ABSTRACTS OF TALKS GIVEN AT THE WSG AUTUMN MEETING, DURHAM, U.K., 23-24 OCTOBER 1982

Abstracts are not given for talks that were progress reports of WSG projects, or where a more detailed paper on the subject appears elsewhere in this or other recent Bulletins.

Importance of the Gulf of Gabes in southern Tunisia for passage and wintering waders

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The Mediterranean is generally considered to be almost tideless, and hence poor in tidal mudflats and the waders that depend on them. There is however, one exception to this general rule: the area in southern Tunisia around Gabes, where the tidal range is about 2 metres and where there are extensive mudflats around the Kneiss Islands.

Oystercatchers *Haematopus ostralegus*, Knots *Calidris canutus* and Bar-tailed Godwits *Limosa lapponica*, which are scarce passage migrants elsewhere in the Mediterranean, occur here in some numbers on passage and as winter visitors. Other species, notably Grey Plover *Pluvialis squatarola* and Curlew *Numenius arquata*, occur in much larger concentrations than at other Mediterranean sites, and the number of wintering Dunlins *Calidris alpina* undoubtedly exceeds 50,000. As one exiled Vendee wader enthusiast commented "The horizon gets up and flies away, just like at home". Curlew Sandpipers *Calidris ferruginea* winter in hunreds at least, making this the only wintering area in Africa north of the Banc d'Arguin in Mauritania for this species.

Other wintering birds of note are Spoonbills *Platalea leucorodia* (Probably 2000 birds, representing much of the Central European breeding population), Flamingos *Phoenicopterus ruber* (many sightings of Darvic-ringed birds from the Camargue), gulls (massive concentrations of Mediterranean Gulls *Larus melanocephalus* and Slender-billed Gulls *L. genei*, mainly from Black Sea colonies), terns (notably Sandwich Terns *Sterna sandvicensis* and Caspian Terns *Hydroprogne tschegrava* from the Black Sea and Baltic), and Cormorants *Phalacrocorax carbo* (ringing recoveries from Danish colonies).

The tidal conditions also provide breeding sites for Redshanks *Tringa totanus* and Common Terns *Sterna hirundo* (which do not breed in central or northern Tunisia), as well as Kentish Plovers *Charadrius alexandrinus*, Avocets *Recurvirostra avosetta* and Black-winged Stilts *Himantopus himantopus*. On the uninhabited offshore islands there are breeding colonies of Little Egrets *Egretta garzetta*,nesting on the ground on peninsulae made by tidal channels, and Slender-billed Gulls.

The Kneiss Islands have been included by the Tunisian authorities in a wetland conservation project established by the World Wildlife Fund. Both the Kneiss Islands and the Thyna Saltpans (exploited by Cotusal, a salt company whose guards control access and show considerable interest in birdlife) figure in IUCN's *Directory of Wetlands of International Importance in the Western Palearctic* and in IWRB's *Preliminary Inventory of Wetlands of International Importance for Waterfowl in West Europe and Northwest Africa*. The area would be ideal for inclusion in the list of wetlands established under the Ramsar Convention, of which Tunisia is a Contracting Party. There seem at present to be few conservation problems, except possibly disturbance of nesting colonies by fishermen, and the nightmare of an oil-spill from offshore drilling operations.

Although the importance of the area is clear, more detail is required to understand fully its functions. Short expeditions, like those made in recent years to Morocco and Mauritania by members of the Wader Study Group, could collect much valuable information and should concentrate on:
1) an inventory of the birds and identification of major feeding and roosting sites for waders, in addition to those roost sites already known at Sfax, Thyna, Chaffar, Oued Maltine and Kneiss;
2) census work: numbers of wintering and passage waders are as yet poorly known;
3) catching: much wader ringing was done at Rades on the Lake of Tunis from 1967 onwards, but Gulf of Gabes birds probably belong to separate populations which migrate northeast - southwest, and in the case of the very numerous Little Stints *Calidris minuta* and Curlew Sandpipers, probably cross the Sahara. Ringing recoveries and the study of weights and biometrics would help to elucidate this.

Investigations along these lines would be of the greatest interest at any time of the year, and in particular at passage periods or in midwinter. It would of course be vital to organise any expedition in closest cooperation with the Tunisian authorities, in particular the Forestry Department of the Ministry of Agriculture, and with Cotusal.

Common Sandpiper food requirements

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Common Sandpiper habitat in Britain is easily recognisable: upland streams of low gradient, and reservoirs. The breeding season is short, and most successful nests hatch between 5 - 15 June. Preliminary diet analysis of adult birds, from observations, faeces and pellets, shows that they will eat any crawling invertebrate and that they feed over the whole range of their available habitats: streams, shingle, earthy banks, grassy banks and pastures. Small pulli feed extensively in damp rushy patches, which also provide good cover. Large pulli and juveniles feed almost exclusively on the stream edge and banks. By this time their bills are almost as long as those of adults. These are able to extract creepy-crawlies from between pebbles exposed on the typical low-gradient areas favoured. In late June, stream invertebrates begin to emerge and their biomass is at a maximum. It thus appears that the time and place of breeding is geared to the requirements of the juveniles.

The female produces 100% of her body weight in 4 eggs. However, it is unlikely that food requirements alone determine her timing of breeding. Firstly, she competes on her feeding sites with many other birds. Secondly, the peak rate of ringing recoveries occurs during the first two weeks in May. In late April 1981 there was a severe snowfall. The breeding population was small in that year, and one colour-ringed bird was found frozen during the severe weather. It seems, therefore, that the risks to adults would be reduced if breeding began later in the season. The sampling of food both before and after it is eaten by Common Sandpipers is being studied at present.

Breeding biology of the Kentish Plover

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Arctic breeding waders often have short breeding seasons in which there is time for only a single nesting attempt. Reproductive success in these situations is usually most affected by influences such as the timing of snow thaw rather than characteristics of the birds themselves. In contrast, Kentish Plovers *Charadrius alexandrinus* breeding in the Camargue have a long breeding season with laying dates spanning nearly four months. In this situation, the number of clutches or broods produced will be affected by such factors as how early a bird starts breeding and how quickly it replaces lost clutches. Hence reproductive success may vary considerably between individuals depending on these factors.

This paper discusses three of these factors likely to affect the number of broods produced in a season.

1. The timing of onset of breeding. Because replacement clutches often cannot be recognized as such, clutches were only included in this analysis if they were started on or before 10th May. Laying date was analyzed with respect to size (winglength), weight, and weight corrected for size (and, in the case of females, the time of day at which the bird was caught) for each of the two parents. Timing of laying was:
(i) related to the size of the female, but not the male: large females bred earlier.
(ii) related to the weight and corrected weight of both males and females: heavy birds bred earlier.

2. Re-laying interval. Re-laying intervals were defined as the number of days from clutch loss to commencement of the replacement clutch. After the loss of a clutch pairs usually re-nest with the same mate. Re-laying intervals were:
(i) not significantly related to either the date of nest failure or the number of days of incubation completed at nest failure.
(ii) not significantly related to male or female size (winglength).
(iii) tended to be shorter the heavier the male prior to clutch loss and were significantly longer the heavier the female prior to clutch loss.

3. Care of the brood. The fledging period is approximately five weeks, but large chicks are often accompanied by only one parent. Estimates of the proportion of broods attended by one or both parents were made for broods of approximately 0, 4.5, 11 and 26 days. Most departures occurred between 4.5 and 11 days when the percentage of broods accompanied by both parents fell from 67 to 12%, and the percentage accompanied by the male alone increased from 28 to 76%. From hatching to fledging, the percentage of broods accompanied by the female alone was low (6-19%) and fairly constant. Thus most females commit only one week after hatching to the care of the young. Observations of colour-ringed birds showed that females were able to use this reduction in commitment to increase the number of clutches produced; two females were recorded breeding with a new mate following the successful hatching of an earlier clutch, and in one case the previous mate was known to be caring for the first brood at the time the female commenced laying with her new mate.

The Hebridean Machair and its breeding waders.

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The west coasts of the islands of North Uist, South Uist and Benbecula in the Outer Hebrides, Scotland, support the most extensive machair in Britain. The machair is a coastal strip of wind-blown shell-sand which lies as a flat plain for virtually the entire length of the three islands. Much of the machair is cultivated, largely on a strip rotation. On the seaward side of the dry machair plain there is frequently a belt of semi-mobile dunes and/or shingle banks, while the inland edge of the machair is often marked by damp grassland and eutrophic lakes. Further inland still is a strip of rough grassland termed "blackland", from which the overlying peat has long since been stripped and which is only slightly influenced by shell-sand. The eastern margin of the blackland is defined by the start of peatland and moorland. Within dry machair, damp machair and blackland there is much variation in vegetation cover and in the case of the latter two, dampness. The complex of habitats supports outstanding densities of several species of breeding waders and each habitat carries a quite distinctive suite of breeding species.

On an 880 hectare island off North Uist, estimates of wader populations were made in 1979 and 1982 and the following numbers (breeding pairs are given for the two years) were estimated: Oystercatcher (115,161), Ringed Plover (52,76), Lapwing (272,253), Dunlin (41,68), Redshank (46,100). Snipe were also breeding in large numbers but were not estimated. In terms of overall densities, waders are most abundant on damp machair, cultivated machair and saltmarshes (these occur locally along the more sheltered western coasts). Mobile dunes and stable dune grass hold lowest densities, with blackland intermediate between these and the above habitats.

Of all the waders Oystercatchers show the least selection for any of the above habitats: they are widely distributed as breeding birds although densities are lowest on mobile dunes. Ringed Plovers, however, show strong selection for the dry cultivated machair, and to a lesser degree for saltmarsh. Lapwings are most abundant on damp machair but densities are also high on cultivated machair, saltmarsh and blackland. The machair Dunlin are unique in Britain; nowhere else does such a large population of the species breed at sea level. Furthermore, the densities are by far the highest reported for the species in Britain. Damp machair grasslands at the edge of the cultivated plain are the preferred breeding areas although saltmarsh and pockets of grass within the dry machair carry populations. Redshanks use all habitats except the dry dunes. Damp machair is particularly important for nesting although in 1982 many broods were located in crops and fallow land on cultivated machair. The extent to which waders use different machair habitats for nesting, adult feeding and for brood rearing is unknown, so the above patterns of habitat distribution must be regarded as extremely generalised.

Breeding waders of the Yarrow Valley; effects of agricultural change and a cold winter

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In 1981 and 1982, 14.4 km^2 of the Yarrow Valley, Selkirkshire, was surveyed for breeding waders. In 1981, wader totals included 245 pairs of Lapwing, 46 pairs of Snipe, 37 pairs of Redshank, 33 pairs of Oystercatcher, and 26 pairs of Curlew. Breeding densities varied between habitats, with highest concentrations of Lapwing and Oystercatcher in arable fields, Curlew and Snipe in rough grazing below 300m, and Redshank in rough grazing below 300m and in damp pasture. Dry pasture was almost completely avoided by all species. Lapwing tended to nest socially, with up to 16 pairs in a field, but the mechanism for this is unknown; it could result from philopatry of young or from social behaviour. Between 1981 and 1982, several areas of rough grazing were ploughed, areas of ploughed land converted to sown pasture and damp pasture drained. A simple model indicated that if these trends continue at the same rate, wader numbers may be halved by 1990, and, eventually, all Redshank, Snipe and Curlew lost from the valley floor.

Considering only fields where the agricultural regime remained the same in both years, between 1981 and 1982 marked decreases occurred in all wader densities, ranging from a 70% loss of Golden Plover and 50% loss of Snipe, Oystercatcher and Redshank, to a 25% loss of Lapwing and a 15% loss of Curlew. It is presumed that these changes were due largely to mortality during the very cold 1981-82 winter. Conditions in the Yarrow Valley fields in spring 1981 and 1982 were similar, though somewhat drier in 1982, but no flocks of apparently non-breeding waders were present in the area. The possibility of such large changes in breeding numbers between years should be taken into account when interpreting large scale surveys of breeding wader populations.

Competition between Golden Plovers and Lapwings

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A study is in progress to quantify the costs and benefits derived by individual birds from feeding in single- and mixed-species flocks. The component species are Lapwing Vanellus vanellus, Golden Plover Pluvialis apricaria and Black-headed Gulls Larus ridibundus. All feed almost entirely on earthworms. The study area is 10 km south of Nottingham, England and contains pasture and arable farmland. The wintering population comprises some 600 Golden Plovers, 700-900 Lapwings and 30-50 Gulls. This paper examined: (i) competition and exploitation over high ranking feeding sites, (ii) prey size selection as influenced by species mixture and flock size, and (iii) whether flock size reflected feeding efficiency of component individuals. Multivariate statistical techniques were used, particularly multiple regression multi-way contingency analyses.

Feeding associations comprising the three species held more individuals of each species than expected, when compared with single- and two-species flocks. Golden Plovers almost always fed with Lapwings, whereas Lapwings frequently fed on their own. Gulls were specialist kleptoparasites, stealing worms from both plover species. Their numbers built up where sub-flock size of Lapwings, and to a lesser extent flock size of both plovers, was highest. Local sub-flocks of each plover species, particularly Lapwings, were larger where worm availability (sampled from upper 3.0 cm of turf sampled along the search path of plovers) was higher.

Both plovers made more intensive use of old pasture fields (age measured in years since last ploughed) during winter than predicted. This was apparently because older pastures contained more numerous and slightly larger worms, and because they contained some areas (patches) with consistently high worm densities. Exclosure/enclosure experiments indicated a numerical decline of earthworms (within the upper 3.0 cm of turf) attributable to predation during the winter: a 70% decline was recorded in old pastures, a 35% decline in young pastures (< 3 years old). The predominant size range removed was that preferred by plovers (between 15 and 35 mm long). Numbers of Lapwings feeding in high-ranking old pastures were similar from day to day during mid-winter, but numbers feeding on low-ranking young pastures were high only when the population of plovers was temporarily high, or during extremely cold conditions, when plovers spread out to feed in less profitable sites. Both plovers achieved a higher net rate of energy intake from older pastures.

Available worms differed in size and hence calorific content. If plovers aim to maximise their net rate of energy intake (calorific gain/searching and travelling time) whilst foraging, they should select the mixture of worms which represents the maximum profitability possibly attainable; this was demonstrated. Worm size-dependent time costs e.g. travel, assessment, extraction and mandibulation were defined. Probabilistic size-dependent costs e.g. breakage, theft and rejection were also defined. Both plovers concentrated on the most profitable sizes of worms (approximately bill length) in the absence of gulls. However they took less profitable mixtures comprising smaller worms when gulls were present (Barnard & Stevens 1981, Barnard, Thompson & Stevens 1982). As gulls were twice as likely to attack and steal larger worms (especially >60mm long) from Lapwings as from Golden Plovers, Lapwing feeding efficiency was greatly reduced in the presence of gulls, whereas that of Golden Plovers was only slightly affected (Barnard, Thompson & Stevens 1982). Gulls apparently also caused an escalation of intra- and inter-specific aggression between plovers. Whereas Lapwings tended to initiate most aggressions in the absence of gulls, they were more likely to be attacked by Golden Plovers in the presence of gulls. From these observations it was predicted that the arrival of a gull should reduce the equilibrium sub-flock size (EFS) of Lapwings (number of conspecifics when rate of individuals arriving and departing are approximately equal) but have little or no effect on the sub-flock size of Golden Plovers, if the EFS reflected the feeding efficiency of components individuals. The predicted changes were observed. Furthermore, gulls frequently arrived at feeding sites with Golden Plovers, but not with Lapwings, so possibly gulls used gulls to locate the most profitable feeding sites containing Lapwings.

Most EF's of Lapwings (EF's of Golden Plovers were rare) occurred on old pastures, and these flocks exhibited much higher inter-neighbour distances than observed in flocks on younger pastures. Possibly many individual Lapwings in EF's occupied areas characterised by high densities of profitable worm sizes, and the intermittent arrival and departure of individuals reflected peripheral individuals either departing or supplanting others from less profitable feeding areas. Certainly levels of inter- and intra-specific aggression initiated by Lapwings were much higher on old pastures, and Golden Plovers fed less efficiently than expected on old pastures where worms were extremely abundant. Sampling of worms showed that Lapwings did indeed feed on much more profitable areas than Golden Plovers. However, in the presence of gulls both plovers fed on equally less profitable areas. Hence Lapwings possibly defended particularly good sites against conspecifics and Golden Plovers, but kleptoparasitic gulls interfered with this situation either because they prevented efficient patch and prey detection or because former defenders of patches left to feed elsewhere.

Golden Plovers generally took smaller worms than Lapwings. In the absence of gulls, Lapwings had a negative effect on the feeding efficiency of Golden Plovers, and there was a positive relationship between numbers of extra Lapwings arriving and numbers of Golden Plovers departing from a feeding site. However, numbers of arriving Golden Plovers had no directional effect on Lapwings. In the presence of gulls however, Golden Plovers had a negative effect on the feeding efficiency of Lapwings (partly through food stealing) and there was a positive relationship between numbers of arriving Golden Plovers and numbers of Lapwings departing from the feeding site. Numbers of Lapwings (arrivals or present) then had no effect on Golden Plovers (Barnard, Thompson & Stevens 1982). Again then, EFS of Lapwings, and sub-flock size of Golden Plovers, appeared to reflect the feeding efficiency of the component individuals, as shaped by effects of food supply and competition.

The major benefit accruing to plovers from tolerating gulls appeared to anti-predatory: gulls were much more vigilant and responded to any sign of danger sooner than plovers (Thompson & Barnard 1983). These observations support the view that mixed species bird flocks in general do not behave like a 'large' flock, rather they reflect complex conspecific and individual strategies for survival.

I thank Dr. Chris Barnard for collaboration, and Hilary Stephens for help with computing.

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Correcting weight data

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Dunlins *Calidris alpina* and Knots *C. canutus* kept in darkened keeping cages for up to 24 hours lost weight most rapidly soon after capture. Thereafter the rate of weight loss decreased exponentially. After about 8 hours in captivity, their rate of weight loss became constant. During the first 8 hours, Dunlins kept under a variety of conditions lost weight at similar rates. After that, repeated handling increased weight loss. Analysis of body condition showed that much of the initial loss was of water, but that muscle protein and fat reserves had begun to be used within 4 hours of capture. Rates of loss deduced in this way allow the weights of waders to be corrected for weight loss during short-term captivity such as during ringing, and are probably widely applicable. There is no evidence that the short-term effects of capture stress cause any long-term problems to waders.

Predation by waders and food production on a Moroccan mudflat in spring

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During two expeditions in the springs of 1981 (March) and 1982 (April) to the Sidi Moussa estuary and saltpan complex (Atlantic coast of Morocco, 150 km southwest of Casablanca), interactions between the macrobenthic food source and the waders that feed on it, were investigated. The study site was located in the upper part of the estuary, where macrobenthic biomass was most abundant. In both years the standing crop of macrobenthos amounted to about 20 g. AFDW.m^{-2}. In March 1981 the consumption by waders exceeded the simultaneous production (mainly of Ragworm *Nereis diversicolor*). In April 1982 the consumption by waders was far less than the simultaneous production of macrobenthos by growth (*N.diversicolor*) and spatfall (the bivalves *Abra tenuis* and *Scrobicularia cottardi*). It appeared that predators other than waders (fish and/or macrobenthic species themselves) were important as consumers. At least at some sites at the Atlantic coast of Morocco, migrating waders seem to meet an abundant food source. Here their problem will be to cope with conspecifics, to obtain an area to feed on, as most species (plovers, Redshank *Tringa totanus* and occasionally Dunlin *Calidris alpina*) are strongly territorial.

Biometric research on waders migrating through or wintering in the Dutch Wadden Sea

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Biometric measurements can be used for several purposes. In this study, biometrics are used to distinguish between sexes and/or different populations. For three main reasons it was necessary to collect data on museum specimens: 1) different measuring techniques and/or different statistics have been used in the literature; 2) second calendar-year birds which are present on the breeding grounds are often included in population means, although they have significantly shorter wings than adults; and 3) in using discriminant-analysis, measurements of individual birds of known sex and breeding area were needed. To present proper data on weight changes and moult scores, it is important to distinguish as much as possible between different populations and sexes. Apart from using measurements in the usual ways, I combine different measurements using discriminant-analysis to achieve a better separation of groups. The accuracy of the discrimination depends on the amount of sexual dimorphism, and/or the amount of variation between different breeding populations. Discriminant-analysis has been found to be a very useful technique. Anyone dealing with similar problems who would like to know more about the methods, should contact me at the address above.

Mid-winter movements of waders within the Firth of Forth

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Counts made for the Birds of Estuaries Enquiry since 1969 have shown that more than 55,000 waders occur in the Firth of Forth during the winter months. This places the Forth within the top ten estuaries in Britain for over-wintering waders. Up to eight species may be present in numbers which exceed 1% of the NW European wintering population.

There are approximately 2,800 hectares of intertidal land in the Firth of Forth with much of it, particularly the soft muddy substrates of the Inner Forth, bordering industrial development. In 1979 several reclamation schemes had been proposed which involved the loss of important feeding areas for waders in the Inner Forth, particularly in Torry Bay on the north shore, and adjoining the oil installations at Grangemouth, on the south side. In early 1979, in response to the threat of loss of intertidal wader feeding habitat, the Nature Conservancy Council started a study, which lasted for three winters, to investigate the use of the mudflats by different species of wader. This aimed in particular to collect information on: the movements of waders between the available feeding areas; changes in feeding areas by individuals during the winter; loyalty to roosts and feeding areas; total population turnover in excess of information available from counts; and movements between the Forth and other estuaries.

Waders were caught at roost sites throughout the Forth using cannon nets and were marked with a temporary plumage dye. Each site used was allocated a specific colour code to enable the site of capture of marked birds subsequently seen in the field to be clearly identified. Regular checks for marked birds were made at all intertidal sites in the area.

Table 1. Summary of Sightings of Colour-marked Waders.

		No. Marked	No. Sightings	% Moved away from Marking Area*
Turnstone	Arenaria interpres	78	104	0.0
Oystercatcher	Haematopus ostralegus	782	451	1.5
Redshank	Tringa totanus	784	339	7.3
Bar-tailed Godwit	Limosa lapponica	35	74	22.9
Dunlin	Calidris alpina	1033	565	34.6
Knot	Calidris canutus	944	916	42.2

(* The Marking Area is defined as a contiguous area of intertidal land adjoining the point of capture.)

Sightings of marked birds indicated considerable differences in the patterns of movements of different species. The results are summarised in Table 1. Turnstones, Oystercatchers and, to a lesser extent, Redshanks, remained loyal to selected feeding areas throughout the winter. No Turnstones were known to move away from any of the seven sites where they were marked. Oystercatchers were marked at three localities and only a small number of individuals moved to alternative sites during the study period. Most Redshanks from the five marking sites remained loyal, although some individuals moved to new feeding areas. These were occasional movements by a small number of individuals and took place gradually throughout the winter. Movements of Bar-tailed Godwits, Dunlins and Knots were much more frequent and widespread. Results from two catches of Dunlins at sites in the Inner Forth showed that greatest use was made of the feeding area around the point of capture, although movements to all other available feeding areas within the Inner Forth (to the west of the road and rail bridges) were recorded. The numbers of sightings decreased with increased distance from the marking site. In the outer Forth there was more frequent interchange between feeding areas. Considerable distances (up to 18 km) were also flown by Dunlins moving between a roost site and selected feeding area. The pattern of movement between Outer Forth feeding areas continued throughout the winter. Longer movements, between areas in the Outer and Inner Forth were not common. Only small numbers of Bar-tailed Godwits were marked, but these birds were seen at both the marking site and several other feeding and roosting sites in the Forth. Sightings of Knots marked at four locations were made regularly at all sites used by Knots in both the Inner and Outer sections of the Forth. Movements between feeding areas were regular and widespread.

Movements of colour-marked waders between the Forth and other estuaries during the winter months were restricted to Knot and Dunlin, the two species which showed the greatest mobility within the Forth.

The results of the project are detailed in: F.L. Symonds, D.R. Langslow & M.W.Pienkowski: Movements of wintering shorebirds within the Firth of Forth: species differences in usage of an intertidal complex. Biological Conservation in press.

Wader research and the role of the WSG and the IWRB research groups

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Through a large number of wader counts, partly coordinated by IWRB, a picture exists now of the size and distribution of wader populations wintering in NW-Europe and NW-Africa. However, from many sites only limited information is available on numbers of waders in autumn or spring, duration of the stay of the birds or the function of a site as a moulting area. Many sites outside this area are even considerably less well documented. Probably important wintering ot staging areas in Africa, Asia and Australia have not been visited yet at all. In general, we still have a rather limited insight in migration patterns and the ecological function of many sites for the birds. There is a task here for the WSG as well as for several IWRB research groups.

In the future it will be important to continue midwinter-counts in NW-Europe and as many sites elsewhere as possible. Results can, amongst others, be used for calculating population trends. Attempts will also be made to coordinate large-scale counts in other months as well. WSG-members are most welcome to cooperate in these counts. However, they can especially contribute to our knowledge by counting in "new" areas and by catching and ringing waders in such areas.

Changes in the use of the Clyde estuary by shorebird populations

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Birds of Estuary Enquiry counts made since 1970 on the Clyde estuary in Scotland show that wintering numbers of several estuarine species have dropped markedly since 1977. The link between the affected species (Redshank *Tringa totanus*, Dunlin *Calidris alpina*, Lapwing *Vanellus vanellus*, Black-headed Gull *Larus ridibundus*, Pintail *Anas acuta* and Shelduck *Tadorna tadorna*) appears to be diet, as species that do not feed on small invertebrates (Oystercatcher *Haematopus ostralegus*, Curlew *Numenius arquata*, Mallard *Anas platyrhynchos*, Red-breasted Merganser *Mergus serrator* and Cormorant *Phalacrocorax carbo*) show no sign of decline. Dye-marking and ringing of Redshanks and Lapwings has shown that whereas previously numbers built up to a late autumn peak, now some birds are leaving the estuary and moving south-west as the autumn progresses. The populations that remain are stable through the winter. We suggest that inexperienced birds (i.e. juveniles and late arrivals) should be the first to suffer and so leave the estuary. Preliminary data on the movements of marked birds support this hypothesis. Late-arriving Redshanks are the larger, Icelandic, birds. It is not known if invertebrate densities have decreased as no consistent sampling has been done over the period of decline in bird numbers, but it is possible that recent improvements in the water quality of the Clyde have resulted in reduced nutrient levels for invertebrates.

Field experiments and calculations on the accuracy of shorebird counts

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Some insight in the accuracy of shorebird counts allows a more efficient interpretation of past and future counts. Furthermore, accuracy of counting may be a crucial factor in the planning of detailed field work in (small) study areas. This motivated the study.

The results summarised below refer to "good counts" in the sense that no rough guesses of important numbers of birds were included. The count gives the general impression of the accuracy of a controlled activity rather than of a series of guesses made in a hurry.

The stochastic error (variability of the result) is defined in the usual way as a standard deviation. Expressed as a percentage relative to the mean it is a relative standard deviation (RSD). The stochastic error has been measured in the field for a single sitting flock of birds. The RSD value is 37%. This high value is due to the importance of varying counting conditions such as vegetation, behaviour of the birds, light conditions. (The separate influences of these factors have not been analysed; their combined effect is treated as a source of variability.) For a single flying flock the RSD value is 17%. These RSD values do not depend on the size of the flocks and no significant differences between species have been detected.

In the counting results for a whole area, the errors made in the single group counts will certainly be present. But also additional sources of stochastic error will act: individual birds or small groups are easily missed or counted twice. So for species which are widely distributed in small numbers over an area we expect this last source of error to be of considerable importance. This is confirmed by repeated counts of two Dutch barrier islands in the Wadden Sea, which showed RSD values exceeding 50% for the less common species. However, for species which are largely counted in a few clearly recognisable groups, much lower RSD values are found. Moreover, these lower values appear to be completely explained by the stochastic errors made in the separate single groups. So for the more abundant species the errors caused by missing and double counting can be ignored. This means that the stochastic error in the counts of large areas can be calculated from the largest group sizes occurring and the basic RSD values for single flying and sitting groups. For instance, the calculated stochastic error in the total number of Oystercatchers *Haematopus ostralegus* in the Dutch Wadden Sea is only 5%. That is much more accurate than a single group count. The reason is that Oystercatchers are counted in many, about equally sized groups. Then the sum is more accurate than each of the contributing numbers. So the accuracy of shorebird counts strongly depends on "the scale of the count".

The abundance level for which the single group errors dominate cannot be given in general. Only for a certain area (or type of area) it is possible to estimate it by means of a repeated count of the area. After that, for the species that are sufficiently abundant, error calculations can be carried out as mentioned above for the Dutch part of the Wadden Sea.

The systematic error is the difference between the mean counting result and the number of birds which is actually present. This type of error is always difficult to measure. For single groups of shorebirds an inaccurate estimate of the systematic error is available. That estimate does not exceed some tens of percents. So for the abundant species, the systematic error does not seem to be very important. That conclusion does certainly not hold for the less abundant species.

Further details are described in a still unpublished paper. Anyone needing more detailed information should contact me at the address above.