance have on breeding success still has to be determined, the increasing agricultural intensification of the area of A Limia must be controlled to safeguard the small Galician Lapwing population, by preserving the last remaining patches of wet grasslands.

The use of satellite imagery in the identification of potential feeding areas for overwintering shorebirds (Charadrii) in the Tagus Estuary, Portugal

E.P. Silva, Rua Dr. Jorge Mineiro, 19-3^a. Esq. 2745 Queluz, Portugal.

This study took place in the Tagus Estuary, between Alcochete and Montijo. It used a SPOT XS image taken at low tide in July 1986, which was geometrically corrected and submitted to an unsupervised classification for qualitative characteristics of the sediment. Sediment samples were taken from eight different, representative and homogeneous squares, with an area of at least 3,600 m², which were described for particle size distribution, organic matter, water and chlorophyll a content, penetrability and cover (water, algae and/or shingle). A topographic model of the sampling area was built for inundation time and distance to low water mark (distLWM) assessment, factors that may equally affect the distribution of waders in the intertidal feeding areas. Birds were sampled in the spring of 1994, in six sectors of 8.5 ha representing different types of sediment, by theodolite intersection between two well-known observation points.

Three models of use of a Global Positioning System (GPS) were tested: differential, mean (the final co-ordinates of a test point are the mean of co-ordinates taken every minute for five consecutive minutes) and false differential (the final coordinates of a test point are the difference between its coordinates taken every minute for five consecutive minutes and their error calculated as the difference between the coordinates of a reference point taken simultaneously with the test point and its real coordinates). We determined errors of position of 9, 35 and 15 m, respectively. More tests should be done, considering a much wider array of situations, to confirm these values. Every sample was georeferenced with GPS, in differential or false-differential mode.

In order to avoid the loss of pixels of sediment elements when applying mode-filter kernels to an image, the pattern of dispersion of water in the area must be taken into account. It was possible to distinguish eight sediment types in the classified image: 1) mud flats with water film; 2) mud flats; 3) oyster beds with water film; 4) oyster beds; 5) sandy mud; 6) muddy sand; 7) sand with

shingle, algae or water film; and 8) sand. The particle size distribution of the sediment samples was positively related to its water content, organic content and penetrability. The water retention capacity of these sediments was not influenced by inundation time or distLWM.

The study area has complex topographic characteristics and inundation time could not be seen as the reverse of height but as the result of intricate water circulation patterns. In this case, the distLWM is easier to verify, therefore assuming a major role in the interpretation of the distribution of waders.

We found that muddy sand sediments have a positive influence on densities of Dunlin *Calidris alpina*, plovers *Charadrius* spp. and Common Sandpiper *Actitis hypoleucos*; Whimbrel *Numenius phaeopus* had significantly higher densities in oyster beds in general; Grey Plover *Pluvialis squatarola* densities seemed to be more influenced by distLWM. Theodolite intersection proved to be an extremely slow method with few advantages.

HABITAT SELECTION

Irrigation ponds and waterbird distribution in agricultural landscapes of the Murcia Region (southeastern Spain): a regional evaluation

Gustavo A. Ballasteros, Miguel A. Nuñez, Juan C. Blanco, Fernando J. Palazon & Francisco Robledo, Monitoring Programme - LIFE Wetlands Project, Consejería de Medio Ambiente (Sección de Espacios Naturales), Avda. Teniente Flomesta, s/n, 30001 Murcia, Spain.

The Murcia Region, located in the southeastern corner of the Iberian peninsula, is characterized by predominantly semiarid climatic conditions. Large wetlands are found along the coast, being closely related with the sea in origin and functioning. Inland wetlands are mostly vectorial, saline seepages associated with ephemeral watercourses and relict floodplains. The scarcity of superficial water resources, however, has not prevented the development of irrigated cultures. Traditionally, this kind of agriculture was based on groundwater extraction, but since the 1970s resources have allowed the transformation of large areas of former dryland cultures and natural habitats.

The building of reservoirs for large-scale irrigation created some new inland freshwater wetlands, which have been colonized by typical waterbird species. In addition, minor scale irrigation works have led to the

construction of many small storage ponds. Locally, these can reach mean densities of up to 1.2 per km². By using these ponds, some waterbird species have been able to colonize large areas of formerly unsuitable habitat. Ponds receive several types of bird use: as nesting and brood-rearing sites, as feeding sites for individuals breeding nearby, as wintering areas, and as stop-over places for migrants. Even endangered species of high conservation value can benefit from their existence in particular situations.

In 1988-89 the importance of irrigation ponds as breeding sites was evaluated in an area surrounding a large natural wetland. Since 1994 new areas have been surveyed with this purpose, two of which are now being monitored in further detail, to study their role during migration and wintering periods, as well as the impact of water management on waterbird species and communities. The results of all these studies are the basis for a first regional evaluation of the use of ponds by different species and groups of waterbirds, which is compared with the use of other types of natural and artificial wetlands by the same taxa.

Feeding habitat use and foraging success in the Little Egret *Egretta garzetta* at Paul do Boquilobo - Portugal

Ana Cristina Cardoso, R. Actriz Palmira Bastos 42. 4^oDto., 1900 Lisboa, Portugal.

The Natural Reserve of Paul do Boquilobo is a freshwater marsh where an important mixed colony of several species of Herons is settled. The feeding habitat use and foraging success of Little Egret was studied in this area during the breeding season.

This species chose open waters, most of them with some aquatic vegetation, like *Scirpus lacustris* and *Ranunculus baudotii*. Rivers and ditches were used but not preferred. Three parameters were used to study foraging success: number of pecks per minute, percentage of successful pecks and number of steps per minute. Foraging success was higher at rivers, ditches and open waters with *Ranunculus baudotii*.

Concerning the conservation of feeding grounds for Little Egrets, priority measures should be taken in order to preserve a tilled plain covered with *Ranunculus baudotii* near the reserve's border, where water recedes slowly and prey such as *Pelobates cultripes*, *Gambusia* sp. and *Procambarus clarkii* concentrate.

Habitat selection of Little Grebe on Intensively managed south Bohemian fishponds

Jaroslav Cepák, Department of Zoology, Faculty of Natural Sciences, Charles University, Vinicna 7, Praha 2, 128 44, Czech Republic, & Petr Musil, Institute of Applied Ecology, Czech Agriculture University, Kostelec nad Cernými lesy, 281 63, Czech Republic.

A decrease in Little Grebe *Tachybaptus ruficollis* breeding population size has been recorded on south Bohemian fishponds since the early 1980s. The number of birds occurring on 160 fishponds declined from 288 birds on 85 fishponds in 1981-82, to 256 birds on 84 fishponds in 1985-86, and to 170 birds on 59 fishponds in 1991-92. This decline has continued since 1992.

We started a more detailed investigation of the ecology of Little Grebe on intensively managed fishponds in the Trebon Biosphere Reserve (South Bohemia, Czech Republic). Investigations were carried out on 123 fishponds, i.e. shallow eutrophic water bodies with very high fish stock densities. Size surface of fishponds under study varied from 0.12 ha to 166.24 ha.

The research was aimed at the following questions:

- Assessment of key-factors affecting presence, abundance and reproduction of Little Grebe;
- Relationships between habitat conditions and breeding success;
- Effect of water transparency on abundance and reproduction of Little Grebe; and
- Factors affecting timing of fishpond occupation.

Field work was carried out in 1993-95. Preliminary results show that:

- Frequency (number of occupied fishponds) and abundance (number of occurring/breeding pairs) were higher on smaller fishponds, which had lower fish density; and
- Little Grebes breed earlier on fishponds with higher water transparency (i.e. with lower grazing effect of fish stock).

Organic matter content and hardness of sediment in a study of spatial distribution of feeding waders

Sophie le Drean Quenec'Hardu, Roger Maheo & Jean Claude Lefeuve, Laboratoire d'Évolution des Systèmes Naturels et Modifiés, Campus de Beaulieu, Université de

Rennes I, 35042 Rennes Cedex, France.

Distribution of feeding waders on mudflats of estuaries and bays is influenced both by activity rhythm constraints (disturbance, distance between roost and feeding areas) and by prey constraints (presence, accessibility, activity). Factors influencing prey parameters concern the sediment on the one hand and the environment (mudflat level) on the other. Among sedimentary parameters, we have studied hardness and organic matter content. These parameters influence benthic invertebrate presence, activity and accessibility.

We have shown that hardness is correlated negatively with water content and positively with particle size. Hardness or its opposite, penetrability, influence prey distribution and activity, their burrowing depth and their accessibility (probing ability).

Sediment organic matter content is linked with density and biomass of detritus feeding invertebrates. On the other hand, the higher the organic matter content, the smaller the particle size is. Therefore it influences prey presence, density and accessibility.

Mudflat levels can be estimated in Mont Saint Michel Bay by the distance from the shore. It is linked to benthic community distribution.

In Mont Saint Michel Bay, multiple regression analysis shows that these three parameters are linked to spatial distribution of Dunlin *Calidris alpina*. Dunlin diet is based on detritus feeding invertebrates. Predictive equations obtained allow to predict the frequency index and the density of Dunlin for different sectors according to organic matter content, hardness and distance to the shore.

Habitat selection and feeding strategy of Purple Sandpiper *Calidris maritima*, wintering in Tromsø, northern Norway (69° 40' N)

Heidi Gabrielsen, NINA, Norwegian Institute for Nature Research, Tromsø, Norway.

Northern Norway holds an annual winter population of Purple Sandpiper of about 100,000. In the Tromsø area there are two main flocks of wintering Purple Sandpiper, containing about 750 and 500 birds.

The Purple Sandpiper forages mainly on *Mytilus edulis* and *Littorina* spp. in the intertidal zone, during both day and night. Studies of other wader species show that different diurnal and nocturnal foraging habitats and foraging techniques are used. Investigations run by K.-B. Strann and S. Nilsen indicate a very small rate of exchange between the two flocks.

The project presented is based on the hypothesis that predation pressure and variation in prey abundance may lead to differences in habitat choice between day and night. We are planning a comparative study of day and night habitat by: 1. finding day and night habitat; 2. measuring prey abundance in both habitats; 3. comparing day and night feeding efficiency; and 4. registration of predation pressure.

So far we have got the results from point 1. The use of telemetry has given us indications of location of feeding and roosting sites, spread of the population and use of different habitats by day and night. Radio transmitters attached to birds from both flocks have revealed that Purple Sandpipers in Tromsø do choose different habitats between day and night. The project is still running and will hopefully give answers to the remaining questions.

Habitat use of waders at the Odiel Marshes (Huelva, Spain)

Francisco Hortas, Departamento de Biología Animal Vegetal y Ecología, Facultad de Ciencias del Mar, Apartado 40, Puerto Real, Universidad de Cádiz, Spain.

Waders present in all different habitats at the Odiel Marshes at low tide were studied during 1992. 21.83 ind/ha were counted over a study area of 375.33 ha comprising mud and salt-pans in January.

Waders used salt-pans more often during May. Hence, salt-pans can be considered as important alternative feeding places. Similar results were reported in Cádiz Bay for wintering waders by Pérez-Hurtado and Hortas (1993).

Distribution, habitat use and densities of waders during an annual cycle are discussed, particularly in relation to the importance of the availability of alternative feeding places for some species.

Feeding habitat selection of Black-Winged Stilt *Himantopus himantopus* in Castro-Marim, South Portugal

Luísa Mendes, Rua D. João de Castro 47-A, 2710 Sintra, Portugal.

In Portugal, the Black-Winged Stilt *Himantopus himantopus* is more common in estuarine salt-pans in the center and south of the country. Since the fifties, the number of salt-pans has decreased, due to a recession in the salt extraction industry. The situation today is that the available feeding areas for the species are much reduced, and this has given rise to the urgent need of studying the parameters of feeding habitat selection.

This work was carried out in one of the species most important breeding areas in south Portugal, the Castro-Marim Natural Reserve (150 breeding pairs). From November 1993 to July 1994, counts were carried out in four salt-pans with different types of exploitation (two mechanised - Cepo Velho 1 and Sinexpral and two traditional - Venta Moinhos e Cepo Velho 2, being the last one abandoned).

The area mostly used by the birds throughout the year (excluding January and March) was the mechanised salt-pan Cepo Velho 1. The situation at Sinexpral varied with the season according to the water coverage at the pans. There, the lowest density of birds occurred between February and April, the reason being that the percentage of dry pans was higher during that period, resulting in a decreased of the available feeding area. However more work is needed to test this hypothesis. The traditional salt-pans had in general a lower density of birds, probably due to deeper water.

The larger pans with lower banks were preferred as feeding areas (Mann-Whitney U-test; $p < 0.05$), possibly due to better visibility, as the Black-Winged Stilt is highly sensitive to disturbance. Unfortunately, the majority of the salt-pans in the study area are small and have high banks. The pans with a higher percentage of water coverage (around 90% to 100%) were also preferred (Mann-Whitney U-test; $p < 0.05$), probably due to a higher macro-invertebrate density. Pans with lower water level (less than 10 cm) and higher salinity values (above 210 g/l) were significantly less used as feeding grounds (chi square test; $p < 0.05$), possibly due to prey biomass reduction.

Distribution of waders in salt-pans: the role of water level, tidal cycles and season

Rui Rufino & Renato Neves, CEMPA/ICN, R. Filipe Folque 46, 5^a, 1050 Lisboa, Portugal.

Four salt-pans of the Tejo estuary with different uses, either abandoned, active industrial, active semi-artisanal or transformed, were surveyed during one year. Counts were carried out at fortnightly intervals covering one half of a tidal cycle.

The distribution and numbers of all wader species was recorded at regular intervals together with information on water level, bird activity and function of the salt-pans.

For most wader species higher numbers were found at high tide, for roosting birds, and during the autumn. Birds generally preferred low water levels, even when no foraging activity was observed.

The role of tundra microtopography in nest-site choice by high arctic waders

Mikhail Yu. Soloviev, Dept. of Vertebrate Zoology and General Ecology, Biological Faculty, Moscow State University, 119899 Moscow, Russia; & Pavel S. Tomkovich, Zoological Museum of Moscow State University, Herzen Str. 6, 103009 Moscow, Russia.

The microtopography of tundra was studied in 1990-92 for nest-sites of five species of waders, breeding in northern Taimyr, Siberia. The field technique included taking measurements of surface heights in 80 control points within a range of 1 m around each nest. Related to the nest-site level, these measurements permitted to estimate a set of nine characteristics, describing the position of a nest in the relief.

Discriminant function analysis revealed that vertical ruggedness made the largest contribution to species separation in canonical space, contrasting Little Stints *Calidris minuta*, which nested between smallest tussocks, to other waders. In the series Curlew Sandpiper *C. ferruginea* - Knot *C. canutus* - Grey Plover *Pluvialis squatarria*, the average distance from a nest to the top of a hillock decreased, which possibly provided a better field of view to an incubating bird of a larger species. The nest-site characteristics of Sanderling *Calidris alba* almost completely overlapped with those of Curlew Sandpiper and Knot, but Sanderling avoided competition by nesting significantly later on northern slopes of ridges.

In Little Stints and Curlew Sandpipers vertical ruggedness correlates with distance of leaving the nest on disturbance, because in an open environment birds do not rely on the possibility to escape from a nest undetected and prefer to hide on it. In the Curlew Sandpiper, the Sanderling and the Knot, nesting in similarly rugged surroundings, the tendency to hide on the nest and then make distraction displays increases with increasing bod size of the species and proximity of the nest to the top of a hillock. Grey Plovers developed tactics of active antipredator behavior, combined with breeding on gentle slopes with a good field of view.

BREEDING BIOLOGY

Growth parameters and body condition in chicks of Black-winged Stilts *Himantopus himantopus* and Avocets *Recurvirostra avosetta*: effect of breeding habitat quality

G.M. Arroyo, A. Pérez-Hurtado, M. Castro & J.A. Masero, Dept. Biología Animal, Fac. Ciencias del Mar, Polígono, Rio San Pedro

s/n 11510 Puerto Real (Cádiz), Spain.

The development of waders' nidifugous chicks is influenced by various causes: climatic factors such as rain or cold, food availability, or predator effects determine the growth and survival of chicks (Beintema & Visser 1989; Beintema 1991). In this sense, breeding habitat selection can play a very important role, as different habitats can offer different energetic resources.

Black-winged Stilts and Avocets are two colonial wader species, with biparental care of the eggs and chicks, that frequently breed in mixed colonies in our study area (Arroyo *et al.* 1994). In the present study biometric data of Stilt and Avocet chicks are shown for 1993 and 1994 in the Cadiz Bay Natural Park (SW Spain). The condition of newly hatched chicks (average weight of the chicks captured in the nest) is compared between different habitats, as well as growth rates, using bill size as a measure of chicks' age.

Effect of colony size, density and composition in mixed colonies of Avocets *Recurvirostra avosetta* and Black-winged Stilts *Himantopus himantopus*: preliminary results

G.M. Arroyo, A. Pérez-Hurtado & J.A. Masero, Dept. Biología Animal, Fac. Ciencias del Mar, Polígono, Río San Pedro s/n 11510 Puerto Real (Cádiz), Spain.

The influence of size and density of colonies on reproductive success of seabirds and colonial waders is well known: higher nesting density can favour joint colony defense, consequently producing a higher reproductive success (Birkhead 1977; Skeel 1983). On the other hand, denser nesting groups are more detectable by predators, therefore nest spacing can reduce predation rate (Tinbergen *et al.* 1967). In this way, the predator effect is commonly density-dependent, and can favour the co-existence of different species of breeding birds (Martin 1988).

Avocets and Black-winged Stilts are two Recurvirostrid species which usually breed in mixed colonies in "La Tapa" saline, Cadiz Bay (SW Spain) (Arroyo *et al.* 1994). In this poster, preliminary results about the effect of the size and density of mixed colonies on hatching success are discussed in relation to the causes of nesting failure and the kinds of predators. We also note the influence of the colony composition, as possible consequence of the differences between both species in their behaviour toward predators.

Disaster in paradise: lethal rachitis in Black Terns in an acid fen

Teun Baarspul, Jan Pieter de Krijger & Albert Beintema, Institute for Forestry and Nature Research, P.O. Box 23, 6700 AA Wageningen, The Netherlands.

Environmental effects of acid rain in nutrient-poor ecosystems have been documented for more than 30 years. Less well known are the effects on birds (apart from the obvious disappearance of piscivorous species from dead lakes). There are cases of eggshell thinning and reduced fertility, attributed to calcium deficiency, in birds near acidified lakes and streams, or in dry forests on poor soil. Jaap Graveland argues that this problem is much more widespread, but has not been sufficiently recognised. So far, attention has been focussed on eggs. We now have a first example where in a colony of Black Terns *Chlidonias niger* all chicks failed to fledge, due to calcium deficiency.

Black Terns used to feed their chicks on large insects, which have become much less abundant in The Netherlands. Chicks are nowadays mostly fed on small fish. Black Terns nest in a variety of small waters, usually rich in floating vegetation. They have declined in most habitats, but their disappearance from fens in heathlands and highmoor is most pronounced.

Bargerveen is a remnant of excavated peatbog, which is now a nature reserve, serving as an example of successful peat regeneration. The area has shown an explosive development of large insects, and following that, a spectacular recovery of Red-backed Shrikes *Lanius collurio*, a species almost extinct elsewhere in the country. Bargerveen has a small colony of Black Terns, which were believed to live in paradise too. There is no fish because of the acidity (pH ca. 4.0), but large insects are available *ad libitum*.

In 1995 19 individuals only formed six pairs, nesting very late. Two pairs produced a normal clutch of three eggs, the others laid two. Of 14 eggs, 10 hatched. Those which did not hatch showed abnormal pigmentation, as described by Graveland for eggs deficient in calcium. In spite of high feeding frequencies, chicks stopped growing after ten days, developed abnormalities in wings and legs, and died. Post mortem analysis, performed by Prof. Jaap van Dijk, Dept. of Pathology at the Veterinary Institute of the University of Utrecht, revealed severe symptoms of rachitis, and multiple spontaneous bone fractures.

Sometimes we think we know enough about old topics like acidification, but this example shows that our knowledge of the effects on birds is just starting to build up.

A study on the breeding biology of a heron colony at a wetland natural reserve

Susana Costa Marques, R. Prof. Arsénio Cordeiro, 5-2ª Dta., 1600 Lisboa, Portugal.

The Natural Reserve of Paul do Boquilobo is a small wetland located on the right shore of the river Tejo. The heron colony breeding in this Biosphere Reserve is the largest in Portugal. Three Ardeid species are present, namely Cattle Egret *Bubucus ibis*, Little Egret *Egretta garzetta* and Night Heron *Nycticorax nycticorax*, together with some couples of another Ciconiiform, White Spoonbill *Platalea leucorodia*.

As a part of a plan to establish the basis for a management oriented mainly towards conservation, a study on the reproductive parameters of these species was carried out in 1994.

Tagged nests were checked every week, from March through May (when these and many other nests were destroyed by a flood). It was not possible to have access to Night Heron nests, which were built on the higher level of the *Salix* trees where the colony is settled. Between June and the beginning of September, later nesting attempts were surveyed with binoculars, to obtain more data on the number of young produced per nest for all species, including Night Herons.

The results, compared with those of other studies from around the world, show that clutch and brood size for these populations can be considered as average, except in Little Egret. For this species, the number of chicks ready to leave each nest was lower than any of the values found in the mentioned studies.

Energetics of shorebird chicks in the tundra

Jan van Gils, NIOZ, PO Box 59, 1790 AB Den Burg (Texel), The Netherlands.

The environment of the high arctic imposes two critical limits to the existence of many forms of life. One includes the extreme physical conditions of the environment: cold temperatures, high wind velocities, and low precipitation. The other is the briefness of the growing season. This environment is especially stringent for shorebirds, which occupy their arctic breeding grounds for as little as two months, and whose chicks are among the smallests of warm-blooded animals. Data presented and discussed here are on temporal variation in food abundance, and on growth rate and energetics of American Golden Plover *Pluvialis dominica* chicks.

Optimal nest density in colonies of the Pied Avocet *Recurvirostra avosetta*

Herman Hötter, Forschungs- und Technologiezentrum Westküste, Univ. Kiel, Hafentörn, 25761 Büsum, Germany; & Anne Segebaden, Am Flasshof 18, 25856 Rosendahl, Germany.

Pied Avocet *Recurvirostra avosetta* breed in colonies of different size. Nest densities in the colonies are highly variable. In 33 colonies studied on the Wadden Sea coast of Schleswig-Holstein/Germany the medians of nearest neighbour distances between nests ranged from 0.6 m to 29 m. Hatching success was highest in colonies of moderately high nest densities. Colonies with very high and colonies with low nest densities had lower hatching success rates.

The main reason of nest failure in low density colonies was predation, mainly by gulls *Larus* spp. In colonies of very high densities, nest predation was virtually absent, probably because the Avocets managed to defeat all aerial predators. Nests in high density colonies failed because they were deserted. Desertion in high density colonies mostly affected the numerous clutches of abnormal size (one egg, two eggs or more than five eggs). Interspecific aggression during and before egg laying was significantly more severe in high density than in low density colonies. In high density colonies nest neighbours frequently chased Avocets from their breeding territories during the egg laying period. It was probably this behaviour that resulted in mislaying and deserting eggs.

In conclusion, the nest densities within Avocet colonies seem to be determined by a counter-balance of two forces: avoidance of egg predation which favours high densities, and avoidance of intraspecific disturbance during egg laying, which favours low density colonies. In our study site the counterbalance reached its optimum (as measured by hatching success) at nearest neighbour distances between 1.5 m and 14 m.

A nest of Little Tern *Sterna albifrons* with an egg of Kentish Plover *Charadrius alexandrinus* in an industrial saltpan at Cádiz Bay (SW Spain)

Francisco Hortas, Departamento de Biología Animal Vegetal y Ecología, Facultad de Ciencias del Mar, Apartado 40, Puerto Real, Universidad de Cádiz, Spain.

A nest of Little Tern containing two eggs of this species and another egg of Kentish Plover was found in a mixed colony of Avocet *Recurvirostra avosetta*, Little Tern, Stilt *Himantopus himantopus* and, in a lower proportion, of Kentish Plover. This nest was located in the industrial saltpans of La Tapa in Cádiz Bay (SW Spain).

The nest was monitored until hatching and it was observed that the Little Tern always incubated the eggs. Several hypotheses are suggested to explain this result which is compared to observations made by other authors.

FEEDING ECOLOGY AND ENERGETICS

The impact of macroalgal blooms on the distribution and feeding behaviour of waders in the Mondego estuary, Western Portugal

J.A. Cabral, T. Múrias & R. Lopes, IMAR, Departamento de Zoologia de Coimbra, 3049 Coimbra Codex, Portugal.

Most European estuaries suffer organic pollution and are consequently affected by eutrophication. One of the symptoms of eutrophication, the proliferation of opportunistic intertidal green macroalgae, such as *Enteromorpha* spp. and *Ulva* spp., which can cover extensive areas of the estuarine intertidal zone, is a common response to nutrient enrichment. The increase in biomass and change in composition of primary producers resulting from eutrophication may have profound effects on underlying invertebrate assemblages through deoxygenation of the sediment.

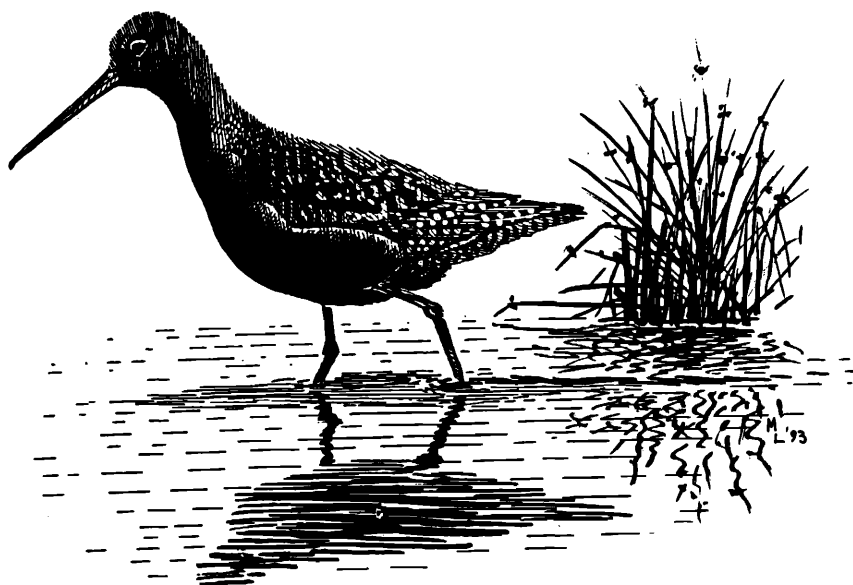
Uncommon blooms of the macroalgae *Enteromorpha* spp. have been observed in the Mondego estuary, probably due to excessive nutrient release. The aim of this study was to test if macroalgal mats influence the distribution and feeding behaviour of waders, assessing some possible effects to these birds if macroalgal mats become sufficiently dense and contiguous covering large areas of the estuary.

Wader predation on *Artemia salina* during winter in the saltmarshes of the Bay of Cádiz (SW Spain)

J.A. Masero, G.M. Arroyo & A. Perez-Hurtado, Dpto Biología Animal, Vegetal y Ecología, Facultad de Ciencias del Mar, Puerto Real (Cádiz), Spain.

The obtaining of energy through trophic resources in supratidal habitats can be of great importance for the survival of waders throughout the annual cycle; above all in circumstances in which the energetic demands increase and the intertidal mudflats do not satisfy the trophic needs of these birds, thus reducing their mortality.

In this paper, the intake rates of five species of waders, Dunlin *Calidris alpina*, Sanderling *C. alba*, Little Stint *C. minuta*, Redshank *Tringa totanus* and Grey Plover *Pluvialis squatarola*, depredate the crustacean *Artemia salina* during the winter in saltmarshes of the Bay of Cádiz (SW Spain), have been calculated.



The role that the salines can perform in increasing the capacity of the system through feeding resources that are supplementary or alternative to intertidal mudflats are discussed.

Foraging ecology of Redheads wintering at the Chandeleur Islands, Louisiana, USA

Thomas C. Michot, U.S. National Biological Service, Southern Science Center, 700 Cajundome Boulevard, Lafayette, Louisiana 70506, USA.

Redheads *Aythya americana*, like other species of diving ducks, congregate in large flocks on the wintering grounds with the largest concentrations found in estuarine open-water areas on the northern and western coasts of the Gulf of Mexico. A population of about 20,000 Redheads winters in Chandeleur Sound, Louisiana, USA.

We studied diet, body composition, time-activity budgets, and nutrition in that population over the winters (November through March) of 1987-88 and 1988-89. We collected 287 birds over the two-year period. For the 190 birds with esophageal food present, 83% of the diet was plant material (primarily roots and rhizomes of the seagrass *Halodule wrightii*). Animal matter (primarily marine gastropods) was higher ($P < 0.05$) in the diets of birds collected > 50 m from the shoreline, and in adult males and females from late winter. Body protein did not change ($P > 0.05$) over the winter, but body lipid content showed an increase ($P < 0.01$) from early to late winter for all sex/age groups.

Based on 1,261 flock scans, feeding activity was greatest in early in early winter and showed a decrease ($P < 0.05$) from early to late winter; resting activity increased ($P < 0.05$) over the same period. Birds fed more ($P < 0.05$) during low tides and close to shore. Head dipping and tipping accounted for 83% of the feeding behaviors; only 6% of the birds fed by diving. Nutritional composition and energy content of *Halodule* did not change ($P > 0.05$) over the winter, but above-ground and below-ground biomasses showed decreases ($P < 0.0001$). *Halodule* was neither the most nutritious, nor the most abundant, seagrass species on the study area. Food availability, tides, nutritional needs, and energetics likely play a role in the differences shown.



Feeding conditions for waders in salt pans

M.H. Moreira, A. Luís, N. Ferreira & A. Ravara, Biology Department, University of Aveiro, Portugal.

The "Ria de Aveiro" is a coastal lagoon that, since the very beginning of its evolution, has been used in a wide variety of ways by local people. One of the most important industries was salt exploitation. Most salt pans are located at the central part of the lagoon and, as the industry is declining, some of them are now being abandoned.

A high percentage of the waders wintering in the lagoon use this "salt pan area". The birds roost and feed during high tide in the salt pans still in use for salt exploitation and, during the low tide period, they feed in the abandoned salt pans. However, the birds do not use all the abandoned salt pans and our data suggest that this behaviour is related to substrate penetrability rather than to the benthic fauna.

Feeding ecology of wintering Ruff in the Senegal Delta

B. Trolliet, O.N.C. Chanteloup, 85340 Ile D'Olonne, France.

There are 170,000 - 200,000 wintering Ruffs *Philomachus pugnax* in the Senegal Delta. We studied their time and energy budgets in February 1990, and January 1991, 1992 and 1993.

The Ruffs spend the night on one or several roosts in the Djoudj National Park and in Ndiel, if water remains at midwinter in this last site. They do not perform any feeding activity on these roosts. In the morning and in the evening, they go to feed on harvested rice fields 3-25 km distant from the roosts. Between these two feeding periods, part of the birds come back to their roosts. The rest stay near the rice fields, resting on ponds or river banks. Mean time spent flying was 1 hr/day (feeding flights, on the rice fields, and on the roosts when disturbed by raptors). Daily foraging time was $2 \times 15 = 30$ min, which is extraordinarily brief for a wader. They fed only on waste paddy rice left after harvest. Daily energy intake of Reeves, estimated using mean dry weights of esophagi, proventriculi and gizzards contents and apparent metabolizable energy of rice, was 133.65 kJ.

Basal metabolic rate calculated using four allometric equations ranged from 0.68 to 0.78 W, and daily cost of flight, using five equations, from 32.9 to 35.7 kJ.

Mean daily energy expenditure of these Reeves ranged from 2.0 to 2.3 BMR. For

non-flight activities, their energy expenditure ranged from 1.5 to 1.8 BMR.

This energy budget is particularly sparing, owing to :

- extremely high proportion of time spent resting (nearly 95 %) allowed by superabundant food;
- ambient temperatures in the thermo-neutral zone; and
- low energetic cost of rice digestion and assimilation.

Winter ecology of Redheads: an overview of research

M.C. Woodin, National Biological Service, Texas Gulf Coast Field Station, Corpus Christi, Texas 78412, USA.

Since the late 1980s, many aspects of the winter ecology of Redheads *Aythya americana* in the western Gulf of Mexico have been investigated. Long-term trends for Redhead abundance and distribution were assessed using results from winter aerial surveys conducted annually by the U. S. Fish and Wildlife Service. Aerial survey data since 1980 indicate that Redheads continue to concentrate in exceptionally large numbers along the western Gulf of Mexico, especially in the Laguna Madre of Texas (USA) and the nearby Laguna Madre of Tamaulipas (Mexico).

The hundreds of thousands of Redheads which annually winter along the western gulf closely approximate the historical proportion of 80% of the continental Redhead population (cited since the 1950's) as wintering in the western Gulf of Mexico. Data on Redhead behaviors were collected by scanning flocks of birds for 2 min at 15 min intervals, assigning their activities to categories of behavior (*e.g.*, feeding, sleeping, drinking, *etc.*), and recording each observation on audio tape.

Results showed that almost all feeding by Redheads occurred in the Laguna Madre and other saltwater habitats, while almost all drinking occurred in freshwater ponds. Dependence by Redheads on ponds as sources of drinking water was especially pronounced during drought, when the Laguna Madre became hypersaline. Redheads were collected for studies of diet composition, trace element concentrations, and others (such as molt status and nutrient reserves). Birds were dissected, and foods in the esophagus and proventriculus were removed, sorted, dried, and weighed on an aggregate percent wet-weight basis.

Results showed that Redheads in winter sustained themselves on a diet which was

nearly monotypic; about 80% of Redhead foods in winter was *Halodule wrightii* rhizomes. Livers from 39 Redheads were analysed for trace element concentrations. While results indicated some elements bioaccumulate over winter (e.g., silver, selenium, copper), concentrations did not reach levels of concern, except possibly for lead.

CONSERVATION AND MANAGEMENT

The value of refuge areas in Rail population management

D.J. de Carvalho Rodrigues, Departamento de Engenharia Florestal - Instituto Superior de Agronomia, Tapada da Ajuda, 1399 Lisboa, Portugal; P.J. de Quadros Tenreiro & A.M. Dorotéa Fabião, Coordenação de Coimbra - Instituto da Conservação da Natureza, Rua Padre António Vieira nº 1, 1º, 3000 Coimbra, Portugal.

The population dynamics of Moorhen *Gallinula chloropus* was estimated in Paúl da Madriz (a marsh that is a hunting refuge) using capture-recapture methods. Data from 25 months were treated using the Jolly-Seber model and its versions. The results show important variations of population parameters over the year. The population moved between the marsh and the rice fields as a result of rice calendar, shelter and food conditions of the rice fields, and internal conditions of the marsh.

The Paúl da Madriz works as a breeding area and, especially, as a seasonal refuge for the Moorhen population of the contiguous valley (mainly rice fields), being a key factor in the management of local Moorhen populations, allowing a population size that supports shooting mortality.

The marsh must have an identical value for the local Coot *Fulica atra* and Water Rail *Rallus aquaticus* populations of the Pranto River Valley; however, with the few present captures it is not possible to estimate the population dynamics of these species.

The management of rail populations in a rice field area or a temporary wetland area should include the creation and management of a permanent wetland in the neighbourhood.

Effects of shellfish-gathering activity on habitat availability for wintering waders in the rias of Galicia (NW Spain)

Jesus Dominguez, Francisco Arcos & Enrique Rego, Dept. Biol. Animal, Univ.

Santiago, 15706 Santiago de Compostela, Spain.

Shellfish gathering - whether on foot at low tide, or from small boats in the infralittoral zone - is a traditional activity in the rias (estuarine bays) of Galicia in northwest Spain. According to a 1990 census, there are over 18,700 registered shellfish gatherers in this region, about 5,600 of whom work in the Ria de Arousa. Shellfish are collected mainly in autumn and winter (October to March), which is precisely the most important period for overwintering waders. Shellfish gathering activity is concentrated in sandy and sandy/muddy intertidal areas with high densities of the Cockle *Cerastoderma edule* and clams of the genus *Venerupis*.

It thus seems likely that there is competition for space, and possibly food, between people and waders (particularly the Oystercatcher *Haematopus ostralegus* and the Curlew *Numenius arquata*, which show a particular preference for such areas).

Here, we report the preliminary results of research carried out in the winters of 1993/94 and 1994/95 with the aim of evaluating the impact of shellfish gathering in the intertidal zone on the spatial distribution and behaviour of waders. Specifically, we recorded the time spent by shellfish gatherers in specific parts of the study area, monitored the spatial distribution of waders on days with and without shellfish gathering activity, and experimentally determined flight distances for the Oystercatcher and the Curlew.

Our results indicate that human activity effectively displaces waders from large areas of the intertidal zone for much of the total winter low-tide daylight period. Fieldwork currently underway is aimed at evaluating whether this has led to an increase in the proportion of feeding activity taking place at night, and/or effects on feeding behaviour variables such as prey ingestion rate and energy balance.

Conservation status of waders in rice irrigation schemes of northern Tanzania

Josiah M. Katondo, Jasper N. Ijumba, David E. Mmari & Suleman Mgallah, Bird Pests Research & Control Section, Tropical Pesticides Research Institute, P.O. Box 3024, Arusha, Tanzania.

Observations made in two rice irrigation schemes at Lower Moshi (July 1991-1995) and in the Lake Manyara area i.e. Mto wa Mbu and Magugu (February and July 1994) in northern Tanzania showed that these man-made wetlands support life of many waterbird species, including 12 species of Charadriiformes. Observations in these agrosystem wetlands, located over 250 km

apart, indicated that rice fields when flooded become an ideal feeding and roosting habitats for these waders. Waders (except Crowned Plovers *Vanellus coronatus*) showed great preference for newly ploughed and inundated plots as well as newly replanted plots in which rice had not reached booting stage. In both cases they co-foraged with other waterbirds such as egrets, ibises, spoonbills, hamerkops, storks, ducks, geese and jacanas.

At Lower Moshi, rice is grown in about 1,200 ha throughout a year using modern irrigation methods thus making habitats suitable for waterbirds all the time. Records for Lower Moshi show that thousands of palearctic waders such as Little Stints *Calidris minuta* and sandpipers winter in the area every year from September through April. In Manyara area, rice is grown under traditional irrigation systems during the rainy season. When there are no flooded fields waders and other waterbirds rely on nearby riverine systems and the shoreline of Lake Manyara. Observations showed that although the Lake Manyara area supports 19 species of waders, 10 utilized rice fields. Two species, Painted Snipe *Rostratula benghelenis* and Water Dikkop *Burhinus vermiculatus*, were confined to rice fields and could not be spotted elsewhere among several habitats around Lake Manyara area. During July/August 1994, rice fields (about 50 and 500 ha in Mto wa Mbu and Magugu areas respectively), were dry; consequently, most of the resident waders were absent.

In conclusion, presence of flooded rice plots enhances survival of waders by providing suitable feeding and roosting environment. Lack of potential disturbance from farmers enables the waders to utilize the flooded fields which seem to have high productivity of food resources for waterbirds. In this way, rice cultivation plays an important positive role in conservation of waders and other waterbird species.

The salt pans of the Sado estuary: an endangered area crucial for migratory bird species

C. Pimentel & M.H. Costa, Departamento de Ciências e Engenharia do Ambiente - FCT/Universidade Nova de Lisboa, Quinta da Torre, 2825 Monte de Caparica, Portugal.

The Natural Reserve of the Sado Estuary, located on the west coast of Portugal, is considered one of the most important wetlands in Europe. It is a resting, feeding and breeding area for migratory bird species, many of them protected by international conventions. Its solar salt pans are an artificial habitat, built and kept by man for hundreds of years. Due to their special features (constant water level, small depth and considerable amount of nutrients) they

became extremely important to the reproduction of several bird species, such as Kentish Plover *Charadrius alexandrinus*, Black-winged Stilt *Himantopus himantopus* and Little Tern *Sterna albifrons*.

Nowadays this habitat is at risk due to the progressive abandonment of the salt-winning activity, with the salt-pans embankment, their replacement by paddy fields, pisciculture, or simply marsh invasion. Nevertheless, information concerning the salt marsh and particularly the salt-pan ecosystem is very scarce, and data about local contamination do not exist. Information about the contamination of the birds' diet is equally scarce.

The Natural Reserve of the Sado Estuary at present has a salt pan area of 2,000 ha. Seven salt pan groups with distinct environmental features can be compared. The salt-pans, as an extreme environment, have a simple trophic web. In the Sado salt-pans, this trophic web is formed basically by halotolerant and halophytic microalgae, insect larvae, and *Artemia salina* and *Palaemonetes varians* in the water column.

This paper presents a characterization of the ecological conditions and heavy metal contamination of the several ecosystem compartments studied. Feathers and eggs of the three bird species mentioned above were analysed; special attention was given to *H. himantopus*.

The response of aquatic birds to the management of reservoirs in the south-west of Spain

J.M. Sánchez, A. Muñoz del Viejo & P. Bartolomé, University of Extremadura, Av. Elvas, 06071 Badajoz, Spain.

The gradual disappearance of natural wetlands and the creation of artificial reservoirs for human needs in the Iberian Peninsula have caused numerous aquatic bird populations to select these reservoirs for their wintering, breeding and migration. Because these anthropogenic water systems have a high degree of instability (water level fluctuations, recreational activities, etc.), considerable populations stress and breeding failure have occurred.

In an attempt to alleviate some of the harming factors which come about as a result of human use of these large artificial areas of water (reservoirs), a number of small secondary dykes and islands were built in two of the reservoirs where the largest populations of aquatic birds are found in Extremadura (south-west Spain); the Orellana reservoir (Ramsar site since 1992) and the Los Canchales reservoir, both of them belonging to the middle basin of the

Guadiana River.

The response of aquatic birds to this management of the reservoirs has been varied; for example, as a consequence of the drought in recent years, the islands constructed in the Orellana reservoir have never been operational. The small dykes however have brought about a spatial redistribution of one of the most important wintering groups in the reservoir, the Anatidae; these birds have chosen these areas and others close to them, possibly because they are quieter and have a greater food availability of subaquatic vegetation produced by a more stable water level.

The islands built in the Los Canchales reservoir were operational in the spring-summer of 1994 and absorbed all the breeding colonies of birds. Furthermore, the presence was detected of species which until then had not nested in the reservoirs: Black-headed Gull *Larus ridibundus* and Gull-billed Tern *Gelochelidon nilotica*. For the first time since breeding colonies of aquatic birds had settled on this reservoir, a total breeding failure did not occur.

SPECIAL TOPIC

Eco-ethological notes on a wintering flock of Slender-billed Curlews *Numenius tenuirostris*

M. Zenatello, N. Baccetti & L. Serra, INFS, Via Ca Fornacetta 9, I-40064 Ozzano Emilia BO, Italy.

A wintering flock of up to 18 or 19 Slender-billed Curlews was first observed during a general winter waterbird count on 21-22 January 1995 in the Gulf of Manfredonia, Apulia (S. Italy). The birds could be found again on 5 February, after the closure of the hunting season (31 January), and their presence was monitored during four additional visits to the area, until only two of them remained (27-28 March). On some occasions the flock could be observed during the whole day, allowing us to make some preliminary remarks on behaviour and ecology in a situation different from the only one already known to some extent, i.e. that of the Lagoon of Merja Zerga, Morocco.

Feeding

The only foraging site which the birds regularly exploited was the central part of a saltmarsh surrounded by scrubs and tamarisk stands (total 250 ha), partly flooded by rainfall. Food items were collected probing in low *Salicornia* patches and shallow water, or pecking on dry soil, often inside *Suaeda* scrubs with a peculiar up-ending posture (most probable prey: landsnail

Cernuella virgata). The birds did not avoid crossing quite dense scrub patches, in which they were almost invisible from outside. Movements between feeding spots consisted often in rapid and uninterrupted walks up to 600-700 m. Exploitation of arable lands for feeding could not be confirmed. Feeding was observed at every time of the day, although during the mid-day hours scattered birds were often inactive.

Roosting behaviour

In January the birds left the feeding area before sunset, heading towards a large roost of Common Curlews *Numenius arquata* located 17 km away; on most other occasions they were seen roosting in loose groups, on the shore of flooded depressions inside the feeding area, without any associated species or with Lapwings *Vanellus vanellus*. Comfort activities, including bathing, occurred at the roosts, both at dawn and sunset.

Intra- and inter-specific behaviour

Apparently no territorial behaviour, foraging birds usually distributed irregularly, keeping visual contact with each other; a single instance of antagonistic behaviour, including 'high-wings' posture and fighting, was observed in March. During the whole period, foraging birds were often seen together with Common Curlew and Lapwing, or Ruff *Philomachus pugnax*, Black-tailed Godwit *Limosa limosa* and *Tringa* species. Slender-billed Curlews were not flushed by the passage of hunting raptors (Peregrine Falcon *Falco peregrinus*, Marsh and Hen Harriers *Circus aeruginosus* and *C. cyaneus*), while associated species regularly took off at Harriers' approach.

Tolerance to man

The birds were not particularly tame as often reported and kept an escape distance of at least 400 m from un-hidden observers. Foraging Slender-billed Curlews seemed, however, more reluctant to take off than Common Curlews and other wintering waders, in case of slight disturbance even walking away through the vegetation rather than flying.

Voice

The species is quite vocal, though possibly not as much as Common Curlew. Simple calls are invariably uttered at take-off or when flying birds pass over resting ones, only occasionally at pre-roosts. More complex calls are quite rare (e.g. during antagonistic behaviour). Two voice types could be recorded.

10TH INTERNATIONAL
WATERFOWL ECOLOGY
SYMPOSIUM:
ABSTRACTS OF TALKS

HABITAT LOSS AND HABITAT
CHANGE

**Restoration of wetland habitat in a Dutch
dune reserve**

*Gert Baeyens & Leo van Breukelen,
Amsterdam Water Supply, Department &
Planning, Vogelenzangseweg 21, 2114 BA
Vogelenzang, The Netherlands.*

Large parts of the Dutch coastal dunes have been desiccated by the extraction of ground water for the production of drinking water. Since the 1950s watertables have risen again due to the infiltration of river water in the dune ecosystem. The infiltration ponds attracted increasing numbers of ducks and other waterfowl. Since the 1980s, numbers dropped severely due to the sudden increase of a Fox *Vulpes vulpes* population. Not only the breeding adults but also their nest contents were predated.

Although Foxes are not shot, some duck species seem to restore and ducklings are seen again in relatively high numbers. The research examines which parameters in and around the aquatic ecosystem favour foraging and nesting success. Important features are bank vegetation, submersed vegetation, macrofauna, disturbance by humans, accessibility for Foxes and hydrological management.

**A reconstruction of habitat change from
an irrigation scheme in the Göksu Delta,
Turkey**

*Vincent van den Berk, National Reference
for Nature (IKC), Ministry of Agriculture,
Nature Management and Fisheries,
Wageningen, The Netherlands; Wladimir
Bleuten & Martin Wassen, University of
Utrecht, Utrecht, The Netherlands; & Nafiz
Güder, Society for the Protection of Nature
(DHKD), Istanbul, Turkey.*

Virtually all wetland ecosystems in the Mediterranean are characterized by repeated modifications during millenia of human culture. This is particularly so for wetland ecosystems in coastal plains. The Göksu Delta (c. 15,000 ha) on the Turkish south coast is such an example.

The land above 2 m asl, more than 40% of the area, is irrigated and intensively farmed. Below 2 m asl, is a belt of farmland where wheat is grown in rotation with rice, grading into grazed saltmarshes, wetlands, dunes and beaches. The Göksu Delta has the highest number of bird species recorded of any site in Turkey. The list includes about 15 globally threatened bird species and almost 30 nationally threatened and nationally rare bird species. The area is an acknowledged international important wetland, where Ramsar Convention criteria are amply met. The entire delta was declared a Protected Special Area in 1990 and a Ramsar site in 1994.

A reconstruction of the most recent development boost is presented. It covers the past 70 years of development following the start of the Turkish Republic and the sedentarization of the nomadic population. The highly dynamic and complex eco-hydrological system was rapidly dismantled. Instead, water management became dominated by agricultural demands. These developments changed aquatic habits considerably and continue to do so. Large inputs of fresh riverwater caused desalinization; lagoons were connected to the drainage system causing fixed waterlevels; temporary marshes changed into perennial lakes. Following the gradual eutrophication and siltation, vegetation invaded the lakes.

The changes are reflected in the functions and facilities of the area for waterbirds as could be deduced from a series of winter counts (1967-1995) and breeding bird data since the 1950s and 1989-1992 in particular. Today's importance for birds is closely linked with the agricultural developments. The Ramsar Convention criteria do not match with the situation of a seriously affected natural ecosystem.

This kind of wetland conversion might be typical for many wetlands in the Mediterranean. The Göksu Delta case illustrates that man-induced changes are not necessarily negative. Evaluations help in designing mitigatory measures when wetland manipulations occur.

**Loss and change of habitat and possible
effects on Mallard populations of the
Mondego and Vouga river basins**

*David José de Carvalho Rodrigues,
Departamento de Engenharia Florestal,
Instituto Superior de Agronomia, Tapada da
Ajuda, 1399 Lisboa, Portugal.*

I summarize present knowledge of Mallard *Anas platyrhynchos* ecology in the Mondego and Vouga Rivers basins related to possible loss and change of habitat.

Recent results of capture and recapture/recovery/resighting (nasal markers) efforts show that there is only one local population with two subpopulations, each of them related to a river basin. The local Mallard is sedentary but there are frequent movements between subpopulations. A few migratory Mallard may arrive in winter. The spatial utilisation of habitat changes through the year. Feeding grounds are mostly rice fields and roosting areas are man-made, either specifically for waterfowl (S. Jacinto, Lagoa das Braças) or, indirectly, through the abandonment of rice fields that have become marshes (Paúl de Arzila, Paúl do Taipal, Paúl da Madriz). During breeding and moulting, abandoned extensive fish-rearing places are heavily used by Mallards.

Current Mallard habitat loss and change is mainly the result of modern agriculture and intensive fish-rearing. An example of roost loss and another of changes in rice fields due to modern agriculture will be discussed.

**Estuarine waterfowl impact assessments:
possibilities and pitfalls**

*Nigel Clark, British Trust for Ornithology, The
Nunnery, Thetford, Norfolk, IP24 2PU, UK.*

There are currently no generally accepted methodologies for undertaking impact assessments in the estuarine environment in Britain. Three types of assessment were identified. First, predictions from the habitat requirements of a species and the changes to its habitat. Second, comparison of the future available habitat with the bird populations on similar habitats elsewhere. Third, assessment of the populations that currently use an area assuming that those birds will be lost from the population. Each of these methods has both advantages and disadvantages which can be summarised as follows:

Predictive

- + should ultimately produce the best estimates
- + ultimately should make predictions easier
- difficult and expensive to undertake
- difficult to convince a non-scientific audience
- opportunity for positive or negative assessments depending on standpoint

Analogous

- + comparatively simple to undertake
- + possible to undertake with present knowledge
- often difficult to convince a non-scientific audience
- requires several years of data
- difficult to find analogous sites

Empirical

- + easy to undertake
- + easy to convince a non-scientific audience
- need several years of data
- opportunity for positive or negative assessments, depending on standpoint

Examples for the work of the BTO on a range of estuarine development are used to show the relative merits of the different methods of assessment. It was concluded that:

1. there are few case studies where predictions have been tested;
2. almost every case is different making comparison with other studies difficult;
3. there is a need for post-development appraisal to be part of the planning process in order to learn from past studies; and
4. scientists need to seek research grants to look in depth at the effects of estuarine developments.

The effect of loss of (natural) habitat on the distribution and survival of Brent Geese

Barwolt S. Ebbinge & Barbara Ganter, DLO-Institute for Forestry and Nature Research, P.O. Box 23, 6700 AA Wageningen, The Netherlands; & Peter Prokosch, WWF Arctic Programme, P.O. Box 6784, St. Olavs plass, 0130 Oslo, Norway.

In order to assess the effect of habitat loss on a population scale it is not sufficient to monitor the decline in numbers on the lost site, but the future fate of the individuals that lost their particular site has to be followed as well. This was done by monitoring individually marked Brent Geese *Branta bernicla* that were caught on the Rodenäs-Vorland (Schleswig-Holstein, Germany), just before this spring staging site was embanked in 1982, and comparing these individuals with a control group marked in the same spring on saltmarshes in Schleswig-Holstein that were not embanked. A European network of hundreds of volunteer observers made this analysis possible.

From other studies it can be concluded that there is a great variability in the quality of spring staging areas, and that preferred areas have reached their spring staging capacity. After an overall population decline such preferred areas remain filled, whereas less preferred areas show a decline in numbers. After embankment, the use of the Rodenäs-Vorland by Brent Geese declined dramatically (peak spring counts of 18,000 Brent before, 4,000 after the land claim). Birds dispersed mainly to nearby islands in Schleswig-Holstein, but some also made

long-distance movements, e.g. to the Dutch island of Texel, where carrying capacity had not yet been reached.

To assess whether habitat loss had any effect on subsequent survival, observations of the two groups on the wintering grounds in Great Britain and France were compared.

Migration theory and habitat change

Bruno J. Ens, IBN-DLO, P.O. Box 167, 1790 Ad Den Burg, The Netherlands; Thomas P. Weber, BBSRC/NERC Ecology and Behaviour Group, Dept. of Zoology, Univ. of Oxford, South Parks Road, Oxford OX1 3PS, UK; & Alasdair I. Houston, School of Biological Sciences, Univ. of Bristol, Woodland Road, Bristol BS8 1UG, UK.

The idea that competition for food within and between birds species is the driving force behind the evolution of the migrations of these species has a long history. Initially, such theories even dealt with the organisation of entire bird communities, but later the theories became more modest dealing with differential migration within a species for instance. The empirical success of these theories must be considered low, either because the theories did not inspire empirical work, or because it proved hard to link the empirical work to the theories. Recently, attention has shifted to the migratory decisions of the individual birds in the attempt to find answers to interrelated questions such as:

1. Which stopover sites should be used by the birds?
2. When should these stopover sites be used by the birds?
3. How long should the birds stay at a given stopover site?
4. With what mass should the birds depart?

These theories have inspired some good empirical work, as well as some further theoretical developments. These developments include replacing speed of migration and other short-term maximization criteria with fitness as a long-term maximization criterion. As a result, the models can be used to investigate the effect of habitat change at one or more stopover sites on the probability of survival during migration and the prospects of reproduction upon arrival. Predictions are different for cases where change was sufficiently slow so that the birds had time to adapt, compared to cases where habitat change was so quick that the birds could not adapt and employ what are now maladaptive decision rules. A full-blown prediction of the population consequences of habitat change requires a complete population model and a explicit incorporation of the competition process.

It will be argued that at our current level of understanding the most profitable research strategy is to concentrate our efforts on the costs and benefits of the many decisions that face a bird during migration. The insights thus obtained may suggest new directions for tackling the role of competition in the evolution of bird migration.

The use of WeBS Low Tide Counts data in predicting the effects of habitat loss

Julianne Evans, British Trust for Ornithology, The Nunnery, Thetford, Norfolk IP24 2PU, UK.

The main source of numerical information on waders and wildfowl in the UK is the Wetland Bird Survey (WeBS). The accurate population statistics provided by this volunteer-based counting scheme have been used for many years in site protection work. However, because the majority of counts take place at high tide, the limitations of the data for assessing the potential impact of proposed developments have become increasingly clear. High tide roosts form at variable, and often considerable, distances from feeding areas and, more importantly, the availability of suitable feeding opportunities is the major factor limiting the abundance of most bird species on estuaries. There was therefore a need for a scheme to run alongside the core WeBS counts, which provided information on where the birds being counted at high tide were feeding.

In 1992, the WeBS Low Tide Counts scheme was begun, to provide a standardized and reliable ongoing assessment of the relative importance of different parts of individual estuaries as feeding areas for waterfowl. The initiation of this new national scheme is a major advance for estuary conservation in the UK.

In the three years since the scheme began, data have been collected on 30 estuaries throughout the UK. Between-species comparisons on individual estuaries reveal considerable differences in their patterns of distribution at low tide. However, for each species, the patterns of distribution are very similar across all estuaries. Using these characteristic distribution patterns, it is possible to assess the degree of vulnerability of a species to habitat loss under a range of circumstances, for example localized development, land reclamation and sea level rise. Each of these will remove different parts of the intertidal area and their effect on each species will differ accordingly. A thorough understanding of these effects is essential for the future safeguard of estuaries in the UK.

A method of quantifying the effects of human disturbance for animal populations

Jennifer A. Gill, School of Biological Sciences, University of East Anglia, Norwich, NR4 7TJ, UK.

The impact of human disturbance on animal populations is currently an important conservation issue. Many studies have indicated that disturbance can alter the distribution of populations, either by recording the change in distribution that results from disturbance, or by comparing numbers of animals in sites that differ in disturbance. However, policy-makers demand that any potential impact of disturbance from development be quantified in terms of the number of animals affected and the severity of the impact.

In studies of the distribution of foraging animals, the response to human disturbance can be viewed as a trade-off with use of the available resources. When this trade-off results in fewer animals inhabiting a site than would be expected from the available food supplies, the impact of disturbance can be quantified as the amount of unused resources. The amount of unused resources can then be translated into the number of animals that these resources could have supported in the absence of disturbance. If the degree of response to a range of disturbance levels is known, this methodology also allows predictions of the effect of altering disturbance levels on the distribution of a population.

This technique has been carried out in a study of Pink-footed Geese *Anser brachyrhynchus* wintering in Norfolk, England. This population feeds on harvested sugar beet remains during the winter. The extent to which sugar beet fields are depleted declines linearly with decreasing distance to the nearest road. The slope of this relationship describes the susceptibility of the geese to this form of disturbance. The consequences of changes in disturbance levels for the size and distribution of the population can be explored by altering the value of this slope. For this study, such an approach indicates that slight changes in the current levels of disturbance could have a substantial effect on the size of the population of Pink-footed Geese feeding on these fields.

The concept of carrying capacity

John D. Goss-Custard, ITE, Furzebrook Research Station, Wareham, Dorset BH20 5AS, UK.

This paper discusses the value of the term "carrying capacity" as it has been applied to

shorebirds wintering on estuaries. To do this, it uses an individuals-based and physiologically-structured model of Oystercatchers *Haematopus ostralegus* feeding on shellfish. Carrying capacity has been defined as the point at which, for every additional bird that arrives, another one either dies or emigrates; from then on, numbers cannot increase and the habitat is fully occupied. The model shows that this point can, in fact, be reached. It also shows that, in the particular system modelled, carrying capacity is reached late in the winter and on neap tides. However, whether or not capacity is ever reached in the real world depends on there being a sufficiently large number of birds attempting to establish themselves on the estuary; capacity cannot be reached if there are not enough potential recruits available to do so.

The interesting question now is identifying the circumstances in which there are enough potential recruits for capacity to be reached. The paper discusses further simulations that help to identify these circumstances.

Numbers of breeding herons and Spoonbills in relation to ecological changes in the reedbelt of Neusiedler See, Austria

Alfred Grüll, Biol. Station Neusiedler See, 7142 Illmitz, Austria; & Mag. Andreas Ranner, Birdlife Österreich, Burgring 7, 1014 Wien, Austria.

The reedbelt of Neusiedler See today is one of the most important breeding sites for the Great White Egret *Casmerodius albus*, with up to 500 pairs. This is about half of the European population (without Russia and Ukraine). The numbers of Purple Heron *Ardea purpurea* and Spoonbill *Platalea leucorodia* also attain (or have attained) at least 1% of the European population.

Complete aerial counts of all colonies were carried out 1960, 1970-74 and again since 1981. During that time only the Great White Egret increased, while Purple Heron and Grey Heron *Ardea cinerea* suffered significant declines. The former breeding population of Spoonbill (with more than 250 pairs before 1975) is now almost completely lost. These dramatic changes in the populations of these large reed-dwelling wading birds are discussed with regard to the following ecological factors: water level, reed harvesting and burning, deposition of organic matter in the reedbelt, changes in feeding and wintering habits and disturbance by tourism.

Of the most important environmental changes, eutrophication and stabilisation of water level in the lake as well as the continuous lowering of the ground water level

in surrounding wetlands could be crucial. On the basis of this analysis the threats to these species are estimated and predictions are made concerning future population trends at Neusiedler See.

Habitat loss in the Wadden Sea - consequences for waders and waterfowl of the land claim in the Nordstrander Bucht, Germany

Hermann Hötker, FTZ, Universität Kiel, Hafentörn, 25761 Büsum, Germany.

In the Nordstrand Bay on the German Wadden Sea coast, an area of 3300 ha of mudflats and saltmarshes was claimed in 1987. Counts in 1979 revealed that the area had held internationally important numbers of 14 waterfowl and wader species before the land claim took place. Predictions on the possible effects of the land claim were made on the basis of experiences from formerly claimed parts of the Wadden Sea.

Most of the predictions made before the land claim became reality. Brent Geese *Branta bernicla bernicla* and most of the coastal wader species decreased in numbers immediately after the new dike has been built. Waders could hardly use the claimed area for feeding, although a large artificial saltwater lagoon incorporating a tidal regime was constructed. The new dike reduced the overall feeding time of waders in the remaining unclaimed Nordstrand Bay.

The difficulties in predicting and assessing the effects of land claims on wader and waterfowl populations in the Wadden Sea will be discussed.

Effect of disturbance on distribution and turn-over of spring-staging Pink-footed Geese *Anser brachyrhynchus*

Jesper Madsen, National Environmental Research Institute, Kalø, 8410 Rønne, Denmark.

The 'habitat matching rule' of the Ideal Free Distribution theory (IFD) predicts that foraging animals, if unconstrained by risk of being predated, will distribute themselves between patches according to the amount of food. In most situations, however, foraging animals live under threat of predation, which will cause a deviation from habitat matching. I studied the site utilisation of spring-staging Pink-footed Geese in Vesterålen, northern Norway during two seasons without, and two seasons with, organized scaring by farmers, comparable to potential predators.

In the two years without scaring, there was a

linear relationship between the size of areas used by geese and the average number of geese in the sites, which was in accordance with the expectations from the 'habitat matching rule'. In the two years with scaring, the relationship broke down, the geese 'under-using' sites where scaring took place compared to sites without scaring. However, overall numbers of geese in the area declined in the two years with scaring, which can be explained by higher turn-over rates of individuals in disturbed sites, demonstrated by length of stay of neck-banded birds in undisturbed and disturbed sites, respectively. The case shows that IFD can be a useful tool to predict the relative effects of disturbance which are equivalent to functional net habitat loss.

Did the loss of 5,600 ha of intertidal area in the Oosterschelde (The Netherlands) affect waterbird populations? The results and the lessons

Patrick Meire, Institute of Nature Conservation, Kiewitdreef 5, 3500 Hasselt, Belgium; & Peter Meininger, Ministerie van Verkeer en Waterstaat, Rijksinstituut voor Kust en Zee, 4330 EA Middelburg, The Netherlands.

The Oosterschelde is a major estuary in the Delta area of the SW-Netherlands. It is a wintering area for nearly 300,000 waterbirds, the majority being coastal wader species. Due to large coastal engineering works, the intertidal area was reduced from 17,000 to 11,365 ha in 1987. An ambitious research project was undertaken to study the effects of these works on the Oosterschelde ecosystem. In this paper we give a summary of the main results of this project but focus on the effects of the engineering works on waterbird populations and their main prey populations, the macrozoobenthos. These were studied during several years before, during and after the works.

In the entire Oosterschelde/Krammer-Volkerak area, numbers of wintering waders decreased and the seasonal pattern shifted from a midwinter maximum to a peak in autumn. Changes varied considerably between species and were correlated with their distribution within the estuary. Populations of intertidal foragers apparently were (and consequently still are) close to carrying capacity, and further changes in capacity, as foreseen from geomorphological changes still under way in the estuary, are likely to be reflected in bird populations. At least for several species carrying capacity could be limited by the stocks of food.

As well as the presentations of the results we discuss the research approach adopted and lessons for the future.

Predicted impacts in Deep Bay, Hong Kong of river 'regulation' projects

David S. Melville, Steve McChesney, Carmen Anderson & Paul J. Leader, WWF Hong Kong, GPO Box 12721, Hong Kong.

Deep Bay lies in the northwest corner of Hong Kong on the border with the People's Republic of China. It covers 115 km² and nowhere is deeper than 6 m. With an average depth of 2.9 m and tidal range of 2.8 m extensive tidal flats are exposed at low tide. The upper margins are covered by mangrove, the sixth largest area in China, and backed by tidal shrimp ponds and fish ponds. The Shenzhen and Shan Pui Rivers flow into the head of the bay. Due to extensive urbanisation of the lower parts of the catchment of these rivers flooding during the summer wet season (c. 1.9 m of rain p.a.) the Hong Kong and Chinese Governments are undertaking river 'training' projects to reduce flooding and, in the case of the Shenzhen River to improve navigation.

A cross-border EIA study was conducted on the Shenzhen River project which collected much baseline data on ecology of the bay. The bay supports over 65,000 waterfowl in mid-winter and up to 15,000 shorebirds in spring. Internationally important (>1%) numbers of four species of waterfowl occur in the area, including c. 24% of the world population of Black-faced Spoonbill *Platalea minor*, and c. 10% of the world population of Spotted Greenshank *Tringa guttifer*.

Computer modelling of hydrology and sediment movements resulting from the Shenzhen River regulation indicate an increase in sedimentation during dredging, but a subsequent decrease following completion of the works but a depositional environment will remain. Changes in sedimentation may affect benthos as well as increase the rate of mangrove encroachment, thus reducing feeding areas for waterfowl. Loss of mangroves along the River (c. 10 ha) is not expected to affect productivity in the bay as stable isotope studies indicate that most organic input is allochthonous, probably coming from livestock farms and human sewage. The bay is heavily polluted by organic wastes and this is reflected in the species-poor benthic community with very high densities of annelids including capitellids and oligochaetes.

Information from enclosure experiments and a simple energetics model indicate that Deep Bay may be approaching carrying capacity for waterfowl. Impacts of the river regulation projects could adversely affect waterfowl.

Potential effects of loss of salt pans on migratory and wintering waders in the Mondego estuary (Portugal)

T. Múrias, J.A. Cabral & R. Lopes, Instituto do Mar (IMAR) - Coimbra, Departamento de Zoologia, Universidade de Coimbra, 3049 Coimbra Codex, Portugal.

Salt pans represent one of the most important feeding habitats for waders in the Mondego estuary (Western Portugal), during both low and high tides, particularly in the energetically expensive migratory periods (March-May and July-October). In the past ten years, an increasing number of the estuary's salt pans have been abandoned or converted into fishfarms. Active and inactive salt pan and fishfarm usage by waders are briefly described and compared. Attempts were made to evaluate the possible consequences of salt pan loss on the migratory and wintering populations of estuarine waders, and suggestions for possible measures of minimization of such impacts are presented.

The effect of changes in agriculture on breeding and staging Greylag Geese *Anser anser* in south Sweden

Leif Nilsson, University of Lund, Ecology Building, 22 362 Lund, Sweden.

A neck-banded breeding population of Greylag Goose in a lake area in southernmost Sweden has been intensively studied since 1985 to monitor individual breeding performance, habitat choice, feeding ecology, movement patterns *etc.* throughout the stay in Sweden. The geese breed in five lakes in an agricultural district. Since the start of the study, major changes in agriculture have occurred close to the lakes, changing large areas from cereals to extensive grazing for cattle while other areas were just set-aside. Breeding performance of the geese from different lakes differed markedly and could partly be related to differences in landuse. Moreover marked changes in local movement patterns could be established during the study period, the geese leaving the area for coastal staging areas to a much higher degree than during the early part of the study.

The lake area is also used as a late summer and autumn staging area for Greylag Geese from the local population and from elsewhere. During 1985-87, Greylag Geese all fed on cereal fields close to the roosts on the lakes. After the changes in agriculture the geese used new feeding areas much further away from the roosts and some of the geese moved early to coastal staging areas. The geese also started to use new field types. Moreover changes in autumn migration pattern were established. Effects on the goose population will be discussed.

Predicting the effects of habitat change on shorebird populations: an empirical study of the interaction between Oystercatchers *Haematopus ostralegus* and a cockle *Cerastoderma edule* fishery

Ken Norris, Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire, SG19 2DL, UK.

The Burry Inlet in South Wales is an estuary which supports internationally important numbers of Oystercatchers and an important commercial cockle fishery. The aim of the present study was to determine (1) whether the exploitation of cockles by the fishery affected the number of Oystercatchers using the estuary, and (2) to provide a simple means of predicting the effect of changes in fishing intensity on bird numbers.

The number of Oystercatchers counted on the estuary shows a pronounced seasonal trend, with peak numbers occurring during winter (September to February) and declining dramatically by spring (March and April). The proportion of the winter population counted in spring varies from <5% to >60%, between years.

Landing statistics and estimates of the biomass of cockles available to the fishery suggest that the fishery removes between 10% and 35% of the biomass of cockles each year. The proportion of the biomass removed by the fishery is highest when the total biomass of cockles available to the fishery is lowest.

The size of the winter population of Oystercatchers is not strongly related to the biomass of cockles. The data suggest that competition for food is likely to be most intense when the biomass of cockles is lowest. The decline in the number of birds counted between winter and spring is highest when the biomass of cockles is lowest. This could be due to depletion of cockle stocks by the fishery, competition for food between the birds, or a combination of both.

A simple linear regression model was used to partition the effects of fishing and predation on the decline in the number of Oystercatchers counted between winter and spring. In the absence of fishing the model predicted that between 28% and 76% of the winter population should be counted in spring, over the observed 6,000 to 15,000 tonne range in cockle biomasses. However, the data suggest that between 13% and 66% of the winter population are actually counted over this range of cockle biomasses. This simple model can be used to predict the effects of changes in the intensity of fishing on seasonal changes in bird numbers between winter and spring.

The available data suggest that Oystercatchers either leave the Burry Inlet or

die between winter and spring as a result of food depletion and/or interference competition; emigration being more likely. The magnitude of these effects is primarily determined by the biomass of cockles present on the estuary in early winter, but can be exacerbated by the additional depletion of cockle stocks by the fishery.

Game theory models of habitat loss

William J. Sutherland, School of Biological Sciences, Univ. of East Anglia, Norwich NR4 7TJ, UK.

I will describe a theoretical framework based on game theory that can be used to predict the consequences of habitat loss and will describe how this can be applied to studies of both waterfowl and waders.

Predicting the effects of tundra loss and modification on arctic shorebirds and waterfowl

Declan M. Troy, Troy Ecological Research Associates, 2322 E. 16th Ave., Anchorage, Alaska 99508, USA.

A series of studies was conducted at Prudhoe Bay, on the Arctic Coastal Plain of Alaska, to determine how roads and facilities associated with oil fields affect the suitability of tundra for shorebirds and waterfowl. Three stages of study were to determine: 1) the extent of the problem, 2) the causal factors, and 3) the fate of affected birds. Initial investigations estimated the spatial extent of road effects. Sampling extended from the edge of the roads up to 1 km distant.

Changes in bird use of the roadside area were estimated by comparing the observed distribution of birds with that expected from habitat availability. Detailed geobotanical maps and corresponding summaries of habitat use by each species were used to predict abundance distributions in the undeveloped area as well as the roadside area. We successfully predicted distributions in the remote area but there were significant departures from expected distributions near roads.

Subsequent investigations sampled areas of varying levels of potential causes of distribution changes: disturbance (traffic), dusting, drainage alteration, snow melt, and thermokarsting. When possible, habitat suitability for each species (and period of summer) was incorporated into these analyses. The final aspect of the effort was to determine what happens to individual birds affected by habitat loss or alteration. Site-tenacious shorebirds were marked to be individually recognizable and their nest sites

located in an area prior to building of an oil field extension. The return rates and distance between nest sites between years was compared for individuals most influenced by habitat changes and those distant from facilities.

Roads appear to have caused changes in the distribution of many species. In general, shorebirds retracted from roads, whereas waterfowl and Red-necked Phalarope *Phalaropus lobatus* increased use of roadsides. Avoidance effects were most pronounced during the breeding season. Most effects were within 100 m of roads. Several factors contributed to the observed distribution changes; the most important being drainage alterations, snow melt, and disturbance. Few absolute relationships were found, most changes resulted in shifts in species composition, e.g., flooding reduced nest densities of shorebirds but increased use by waterfowl. The banding studies confirmed that nesting attempts declined in areas adjacent to facilities; however, birds displaced by habitat alteration returned and nested in adjacent areas.

Problems in predicting habitat changes and their effects on piscivorous birds following Nile perch introduction into Lake Victoria

Jan H. Wanink, Research Group in Ecological Morphology, Institute of Evolutionary and Ecological Sciences, University of Leiden, P.O. Box 9516, 2300 RA Leiden, The Netherlands.

The introduction of Nile Perch *Lates niloticus* into Lake Victoria in the 1950s was preceded by a dispute about the effects of this large predator on the fish community. Some scientists thought that Nile Perch would deplete the small haplochromine cichlids, while others predicted a destruction of the larger tilapias. Although the consequences of the introduction were discussed in relation to fisheries, they also applied to avian piscivores. Pied Kingfisher *Ceryle rudis* and Great Cormorant *Phalacrocorax carbo* mainly fed on haplochromines, while the African Fish Eagle *Haliaeetus vocifer* preferred tilapias.

Unfortunately, the Nile Perch was introduced before ecological data to support either of the two predictions were available. Changes in Lake Victoria could have been predicted from the effects of Nile Perch introduction into Lake Kyoga (Uganda). In this relatively small lake the perch rapidly reduced the haplochromines, while Nile Tilapia *Oreochromis niloticus* and the small pelagic cyprinid Dagaa *Rastrineobola argentea* managed to survive.

Nile Perch needed 25 years to invade all

parts of Lake Victoria, but after that its effects on the fish community were comparable to those in Lake Kyoga. By then the survival of Nile Tilapia and Dagaa had been predicted from their marginal habitat overlap with Nile Perch. Although much more knowledge about the ecosystem was available, predicting changes remained difficult. In contrast to the predictions, the Nile Perch population did not collapse after the haplochromines had disappeared. The species switched to a diet of shrimps, Dagaa, and its own offspring.

Dagaa became the major prey of kingfishers and cormorants. Although survival of Dagaa had been predicted, its strong increase was unexpected. It was explained by life history theory afterwards. Recent studies have indicated that Pied Kingfisher and Great Cormorant now need to catch much more fish than in former years to meet their daily energy needs. However, the birds managed to become extremely size selective. Kingfishers changed their foraging behaviour so that they can exploit prey which used to be inaccessible.

Main directions of the changes in Lake Victoria could be predicted by ecological studies in the lake itself or in a comparable ecosystem. But precise predictions were prohibited by unforeseen life history tactics of prey and adaptive foraging behaviour of predators.

An approach to predict the effect of hydrological changes in wetlands on waterfowl: the Kizilirmak Delta case

M.J. Wassen, W. Bleuten & P. Van Horssen, Department of Environmental Studies, Utrecht University, P.O.Box 80.115, 3508 TC Utrecht, The Netherlands; V. Van den Berk, National Reference Centre for Nature (IKC), P.O.Box 30, 6700 AA Wageningen, The Netherlands; & S. Demirçan, Society for the Protection of Nature (DHKD), Kizilirmak Delta Project, P.O.Box 38, 55410 Bafra, Samsun, Turkey.

To assess the impact of human interference in hydrology on ecosystems integrated hydrological and ecological models are needed. In such models water quantity and water composition as well as ground water and surface water need to be incorporated. In the ecological submodels the effects of changes in these abiotic components on biotic components should be assessed. For the Kizilirmak Delta (Turkey) such models were developed.

The Delta located at the Black Sea coast is a Ramsar site of great importance for breeding and migrating birds. The 900 km² delta contains 10,000 ha of wetlands consisting of shallow lakes, reedbeds, marshes and

flooded forests. The different lagoons contain brackish to almost fresh water, depending on the spatial variation in the quantities of inland water supply. A total of 308 bird species have been recorded in the delta of which 140 are breeding species. Apart from the wetlands the delta harbours dunes, grassland and arable land. Most of the delta is used for agriculture.

For improvement of soil and water conditions in the agricultural land a dense network of irrigation and drainage canals has been designed by the National Water Management Authority (DSI). An interception canal separating the wetlands from the agricultural land is under construction. These water management plans may affect the water level and the water composition in the wetlands. As a result vegetation may change which consequently may affect bird life.

The developed models consist of (1) a three dimensional finite difference groundwater model, (2) a statistical multiple logistic regression vegetation response model and (3) a conceptual matrix bird response model. The models were largely based on field data gathered in summer. In the modelling phase expert knowledge was added. The combination of expert knowledge and empirical data resulted in powerful tools which were developed within a reasonable time span (one year).

In this paper the development of the models will be outlined and the application of the models will be demonstrated by comparing the predicted effects of various scenarios for future water management in the area. Possibilities for developing scenarios for improvement of both agricultural land use and sustainable conservation of wetland wildlife, fisheries and reed harvesting will be discussed.

NUMBERS AND DISTRIBUTION

The role of protected areas in the conservation of waders and wildfowl of the Humber estuary, UK

Leslie Batty, Bishop Burton College, Beverley, Humberside HU17 8QG, UK.

The Humber estuary is the fifth most important site for wintering waders and wildfowl in the UK, with an average maximum total of over 120,000 birds. It has recently been designated as a Special Protection Area and is also remarkable for the number and extent of other statutory and voluntary designations, including seven Sites of Special Scientific Interest, a statutory wildfowl refuge, fourteen nature reserves and a Heritage Coast.

Recent campaigns and publications have highlighted the nature conservation status and needs of Britain's estuaries and have suggested strategies for their management. However, no reference has been found to any assessment of the role of existing protected areas in the conservation of waterfowl in an individual estuary. A study was therefore carried out to determine: a) the reasons the protected areas of the Humber were selected and the extent to which they were established for the conservation of birds; and b) the importance of the protected areas in safeguarding the most valuable ornithological sites and populations, and the extent to which they form a comprehensive network.

All except one protected area appear to have been selected primarily or to a large extent because of their ornithological interest, although some of this selection seems to have been based on inadequate data. The actual ornithological importance of each site was therefore evaluated against specifically developed criteria, using data from the Birds of Estuaries Enquiry and other sources. The study found that:

- All except one of the SSSIs, but only seven (54%) of the nature reserves, were considered to be of ornithological importance.
- Seven waterfowl species (78%) have over 80% of their breeding population within the nature reserves, but for 13 species (57%) less than 40% of their non-breeding populations occur in the nature reserves.
- A study of species-area relationships showed several nature reserves to be much smaller than the optimum size.
- Some of the most valuable sites for waders and wildfowl are not protected, whilst relatively unimportant sites are.
- Important areas of agricultural land which are used by large numbers of birds for roosting and/or feeding are completely outside the boundaries of the SSSIs and the SPA.

Co-operation between conservation organizations is needed in order to develop a co-ordinated strategy for the establishment of a more effective network of protected areas, based on adequate knowledge of population sizes, ecology and intra-estuarine movements.

Wintering of waders in Morocco: a synthesis of the 1983-1994 census and identification of most important sites

Mohamed Dakki, CEMO, Inst. Scient. de Rabat, BP 703, Rabat-Agdal, Morocco.

A global view of the wintering of waders in Morocco is given, from an analysis of the

results of the mid-winter census organized during the twelve years 1983-1994.

The large lagoons, bays, estuaries, beaches and rocky shores of the Atlantic coast are the best sites for waders. The highest numbers (up to 87,000) are regularly recorded at the Ramsar site of Merja Zerga (lagune de Moulay Bou Selham). This site is followed by the Dakhla Bay (up to 22,000) the Sidi Moussa-Walidia lagoon complex (17,000), the Khnifiss lagoon (12,500) and the Lower Loukkos Marshes (11,000). In 15 other sites, maxima recorded are between 1,000 and 4,000 birds; however, some of them (Dayet Al hafs, Sehb El Mejnoun, Merja Boukka, Marais de Iwad Smir and Merja Dawra), have been deeply damaged or completely lost.

The fall and rise of Dutch Spoonbills: lessons in protection and management

Tom M. van der Have, *BirdLife/Vogelbescherming Nederland, Drieburgseweg 16c, 3708 JB Zeist, The Netherlands.*

Spoonbills *Platalea leucorodia* commonly bred in the The Netherlands up to the first half of the 19th century. Loss of breeding sites by land claim caused a dramatic decrease and only two colonies remained. Despite better protection by law (initiated by Vogelbescherming Nederland) and establishment of nature reserves, numbers continued to decline due to loss of feeding grounds, reduced availability of food and degradation of stopover sites. The population crashed in the early 1960s as a result of biocide poisoning in the Western Waddensea. The population then dropped from 400 to 150 pairs.

Consequently, Vogelbescherming Nederland initiated a long-term study of Spoonbill migration and population dynamics. In addition, several important stopover sites were protected and hunting decreased due to better legal protection in several countries along the flyway. Since then the population has grown (1970-80 2.0%, 1980-90 7.2%, 1990-95 7%) up to c. 750 pairs in 1995. At the current growth rate the population would be expected to double every ten years. The major factor driving this increase is the (re)colonisation of the Waddensea islands exclusively in strictly protected nature reserves. This trend can only be sustained if new breeding sites continue to be colonized and stopover and wintering sites remain protected.

Of particular importance with respect to potential breeding sites is the availability of freshwater foraging areas in early spring. Although the Waddensea breeding birds switch from freshwater fish to shrimps *Crangon crangon* in tidal areas during May, the availability of small fish, in particular "sea-

bred" anadromous Three-spined Sticklebacks *Gasterosteus aculeatus* in early spring is crucial. This dependence on freshwater sites is probably related to the colonial breeding habit. In the pre-nesting and nesting stages males have to guard their mates against extra-pair copulations during daytime (Aguilera 1989) and are forced to forage at night. The tidal rhythm would frequently interact with this sex-dependent day/night shifts in foraging. Furthermore, this phenomenon would imply that foraging ability in males would directly pay off in reproductive success: skillful foragers would be more successful in guarding their mates and have more time to for extra-pair copulations.

Taxonomic and ecological distribution patterns of migratory, holarctic-breeding waders

Philip A.R. Hockey & Keith S. Barnes, *Percy FitzPatrick Institute of African Ornithology, University of Cape Town, Rondebosch, 7700, South Africa.*

Based on a global analysis of the breeding and nonbreeding distribution of waders, the first part of this study sets out to answer two key questions:

1. Are there distribution patterns which are repeated across different migratory flyways?
2. Are there morphological or taxonomic correlates of wader distribution patterns? The second part of the study concentrates on nonbreeding wader assemblages at coastal wetlands in the east Atlantic and addresses two additional questions:
3. Do community-level attributes of wader assemblages vary consistently or predictably with latitude?
4. If such patterns exist, can they be explained by environmental variables?

At a global level, several patterns were identified. Three 'groups' of migratory waders were recognized: long-distance, broad-ranging and short-distance. Breeding and nonbreeding distributions of these three groups are mirror images of one another, indicating that leapfrog migration is the norm. There is a tendency for small species to breed further north than large species, but there is no phenotypic evidence for adaptation to long-distance flight among long-distance migrants. The proportion of scolopacid species in the species assemblage increases from north to south.

An index of species packing was derived based on species-specific morphology and the proportional abundance of the rarer of each pairwise combination of species within an assemblage: the index ranges from 0

(loose ecological packing) to 2.5 (tight ecological packing). The pattern of species packing is symmetrical about the Equator. Tropical assemblages are characterized by having a relatively high species evenness, a higher numerical proportion of obligate visual foragers than found elsewhere, and a high species packing. The predominance of (short-billed) obligate visual foragers at tropical latitudes almost certainly reflects attributes of the prey base. At temperate latitudes most prey are buried in the substratum whereas in the tropics there is a relatively high abundance of surface-active prey, especially crabs.

Based on the above patterns and analyses, we suggest that the effects of estuarine habitat loss/degradation on waders are likely to be most severe in the tropics. Apart from tropical assemblages having a high species evenness, the predominance of obligate visual foragers increases the probability of several species being space- rather than food-limited. The number of birds impacted per unit area of habitat loss will be greatest at south temperate latitudes, but the diversity of species impacted at these latitudes will be low relative to more tropical latitudes.

Ecology of waterbirds on the Nakdong River Estuary, Korea

Hwa-Chung Kim & Pyong-Oh Won, *Institute of Ornithology, Kyunghee University, Seoul 130-701, Korea.*

Surveys of waterbirds were conducted on the Nakdong Estuary with scattered sandbars of Taema-dung, Changja-do, Kalmaegi-dung, Paekhap-dung, and on the southernmost part of Ulsuk Island a total of 21 times from 19 April 1992 to 20 April 1993. The results are as follows:

1. The sum of the maximum numbers of individual waterbirds of the 83 species observed during the period of survey was 105,474. The maximum number of waders was 20,935 (19.8%), consisting of 30 species, and that of wildfowl was 71,666 (67.9%), consisting of 25 species. The most abundant wildfowl species was Mallard *Anas platyrhynchos* (30,401), and the most abundant wader was Dunlin *Calidris alpina* (7,127).
2. The mean density and biomass of potential food organisms of waders was 996/m² and 66.1 g AFDW/m² in spring, and 827/m² and 42.1 g AFDW/m² in autumn, respectively.
3. The mean feeding rate of nine wader species in their diurnal activities observed three hours before and after high tide was 80.0%. The mean frequency of pecking (or probing) by small sized wader species such as Red-necked Stint *Calidris ruficollis* and Dunlin

was 40.0/min (SD=15.3) and 36.7/min (SD=14.9), respectively. The mean frequency of pecking by Australian Curlew *Numenius madagascariensis*, which is a large sized curlew species, was 10.0/min (SD=6.4). The rate of successful capturing was comparatively higher in Grey Plover *Pluvialis squatarola* (56.8%), Mongolian Plover *Charadrius mongolus* (40.3%), Kentish Plover *Charadrius alexandrinus* (36.0%) and comparatively lower in Red-necked Stint (11.0%), and Dunlin (5.4%).

4. In the diurnal activities of Shelduck *Tadorna tadorna* and Curlew from 9:00 to 17:00, their feeding activity is an average 59.1% and 90.5%, respectively. This means that they usually feed in daytime. Many species of wildfowl seem to rest or roost in the daytime. The rate of resting among some wildfowl showed little difference: for example, White-fronted Goose *Anser albifrons* 87.0%, Bean Goose *Anser fabalis* 87.4%, swans 79.5%, Mallard 83.4%. Most wildfowl species wintering on the Naklong Estuary started to move for feeding at sunset, and returned at sunrise for resting or roosting.

Methods for the detection of unusual population behaviour: applications for waterfowl at a national and flyway level

Jeff S. Kirby & Michael C. Bell, *The Wildfowl & Wetlands Trust, Slimbridge, Gloucester GL2 7BT, UK*; & Paul M. Rose, *International Waterfowl and Wetlands Research Bureau, Slimbridge, Gloucester GL2 7BX, UK*.

The detection of unusual aspects of population behaviour, such as consistent and unprecedented declines, is likely to be important in population surveillance. Indeed this is necessary to trigger conservation action before such action becomes critical, allowing the initiation of more detailed monitoring, practical conservation action or research into possible causes of the observed changes. This would allow preventative, rather than curative, conservation management, the need to take action depending on several factors, including the precise nature of the change and importance of the population involved.

We present methods for the objective analysis of population behaviour, allowing important periods of population change to be identified and quantified. The methods are based on rigorous analysis of index numbers and are illustrated using count data for a variety of species. The data utilized are mainly those from the Wetland Bird Survey in the United Kingdom (UK) but, where important changes are detected, count data for north-west Europe are used to place the UK results in a wider context. The

usefulness of the techniques is evaluated and discussed in relation to the role of waterfowl as monitors of environmental change, for example habitat loss, and in relation to target setting for particular species and the conservation of biodiversity more generally.

Distribution, population trends and habitat use of breeding Curlew and Black-tailed Godwit in Russia

Elena A. Lebedeva, *Russian Bird Conservation Union, Kibalchicha 6, bld.5, off.110, Moscow 129278, Russia*.

For Curlew *Numenius arquata* and Black-tailed Godwit *Limosa limosa* all available Russian literature on distribution, numbers, habitat use and population trends in 1970-1995 was analysed (98 and 100 references resp.); for some areas data were verified with regional specialists. This resulted in the first regional breeding population estimates of these species ever made for Russia, and the first quantitative estimate of total breeding populations for the western part of Russia.

The northernmost breeding records of the Curlew are north of the Arctic Circle on the Kola peninsula; it approaches the Arctic Circle in the Komi Republic and east of the Urals in the lower Ob valley. The Black-tailed Godwit has expanded northwards as far as the south of the Komi Republic (Luza river), northern parts of the Kirov region (bogs in the upper Kama valley), and Vologda region (central parts along Sheksna water reservoir). It is quite possible that records of the species in Tomsk and Kemerovo regions also indicate a range expansion. However, in the latter case and in other areas of Russian Asia this could be simply the result of surveys in areas not explored before.

The total population size of Curlew in European Russia (ER) up to the Ural mountains ranges from 25,500 to 57,500 pairs; up to the Yenisey river an additional 17,500 to 59,000 pairs could be found, thus giving a total estimate of 43 to 116 thousand breeding pairs in the total western part of Russia up to the Yenisey river. In the ER from 92% to 94% of the population is concentrated in northern regions, 3% to 7% in the central regions and less than 1% of pairs in the southern regions.

A similar assessment for the Black-tailed Godwit indicated that it is at least 5 times less numerous than the Curlew - our total estimates ranged roughly from 1,250 to 5,350 breeding pairs in ER, and from 2,411 to 10,300 breeding pairs in the whole of western Russia. Although it has increased it still remains rare in northern ER (270 to 670 breeding pairs or 13-22% of the Russian European population). The major part of the

population is concentrated in the central regions of ER - from 63% to 67% of pairs, and 11% to 24% can be found in southern ER regions.

A comparison of obtained data with population estimates for wintering grounds of the two species leads to the conclusion that breeding ground estimates are very accurate. Habitat use and population trends of both species are analysed as well.

Status, distribution and conservation of breeding wader populations in the Valencian area of E Spain

Carlos Oltra Martínez, *Estació Ornitológica L'Albufera, Av. Los Pinares 106, 46012 Valencia, Spain*; & Miguel Ángel Gómez Serrano, *Colla Ecologista de Castelló, Apdo. 566, 12080 Castellón, Spain*.

Wader breeding populations in Spain are poorly known. The results of a census during the period 1988-1993 in the Valencian area of eastern Spain and the conservation problems affecting these birds are presented. Trends in breeding numbers for each species and the nature of its population for all areas where breeding occurs are also described.

During the study period more than 100 areas with possible breeding populations of waders have been visited; 32 of these areas have, at least, one breeding species, but only ten had more than three wader species breeding. The most important habitats in the Valencian area are beaches, salt and freshwater marshes, salines and reservoirs, but also airfields, harbours or outlets. The areas are mainly coastal wetlands located in the south of the study area.

Six wader species were confirmed as breeders: Black-winged Stilt *Himantopus himantopus*, Avocet *Recurvirostra avosetta*, Collared Pratincole *Glareola pratincola*, Little Ringed Plover *Charadrius dubius*, Kentish Plover *Charadrius alexandrinus* and Stone Curlew *Burhinus oedichnemus*. Three more are "probable breeders" (young in area or adult displays in breeding period): Lapwing *Vanellus vanellus*, Redshank *Tringa totanus* and Common Sandpiper *Actitis hypoleucos*. Black-winged Stilt and Kentish Plover are the commonest and most widespread species while Little Ringed Plover and Stone Curlew are the most scarce.

The main threats to breeding wader populations are land-use changes such as agricultural transformation, drainage and sand extraction. Human disturbance from fisheries, planes, aquatic sports or industrial activities also cause breeding failure or population decline.

In some areas human activities have allowed habitat restoration, like in Racó de l'Olla (L'Albufera, Valencia) or the Serradal Beach (Castellón). In these areas waders such as Kentish Plover and Avocet have increased in numbers or recolonized old breeding areas. The evolution of these areas after restoration is described in detail.

Long-term annual census and productivity data: their use in population viability analyses

Richard A. Pettifor, J. Marcus Rowcliffe & M. Owen, *The Wildfowl & Wetlands Trust, Slimbridge, Gloucester GL2 7BT, UK.*

The Wildfowl & Wetlands Trust (WWT) has collected information on annual numbers of geese wintering in Great Britain since the 1950s, together with sample counts of the number of juveniles in the flocks and the mean brood-size each year. Recently, we have used these data to construct stochastic age-structured models of two populations: the Iceland/Greenlandic Pink-footed Goose *Anser brachyrhynchus* and the Svalbard population of Barnacle Goose *Branta leucopsis*, the entire populations of which winter within the UK. Since 1970, WWT has also undertaken a long-term individual-based study of the Barnacle Goose population focused on colour-ringed birds, both on their breeding and wintering grounds. Statistical analyses of these demographic data provided measures of the relevant parameter estimates and their standard errors incorporated into the models. The Pink-footed Goose population has increased at a rate of 2.18% *per annum* between 1950 and 1984; since then it has increased at a rate of 7.61% *pa*.

Four classes of model were developed in an attempt to understand these differing growth patterns: deterministic models with constant survival and improved conditions on the breeding grounds relating to spring temperatures; two stochastic models with varying density-dependence; and stochastic models with two subpopulation elements (one with strong density-dependence reflecting breeding conditions on Iceland and one with weaker density-dependence reflecting breeding conditions on Greenland). Variants of all three stochastic model classes showed reasonable fits to the observed data. The implications of each will be discussed.

The Barnacle Goose models were more straight-forward, incorporating estimates of survival and productivity in relation to female age, pair duration population size and spring temperature. Sensitivity analyses of the models for both populations indicated that population size and growth rate were most effected by changes to the survival parameters. We then used these models to examine the susceptibility of the populations

to random mortality effects of a variable magnitude occurring with a probability ranging from once every year to once every thousand years.

The importance of these analyses will then be discussed with reference to habitat loss and anthropogenic environmental change, and to the "threatened/unfavourable/favourable" conservation status recently adopted by the Agreement of the Bonn Convention for the Eurasian/African migratory waterfowl and BirdLife International.

Population dynamics in heterogeneous environments: occupation of habitat patches

Hannu Pöysä, *Finnish Game and Fisheries Research Institute, Evo Game Research Station, 16970 Evo, Finland.*

In most of northern Europe breeding environments of waterfowl are effectively subdivided. Migrating birds recolonize habitat 'patches' (lakes, ponds, etc.) each spring and an average individual may inhabit more than one patch in its lifetime. In such a system, the dynamics of the occupation of habitat patches is largely an individual-level phenomenon and closely associated with habitat selection. Even though the process itself is an individual-level one, it may have important population-level consequences.

I studied factors affecting the dynamics of habitat patch occupation (the probability of year-to-year occurrence of a species in a patch) of Mallard *Anas platyrhynchos*, Teal *A. crecca* and Wigeon *A. penelope* in relation to patch size, habitat structure and isolation. Breeding pair censuses of the species were undertaken in southeastern Finland in 1985-95 on 33 lakes differing in size (range 0.2-40.4 ha), habitat diversity (structure of shore vegetation) and the degree of isolation (number of lakes within a radius of 1 km of a lake).

In pair-wise analyses, the probability of patch occupation increased with patch size in all species and also with habitat diversity, in Teal and Wigeon, the probability of patch occupation was associated with the degree of patch isolation: isolated non-preferred small patches were less likely to be occupied as compared with non-preferred small patches surrounded by several alike neighbours. This association is particularly interesting considering that the species studied are migratory. It also has potential conservation implications since non-preferred habitat patches in clusters may provide suitable breeding habitats for these species.

Predicting shorebird numbers from remotely-sensed intertidal sediment distribution

Michael G. Yates, *Institute of Terrestrial Ecology, Monks Wood, Abbots Ripton, Huntingdon, PE17 2LS, UK.*

This paper describes the use of remote sensing in the development of an approach designed to predict the changes in numbers of shorebirds (Charadrii) using an intertidal area after natural or man-made perturbations to the sediment distribution. The biological basis of this approach was the association between shorebird and sediment distribution that arises because the sediment influences the distribution of the birds' prey.

Analysis of remotely-sensed images acquired by the LANDSAT 5 satellite proved to be a successful method for mapping the distribution of sediments on intertidal areas and for quantifying the association between sediment and bird numbers for the Wash, east England. Furthermore, the numbers of shorebirds on other parts of the east coast whose sediments had been mapped from remotely-sensed images could also be predicted. The implication of these findings is that if habitat disruption or loss changes the sediment, then its consequences for shorebirds can be predicted.

FEEDING ECOLOGY AND ENERGETICS

Energy budget of wintering Wigeon

Hendrik Brunckhorst, *Regional Office of the National Park Schleswig-Holstein Wadden Sea, Schlossgarten 1, 25832 Tönning, Germany.*

Activity budgets and energetic costs of Wigeon *Anas penelope* were studied in the Wadden Sea of Schleswig-Holstein (Germany). Activity budgets were measured during 50 complete days and 15 complete nights. The results of these measurements and the observation of flights to and from feeding sites during dusk and dawn, proved that Wigeon feed for 15-17 hours per day throughout the winter (15.4 hr mean value). Full night activity is obligatory and day time feeding supplementary. Measurements of the energy content of food and droppings, digestion efficiency and defecation rate facilitated calculation of net daily energy intake (630 kJ/day mean value).

Energetic costs of activities and thermoregulation were determined by simultaneous use of heart rate telemetry, doubly labelled water and heated taxidermic mounts.

The activity of three Wigeon were continuously recorded by event recorder and video under semi-natural conditions for ten periods of 24 hours. Respirometric studies showed linear relationships between heart rates and oxygen consumption for individual birds. This allowed calculations of the costs of eight different activities (excluding flying) as multiples of basal metabolic rate. Doubly labelled water measurements proved the precision of calculated energy budgets based on these multiples.

Thermostatic costs were estimated at the same time by integrating meteorological data and measurements of two heated taxidermic mounts. The effects of temperature, wind and radiation for standard metabolic rate were calculated. In general, thermostatic costs are of minor importance for Wigeon, since they only occur when the birds are inactive. The heat generated by activity (19-22 hr/day) accounts for 90-100% of total thermostatic costs.

Based on these results, daily energy intake and daily energy expenditure of Wigeon near the northern border of their wintering area was estimated to be 2.2 times BMR between September and April for both sexes.

The energy balance is strongly influenced by the food type. On the heavily grazed pastures Wigeon use by day, they gain 8.8 kJ/hr. On pastures with higher phytomass which they use at night, the net energy intake is four times higher. Feeding on winter wheat and winter rape the gain 51 and 205 kJ/hr respectively. This is due to the higher digestibility of these food plants (45% and 74%). Energetic costs of disturbances are 0.46 kJ/disturbance or 1.3% of the daily energy intake.

The Broad-billed Sandpiper: world's smallest *Nereis*-specialist?

Tom van der Have, Bram bij de Vaate, Guido Keijl, Eric Martijn, Ruurd Noordhuis & Paul Ruiters, WIWO, c/o Dribergseweg 16c, 3708 JB Zeist, The Netherlands.

The feeding ecology of Broad-billed Sandpipers *Limicola falcinellus* was studied in Khor Dubai (United Arab Emirates) in April-May, just before their departure to the main spring stopover site in the Sivash (Ukraine). Prey type and size were determined and compared to the available prey in the tidal mudflats. Intake rate was determined and compared with previous studies in the Sivash.

This study confirms the fact that Broad-billed Sandpipers specialize on relatively large, annelid worms such as *Nereis*. Furthermore, their prey selection might explain their limited distribution within the tidal mudflats in Khor

Dubai as well as in the windflats of the Sivash. The high degree of specialisation is remarkable when compared with the relatively broad diet of Calidrid sandpipers. Our results confirm particularly well the predictions of Burton (1971) with respect to prey size selection of Broad-billed Sandpipers, which were based on detailed morphological analysis of the jaw apparatus in comparison with Calidrid sandpipers. Therefore, the Broad-billed Sandpiper may very well be the world's smallest *Nereis*-specialist.

Scaling relationships in the foraging ecology of sympatric tropical plovers: effects of body size and diet

Philip A.R. Hockey, Jane K. Turpie, Éva E. Plagányi & Tracey E. Phillips, Percy FitzPatrick Institute of African Ornithology, University of Cape Town, Rondebosch, 7700, South Africa.

The foraging behaviour of five plover species (Crab Plover *Dromas ardeola*, Grey Plover *Pluvialis squatarola*, Greater Sandplover *Charadrius leschenaultii*, Mongolian Plover *C. mongolus* and Ringed Plover *C. hiaticula*) was studied at Mida Creek, Kenya (03°22' S, 39°58' E), to assess how foraging behaviour is influenced by body size and diet. Although all five species had functionally identical "walk-stop-search" instantaneous foraging behaviour, the predicted allometric scaling of components of this behaviour with body size were not conclusively demonstrated. Indeed, from this study, it would be impossible to make extrapolations or predictions about the foraging behaviour of other plover species based solely on body size. Variation in almost all foraging parameters could be better explained by interspecific differences in diet, specifically the relative proportions of cryptic and non-cryptic prey taken.

At equatorial Mida Creek, species with predominantly tropical nonbreeding ranges (Crab Plover, Greater Sandplover and Mongolian Plover) had more favourable energy budgets than the other two species, whose distributions extend well into temperate latitudes. Tropical species had a larger search area which they scanned more rapidly than temperate species. Grey Plovers took smaller prey than predicted on the basis of body size and took considerably longer than all other species to satisfy their daily energy demands.

The conservative and apparently suboptimal foraging strategy of Grey Plovers is believed to stem from an evolutionary legacy of territoriality that probably had its origin in temperate latitudes, where the nature of the prey base is quite different from that of the tropics. The behaviour is not selected against in tropical latitudes, however, as Grey Plovers, like the other species studied, had

no difficulty in balancing their energy budgets: they were able to obtain their daily food requirements in about 70% of the available foraging time.

Limitations to predation on Zebra Mussels *Dreissena polymorpha* by diving ducks: a study on estimating the carrying capacity of the IJsselmeer

Joep J. de Leeuw, Zoological Laboratory, University of Groningen, PO Box 14, 9750 AA Haren, The Netherlands; & Mennobart R. van Eerden, Rijkswaterstaat Directorate Flevoland, PO Box 600, 8200 AP Lelystad, The Netherlands.

Diving ducks, such as Tufted Duck *Aythya fuligula* and Scaup *A. marila*, winter in large numbers (up to 300,000 birds, over 50% of the population in NW Europe) in the freshwater lake IJsselmeer, The Netherlands. These ducks mainly feed on Zebra Mussels *Dreissena polymorpha*. Diving ducks strongly prefer the shallow parts (2-3 m deep) of the lake, although mussel densities are 10-50 times lower than in deeper parts of the lake (4-5 m deep), which are hardly exploited by the ducks. However, the condition of mussels (flesh mass relative to shell mass) decreases with water depth.

The question as to whether foraging costs (diving deep in cold water during the winter) or food processing costs (crushing mussel shells, heating up the food mass, and digestion) limits the exploitation of musselbeds, was studied using captive birds. In various experiments with ducks, which had been trained to dive for freshwater mussels, food selection, the energetic costs of diving, and food intake rates in relation to mussel density were measured. The results show that diving ducks consume large amounts of mussels to meet their daily energy demands (1.5 to 3 kg per bird per day; 2 to 3 times their body mass). Diving ducks are able to distinguish between mussels with high flesh content (from shallow water) and low flesh content (from deep water). Musselbeds at shallow water (2 m) are depleted until a threshold value is reached of 1 g AFDM per m². Moreover, there is evidence that feeding on mussels may be constrained by the time available for foraging and the amount of energy expended on foraging (as measured by the doubly-labeled water technique).

We conclude that diving ducks have to balance the cost of foraging (related to density of mussels and water depth) and the relative benefits (related to the condition of mussels) within a narrow range of the energy and time budget in winter. This study suggests that the exploitation of benthic mollusc populations by diving ducks is strongly limited and an attempt will be made to estimate the amount of mussels available for diving ducks.

Carrying capacity predicted for Redheads wintering in Chandeleur Sound, Louisiana, USA

Thomas C. Michot, U.S. National Biological Service, Southern Science Center, 700 Cajundome Boulevard, Lafayette, Louisiana 70506, USA.

The Chandeleur Islands are a 65 km long barrier island chain in the Gulf of Mexico about 40 km off the coast of Louisiana, USA. The waters of Chandeleur Sound adjacent to the largest island (about 45 km long) in the chain are a traditional wintering area about 20,000 Redheads *Aythya americana*. Chandeleur Sound, the Laguna Madre of Texas, the Laguna Madre de Tamaulipas, Mexico, and Apalachee Bay, Florida are the four major wintering areas for Redheads along the Gulf Coast, and all four areas are estuarine seagrass meadow habitat.

We predicted the carrying capacity of the Chandeleur Sound study area to assess whether Redheads could be limited by their winter habitat. Based on 190 esophageal food samples from 287 Redheads collected over two winters, we determined that 83% of the diet consisted of below-ground plant parts (93% rhizomes, 7% roots) of the seagrass *Halodule wrightii*. We established from 17 vegetation transects perpendicular to the main island (average transect length = 1763 m; 5640 vegetation samples spaced at 5 m intervals) that *Halodule* covered 24.2% of the 79 km² study area.

We estimated below-ground biomass of *Halodule*, for each winter month (October through March), from core samples (n=340) taken monthly from three 20 m x 20 m study plots. Below-ground biomass ranged from 119 g (dry mass)/m² in October to 33 g/m² in March. *Halodule* standing crop over the entire study area was estimated to be 2,287 metric tons of below-ground biomass, of which 1,077 metric tons were usable to Redheads (previous studies showed that Redheads will not continue to feed on a *Halodule* patch when rhizome biomass is depleted below 10 g/m²). This equates to 171 metric tons of rhizomes, based on a published root-to-rhizome ratio of 5.3 to 1. From a published consumption rate for Redheads of 77.5 g/m², we estimated that 64% of the standing crop is consumed, and that the area could support a population of about 25,000 Redheads over the winter. Redhead population estimates on the study area from 1955 to 1995 ranged from 2,000 to 29,000 birds (mean = 15,600); therefore, Redheads at Chandeleur Sound could be limited by their food supply during some years.



Siphon cropping in the Tejo estuary, Portugal

Francisco Moreira, Departamento de Zoologia, Fac. Ciências de Lisboa, Portugal.

The diet and feeding behaviour of two species of gulls (Lesser Black-backed Gull *Larus fuscus* and Black-headed Gull *Larus ridibundus*) and six species of waders (Dunlin *Calidris alpina*, Black-tailed Godwit *Limosa limosa*, Grey Plover *Pluvialis squatarola*, Redshank *Tringa totanus*, Knot *Calidris canutus* and Avocet *Recurvirostra avosetta*) feeding on the intertidal areas of the Tejo estuary were studied during the two winters 1992-93 and 1993-94.

The relative contribution of different prey types to the diet of each bird species is described. Most species specialized on one or two preferred prey which represented more than 75% of the ingested biomass; thus, Black-headed Gulls took *Scrobicularia plana* siphons, Grey Plover took ragworms *Nereis diversicolor*, Knot took *Hydrobia ulvae*, Dunlin and Black-tailed Godwit took *Scrobicularia*, and Lesser Black-backed Gull took crabs *Carcinus maenas* and edible cockle *Cerastoderma edule*. Only Redshank (main prey were *Nereis*, *Hydrobia* and siphons) and Avocet (main prey were crustaceans, small worms and fish) had a more varied diet.

The predation of siphons of the bivalve *Scrobicularia plana* by several birds, namely Avocet, Redshank, Grey Plover, Black-headed Gull and Dunlin, is described and the ecological implications of this finding are discussed, both for the prey population and for energy fluxes in the estuarine food web.

Effects of grassland management on foraging conditions for Black-tailed Godwit chicks

Hans Schekkerman, IBN-DLO, PO Box 23, 6700 AA Wageningen, The Netherlands; & Jeroen Postema, Zoological Laboratory, PO Box 14, 9750 AA Haren, The Netherlands.

Since the 1960s, the population of Black-tailed Godwit *Limosa limosa* has decreased substantially in The Netherlands, largely as a result of agricultural intensification. Decreasing hatching success due to earlier mowing and higher cattle densities has been an important mechanism in this decline. However, chick survival may have suffered from agricultural intensification as well, through effects on food availability.

Abundance of grassland arthropods, which form the main prey of Black-tailed Godwit chicks, was measured in Dutch meadows under typically intense agricultural

management (200-300 kg N/ha/yr, several silage cuts from early May onwards) and under reserve management (100 kg N/ha/yr, one hay cut in mid-June). Before the first cut, arthropod abundance was not significantly different between management types, or even higher in intensely managed grasslands due to an earlier development of the vegetation. After agricultural plots were mown, which is the case during the main fledging period of Godwit chicks, arthropods of most groups, including the important Diptera, were more numerous in reserve meadows. Feeding trials with captive-raised chicks showed that chicks ingest 30% more prey per unit time in reserve meadows than in agricultural meadows, while having lower walking speeds. Free-ranging families with chicks strongly preferred reserve grasslands over agricultural grasslands during most of the fledging period.

The results indicate that feeding conditions are better on reserve grasslands than on intensively managed agricultural grasslands. However, a proper study of fledging success of Black-tailed Godwits in relation to grassland management is not yet available, so the link between feeding conditions and population processes remains speculative.

Comparison of day and night feeding rates in mussel-feeding Oystercatchers

Humphrey P. Sitters, *Limosa*, Old Ebford Lane, Ebford, Exeter EX3 0QR, UK.

In this field study of mussel-feeding Oystercatchers *Haematopus ostralegus* on the Exe estuary, SW England, day and night foraging statistics of those birds which hammer the ventral surface of mussels *Mytilus edulis* are compared. A conventional camcorder was used to record foraging observations by day and infrared video at night. The size of mussels eaten was established by measuring the length of the mussel as a proportion of the length of the bird's bill from the video screen. Bill length was established by measurement from the video screen in relation to 50 mm wide white tape attached to sticks liberally scattered over the musselbed. Tests showed that this method slightly underestimates mussel-size and the results were adjusted accordingly.

The parameters studied included: feeding rate (time to find and consume a mussel), handling time (subdivided between 'opening time' and 'eating time' with time spent scanning (for predators and/or kleptoparasites) and time spent carrying the mussel considered separately), inter-catch interval, waste handling time, giving up time in respect to mussels which were rejected, mussel-size, intake rate (mgAFDM/5 minutes) and intra-specific encounters.

Feeding rates at night were found to be slightly but significantly slower than by day. This was because handling times were longer; there was no significant difference in time spent searching. Less time was spent carrying mussels at night but more time was spent scanning. Mussel-size selection was similar during day and night. There were fewer intra-specific encounters at night.

Can random search and optimal diet models explain delayed exploitation of the bivalve *Scrobicularia plana* by Oystercatchers?

Jan H. Wanink, Zoological Laboratory, University of Groningen, P.O. Box 14, 9750 AA Haren, The Netherlands; & Leo Zwarts, Rijkswaterstaat Flevoland, P.O. Box 600, 8200 AP Lelystad, The Netherlands.

Oystercatchers *Haematopus ostralegus* in the Dutch Wadden Sea do not feed on a cohort of *Scrobicularia plana* until some years after settlement. Meanwhile, high juvenile mortality has strongly reduced the density of the bivalves. On the other hand, fast individual growth results in a high total biomass by the time the birds do start exploiting the cohort. Profitability to Oystercatchers of individual *S. plana* is known to increase with size of the prey species. Therefore, the delayed exploitation by Oystercatchers is likely to be a trade off between decreasing encounter rate and increasing profitability. However, the picture is complicated by the burying depth of the prey, which is negatively correlated with profitability. Larger clams bury deeper, thus reducing their profitability to Oystercatchers.

Here we apply the optimal diet model to predict when an Oystercatcher should start to feed on *S. plana*. The model can be used when energy content, handling time and encounter rate are known for every potential prey item. We have monitored density, shell length, body weight and depth distribution of a single cohort during several years. Experimental work with captive birds provided data for handling time as functions of burying depth and shell length. Since Oystercatchers feed solely by touch when aiming for *S. plana*, a random search model could be used to estimate encounter rates. Combining all parameters in the optimal diet model we predict for each accessible prey if it should be taken or rejected on encounter. We compare the predictions to the foraging behaviour of Oystercatchers in the field to find out whether delayed exploitation of *S. plana* maximizes the intake rate of the birds.



IWRB

Wetland and food use by Ruddy Ducks in the prairie pothole region of North America: Implications for the White-headed Duck in Europe

Marc C. Woodin, National Biological Service, Texas Gulf Coast Field Station, Corpus Christi, Texas 78412, USA.

Wetland and food use by Ruddy Ducks *Oxyura jamaicensis* breeding in the prairie pothole region of North America were investigated. Birds were counted five times (April-August) during each of two years (one wet and one dry) along two transects. The transects contained 175 wetlands along their combined length of 40 km. Each wetland was classified by water regime and basin area.

Ruddy Ducks were almost uniformly restricted to fresh to slightly brackish, semipermanent wetlands supporting growth of tall emergent species of *Typha* and *Scirpus*. Proportions of Ruddy Ducks found on semipermanent wetlands exceeded 90% throughout April-August during both years. Actively feeding Ruddy Ducks were collected (37 males and 45 females) from prairie wetlands during three years. Foods in the esophagus were removed and preserved in 80% ethyl alcohol, before being sorted by type, measured to the nearest 0.01 g, and expressed on an aggregate percent wet-weight basis. Females were later dissected and, on the basis of the development of their reproductive tracts, were classified as prelaying, laying or postlaying.

Male and prelaying and laying female Ruddy Ducks consumed 90% invertebrates, but postlaying female Ruddy Ducks consumed less animal matter (73%). Aquatic insects were the single most important food of Ruddy Ducks. Chironomidae (Diptera) larvae and pupae represented large proportions of the foods of all classes of Ruddy Ducks, ranging from a low of 48% in laying females to a high of 85% in males. Other invertebrate groups which were >5% of the foods for at least one of the classes of Ruddy Ducks included Odonata, Ephemeroptera, Hirudinea, Oligochaeta, Amphipoda, Gastropoda and microcrustaceans. Diversity of invertebrates in the diet of Ruddy Ducks was greatest for prelaying and laying females. Ruddy Ducks responded to favorable water conditions on the prairies by concentrating their numbers in relatively large, semipermanent wetlands supporting high populations of aquatic insects (especially Chironomidae) and other invertebrates.

Where Ruddy Ducks and limited numbers of native White-headed Ducks *Oxyura leucocephala* in Europe occupy similar wetlands, White-headed Ducks face extirpation because of 1) high interspecific overlap with Ruddy Ducks in resource use, and 2) the ability of Ruddy Duck populations to respond extremely rapidly to favorable

wetland conditions, a trait common to waterfowl breeding in the highly dynamic wetlands of the prairie pothole region of North America.

HABITAT SELECTION AND COMPETITION

Habitat preferences of wintering wildfowl in Portugal

Luís T. Costa, ICN/CEMPA, Rua Filipe Folgue 46-3º, 1050 Lisboa, Portugal.

Wildfowl counts, covering all Anatidae species as well as coots, cormorants and grebes, have been carried out in Portugal every winter from October to March since 1992. All the main Portuguese wetlands have been surveyed since the launch of this project. Information on number of birds of each species, separated by sexes, and data on climate, water level and disturbance are recorded.

Habitats were delineated in each of the most important wetlands following a hierarchical habitat classification system with five main categories (marine, estuarine, lacustrine, riverine and palustrine) and a vegetation cover characterization.

Data on bird numbers and allocation of each species to habitat patches are analysed as well as the effects of disturbance and habitat change throughout the years. The importance of habitat preferences is discussed concerning the population trends of each species.

Satellites, sediments and shorebirds

Steve J. Holloway, Mark M. Rehfish, Nigel A. Clark & Graham E. Austin, British Trust for Ornithology, The Nunnery, Thetford, IP24 2PU, UK; Ralph Clarke & John Goss-Custard, Institute for Terrestrial Ecology, Furzebrook, The Ridge, Arne, Wareham, Dorset, UK; & Jim Eastwood, Ruth Swetnam & Mick Yates, Institute for Terrestrial Ecology, Monks Wood, Abbots Ripton, Huntingdon, PE17 2LS, UK.

The United Kingdom's main ornithological importance in international terms lies in its estuaries, which hold vast numbers of waders and wildfowl in the non-breeding season. These habitats are facing more threats than ever before from land claim, man-made developments and predicted sea-level rises. Knowing the impact of these events is essential if a balanced case is to be made for or against developments. Developments tend to alter the physical

structure of estuaries, changing, for example, the estuary area, shape, length and tidal range. This study relates these environmental variables to the communities of waterfowl found on the estuary. This allows us to highlight the abiotic factors that most affect waterfowl communities and ensures that planners are aware that waterfowl communities on an estuary may change after a development.

A total of 27 estuaries, with 1050 count sections, chosen to represent a wide range of sediments and other physical variables, have been monitored by teams of volunteers over two winters. A total of 14 counts, which included mapping the distribution of feeding and roosting waterfowl, were made two hours either side of low tide. On average, the low tide counts recorded about 10% of Great Britain's populations of common waders. Using computer enhanced remotely-sensed images, the ITE has accurately identified the sediment types on each estuary. The surface sediment composition has been assessed at a resolution of 10 or 25 m².

The communities were classified using detrended correspondence analysis (Hill 1979) run on a 17 x 27 matrix of the 17 commonest and most widespread species on each sample estuary. The first (DCA 1) and second axes (DCA 2) explained 62.4% and 24.7% of the variation within the data. The most common species on British estuaries were at the centre of the species ordination, while less common species characterized the more unusual community types. The densities of waterfowl, with few exceptions, were higher on the east than on the west coast. It is possible that the breeding grounds affect the wintering grounds. This hypothesis tended to be confirmed by similar waterfowl communities being found on geographically adjacent estuaries with dissimilar sediments.

The communities depended on the length, the channel width at low tide, the exposure to swell, the amount of sand and the sediments other than sand or mud on the estuary. These environmental variables, whose post-development changes are predictable, in total explained 70.9% of the variation in DCA 1 and 59.0% of the variation in DCA 2. It is therefore probable that estuarine developments, such as marinas, and land claims, that affect these environmental variables, will lead to local changes in waterfowl communities.

This is a joint BTO and ITE project, funded by ETSU, on behalf of the Department of Trade and Industry, as a part of the Tidal Power Research and Development Programme.



Use of a spatial decision support system for analysis of habitat use by wintering Northern Pintails

Clinton W. Jeske, Paul C. Chadwick & Wayne Norling, National Biological Service, Southern Science Center, 700 Cajundome Boulevard, Lafayette, Louisiana 70506, USA; Mary C. Finley & Wei Ji, Johnson Controls World Service, 700 Cajundome Boulevard, Lafayette, Louisiana 70506, USA.

A spatial decision support system (SDSS) allows the third degree integration of environmental models in a Geographic Information System (GIS) environment. We instrumented female Pintails *Anas acuta* at Catahoula Lake, Louisiana in October of 1992-1994 and located the instrumented birds weekly through the following March. Using the SDSS with ARC/INFO GIS, we have been able to analyse locations of instrumented Pintails using satellite imagery to determine habitat use. Weather data were used to identify factors important in determining timing of movements.

Female Pintails dispersed from Catahoula Lake, Louisiana in three general patterns, based upon wetland conditions. Timing of movements coincided with periods of precipitation or disturbance, primarily hunting. Pintails which arrive at Catahoula Lake in October and November remain in the agricultural areas of Louisiana and Arkansas, with very limited movements to the coastal marshes or westward into the agricultural areas of Texas. Spring migration follows the Mississippi River into Illinois before flight paths begin to separate. Northward movements into Arkansas occur any time substantial rainfall occurs in the agricultural regions, and northward movements generally stop at the frostline. No differences in adult or juvenile female movement patterns were apparent.

Competition between waders of Inland wetlands

Santos Lozano Palomeque, C/ Almiraz 21-2ºB, 10910 Malpartida de Cáceres, Spain.

Between 1992 and 1995 we studied competition between the most abundant species of waders that annually utilize the "Llanos de Cáceres" (SW Spain). First, we analysed the annual evolution of intraspecific aggression in the most frequent species. The greatest aggression occurs in the postbreeding period, when the suitability of habitat is low because of drought and numbers of waders are highest. During winter, the amount of aggression decreases notably but in spring it increases again.

Next, a hierarchical model the wader

community as a function of the frequency of interspecific aggression and the abundance of each species is presented. Last, we analyse competition for food as a function of the width of the trophic niche and habitat fluctuations. We have thus analysed a series of variables selected by their relationship to the obtaining of food resources:

- interspecific biometric differences;
- overlap of the feeding areas;
- fluctuations in the habitat;
- age and sex composition for the species in which those can be separated;
- size of the feeding groups; and
- differences in the feeding methods between different species.

Ducks breeding on artificial islands on south Bohemian fishponds

Petr Musil, Institute of Applied Ecology, Czech Agriculture University, Kostelec nad Cernymi lesy, 281 63, Czech Republic.

Among changes which have affected fishponds and their surroundings the decrease in extent and changes in the structure of littoral vegetation have been very important in the last decades. Various factors have contributed to changes, e.g. restoration, increase in fish stock density, enormous fertilization, etc. Restoration was aimed at reduction of the extent of littoral vegetation stands, which were bulldozed, and the removed soil was deposited in mounds around fishponds or as artificial islands in them. These changes also affected breeding bird communities, incl. duck species. Decline in numbers of ducks breeding in the lower flooded littoral has been recorded since the 1960s. In contrast, other duck species have started to breed on newly created small islands in this period.

Therefore investigation of ducks breeding on artificial fishpond islands in the Trebon Biosphere Reserve in 1991-1995 was aimed at the following issues:

- duck guild structure on islands in relation to the island habitat;
- reproductive success of particular duck species in relation to the island habitat;
- difference between reproduction performance on islands and in original breeding habitat (in littoral stands);
- nest failures and their causes.

Preliminary results show that:

- Breeding duck guilds on fishponds islands consist mainly of four species: Mallard *Anas platyrhynchos* (30.6%), Tufted Duck *Aythya fuligula* (27.0%),

Gadwall *Anas strepera* (26.5%) and Pochard *Aythya ferina* (15.6%).

- Breeding success was lower in early breeding species, such as Mallard. This species compensated high nest failures in the first half of the breeding season by having the longest breeding season (March to June).
- Comparison of nest sites of particular duck species show that only Gadwall prefer sites in the centre of fishponds. Other duck species prefer sites close to the water.

Who meets whom? Spatial and seasonal differences in the composition of bird communities on tidal flats

Gregor Scheiffarth, Institut für Vogelforschung, An der Vogelwarte 21, 26386 Wilhelmshaven, Germany; & Georg Nehls, Institut für Haustierkunde, University of Kiel, Am Botanischen Garten 9, 24118 Kiel, Germany.

Tidal flats are neither equally used by shorebirds, nor do all shorebirds use the same part of a tidal flat. Therefore, different bird assemblages can be observed on different parts of an intertidal area.

We determined spatial utilization patterns of birds in the Königshafen, a sandy tidal bay in the northern part of the Wadden Sea (55° 01' N, 8° 26' E). Bird counts were conducted during the whole emersion period every 10 minutes on 32 plots with an area of 0.25 ha each. Plots were arranged to vary in sediment composition, elevation and distance

to the high-tide roost. It will be shown, how far bird assemblages differ a) seasonally, and b) in relation to abiotic factors. Furthermore, the question will be addressed as to whether bird communities on different parts of the tidal flats can be predicted by means of abiotic factors in combination with knowledge of the total number of birds in a distinct area.

Redheads and habitat on the breeding and wintering grounds

Marc C. Woodin, National Biological Service, Texas Gulf Coast Field Station, Corpus Christi, Texas 78412, USA.

Numbers of Redheads *Aythya americana* on the breeding and wintering grounds and quality of habitat for breeding birds, broods, and birds in winter were investigated. To provide estimates of numbers of ducks (including Redheads) breeding in the prairie pothole region of North America, Fish and Wildlife Service biologists have conducted aerial surveys of the region annually since 1955.

Since 1961, Fish and Wildlife Service biologists have estimated during annual aerial surveys of the prairie pothole region the numbers of prairie wetlands in May and again in July. Since 1979, Fish and Wildlife Service biologists annually have conducted aerial surveys of the Gulf of Mexico region, where Redheads winter in restricted geographic areas. These include the Laguna Madre of Texas and the Laguna Madre of Tamaulipas, known to historically harbor approximately 80% of all Redheads in North America. Surveys of Shoalgrass *Halodule*

wrightii, the main winter food of Redheads, and other seagrasses in the Laguna Madre (Texas) were available from 1967 and 1988.

Results from the aerial surveys showed highly variable Redhead populations on the breeding grounds and in winter, which nevertheless exhibited relatively stable long-term trends. The mean population of breeding Redheads (1955-94) was 565,000, with a peak of 829,000 birds in 1975. The mean population of gulf coast Redheads (1979-94) was 726,000 with a peak of 1,042,000 birds in the winter of 1979-80. Southern Texas and northern Tamaulipas, dominated by the two Lagunas, supported an annual average of 83% of Redheads in the Gulf of Mexico.

Numbers of May wetlands were used as an index of breeding habitat quality, and numbers of July wetlands were used as an index of quality of brood-rearing habitat. Extrapolation from the two years of seagrass surveys (assuming a constant linear change of shoalgrass area over time) provided an index of winter range quality. Numbers of breeding Redheads were regressed against numbers of May wetlands, shoalgrass area in the Laguna Madre (Texas) during the preceding winter, and numbers of wetlands during the preceding July. Numbers of Redheads in the Laguna Madre (Texas) in winter were regressed against shoalgrass area in the Laguna Madre and numbers of wetlands during the preceding May and July. Results indicated that the only significant ($P < 0.01$) independent variable, for abundances of both breeding and wintering Redheads, was quality of the winter range.

