THE DISTRIBUTION AND ABUNDANCE OF WADERS WINTERING ON THE ALT ESTUARY, MERSEYSIDE, ENGLAND

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Populations of wintering waders on the Alt estuary have increased greatly in recent years and the estuary now ranks as internationally important both in terms of the total numbers of waders present and for its concentrations of Knot, Sanderling and Bar-tailed Godwit. The distribution and abundance of feeding and roosting waders on the estuary were studied from December 1986 to February 1987. For Knot, Bar-tailed Godwit and Dunlin, there was considerable variation in the numbers of feeding and roosting birds on the Alt. Feeding and roosting counts of these species were often dissimilar, a consequence of the mobility of these populations in the area. It may be best to view the Liverpool Bay estuaries as one unit for these species. The role of the Alt in this unit is considerable, at times supporting large proportions of the feeding and roosting birds present in the whole Bay.

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INTRODUCTION

Each year, more than 1.25 million waders (Charadrii) winter on the British coastline, with 80% occurring on estuaries (Moser 1987). These wintering wader populations have been monitored since 1969 by the British Trust for Ornithology's Birds of Estuaries Enquiry (BoEE) (Prater 1981), which has enabled key estuaries to be identified and provided objective data facilitating the protection of important sites.

Three closely adjacent estuaries, the Alt, Mersey and Dee, flow into Liverpool Bay in north-west England (Figure 1). Between them are broad expanses of intertidal sand and mudflats. Despite its much smaller size than the other two estuaries, BoEE counts on the Alt have revealed a dramatic increase in the total number of waders roosting there over recent years. Mitchell, Moser & Kirby (1988) have shown that this increase matches closely a decline of roosting waders on the nearby Dee estuary and implicate disturbance of roosts on the Dee as the most likely cause of these changes. They have further shown that movements between the Dee and Alt estuaries occur daily and suggest that some birds which roost on the Alt may return to feed in the Dee. Because of these changes, the Alt now ranks among the top ten estuaries in Britain for its total wader population (Salmon *et al.* 1987). It is particularly important for wintering Knot *Calidris canutus*, Sanderling *Calidris alba* and Bar-tailed Godwit *Limosa lapponica* (Salmon *et al.* 1987). Part of the Alt has been designated as a site of international importance under both the Ramsar Convention and the European Commission Directive on the Conservation of Wild Birds. The Alt's important bird concentrations may be affected by the construction of a tidal barrage across the Mersey (see e.g. Cadbury 1987).

This paper assesses the current national and international significance of the Alt estuary for wintering waders and provides baseline data on their distribution and abundance during both the feeding and roosting periods. In particular, counts of feeding and roosting waders are compared in order to assess what proportion of those roosting on the Alt also feed there.

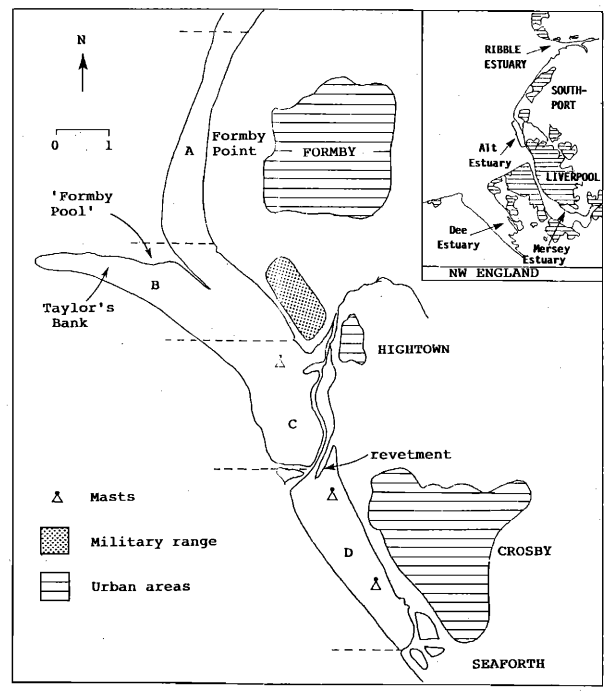

Figure 1. The location of the study area on the Alt estuary. The broken lines and letters show the subdivisions used in the distribution analysis.

STUDY AREA

The Alt estuary, as defined here, is

approximately 2 100 ha in area, encompassing the intertidal flats from Seaforth (national grid reference SJ 310970) to Formby Point (SD 270070) (Figure 1). The river inflow is roughly half-way between the two, at Hightown. It is trained by a stony revetment towards the mouth of the Mersey estuary. The river Mersey separates the south of the Alt from the intertidal flats of the north-Wirral shore, though the mudflats of the north Alt are contiguous with those of the south Ribble. The Alt is close to two major conurbations, Liverpool and Southport, and there is considerable recreational activity on its outer beaches. However, few people venture far into Taylor's Bank or in front of the military firing ranges (Figure 1), where public access is restricted and allowed by permit only.

The estuary was divided into four sections (A-D) (Figure 1). Section A is predominantly sandy, with a few shallow wet gullies each consisting of a thin mud layer overlaying sand. The outer part of sections B (Taylor's Bank) and C are also largely sand, although the area extending from 'Formby Pool' and running south-east towards Hightown, as well as the inner part of section C, are muddy. Conversely, the inner part of section D is sandy, whilst the outer part is predominantly mud.

MATERIALS AND METHODS

BoEE counts are made during the high-water period of spring tides, on a pre-selected date in the middle of each month, when the numbers of roosting waders present are recorded. Further details of BoEE methods are given by Prater (1981). Peak winter BoEE counts over the period 1969-1986 were examined by Spearman Rank correlation analysis, as the trends appeared non-linear. Analyses concerning the estuary's national and international importance for roosting waders were based only on data from the 1982/83 to 1986/87 winters (November to March). The criteria used to assess the importance of an estuary are given in full by Salmon *et al.* 1987. Briefly, a site regularly supporting 1% or more of the estimated British wintering population of a species or 1% or more of the estimated W European population is regarded as respectively nationally or internationally important. In addition, a site regularly holding more than 20 000 waterfowl qualifies as internationally important by virtue of absolute numbers.

In addition to the standard BoEE counts of roosting birds, we made counts while the birds were feeding. One or more observers visited the estuary on 18 days between 13 December 1986 and 22 February 1987 to count the numbers of waders within one or more sections of the study area. Seven visits were made in December, eight in January and three in February. The times of the start and end of each count were recorded and the positions of wader flocks noted onto a sketch map. Counts were conducted at all stages of tide, although with few around high tide. Thus only 3 counts were made during the high tide period (defined as one hour either side of high water), 9 during the low tide period (more than 4 hours either side of high tide), 5 on the rising tide (1-4 hr before high tide) and 3 on the falling tide (1-4 hr after high tide). All, apart from those at high tide, were considered to have taken place during the "feeding period" of the birds. All 4 sections of the study area were counted simultaneously on 10 occasions, allowing calculation of the total numbers of birds on the estuary. The distribution of waders across the study area

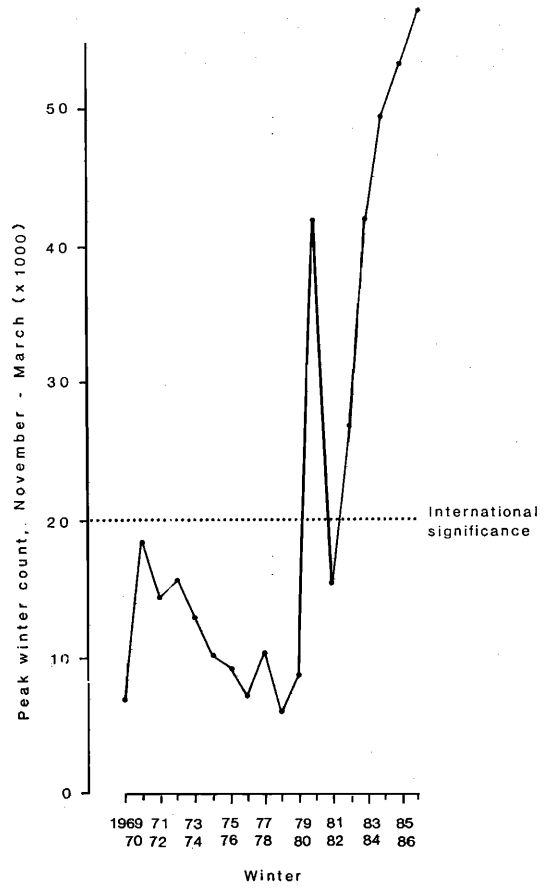

Figure 2. The increase in the total wintering wader population on the Alt estuary between 1969-1987. Figures are peak winter counts (BoEE data).

was examined by calculating the proportion of the total count of each species in each section of the study area at various states of tide. The proportions were derived from median counts.

RESULTS

Numbers present

Prior to the winter of 1980/81, the Alt estuary normally held nationally important total numbers of roosting waders in winter (Figure 2). Since then, the wader population has increased dramatically and the estuary has held internationally important concentrations except in 1981/82. Five species have contributed significantly to this increase: Redshank *Tringa totanus*, Ringed Plover *Charadrius hiaticula*, Bar-tailed Godwit, Knot and Grey Plover *Charadrius squatarola* (Figure 3). Conversely, numbers of roosting Curlew *Numenius arquata* have declined significantly, whilst wintering populations of Turnstone *Arenaria interpres*, Oystercatcher *Haematopus ostralegus*, Dunlin *Calidris alpina* and Sanderling have remained relatively constant or are showing signs of a recent increase in numbers (Figure 3). Over the most recent five-year period, 1982/83 to 1986/87, Knot, Sanderling and Bar-tailed Godwit have each regularly occurred during winter in internationally important numbers on the estuary. In addition, Grey Plover have occurred in nationally important numbers (Table 1).

During midwinter 1986/87, there was considerable variation in the recorded numbers of feeding and roosting waders on the estuary. Numbers of most species were highest in February, but there was marked variation in the pattern of seasonal abundance depicted by roost counts and feeding counts, particularly for Knot, Dunlin and Bar-tailed Godwit (Table 2). Numbers feeding of four species, Dunlin, Bar-tailed Godwit, Redshank and Grey Plover, were low in late January-early February (Figure 4). These counts were conducted on neap tides and were made shortly after a 10-day period of sub-zero temperatures and snow. Feeding counts of Knot did not follow the same pattern (Figure 4).

Recorded numbers of some species roosting on the Alt frequently differed greatly from the numbers recorded feeding, even when counts were conducted on the same day (Table 2). More Curlew fed in the estuary than roosted there; Curlews moved onto adjacent fields over the high tide period. For Knot, Dunlin and Bar-tailed Godwit, there was no obvious relationship between numbers feeding and roosting on the estuary at particular times: large feeding concentrations did not necessarily mean large roosting concentrations.

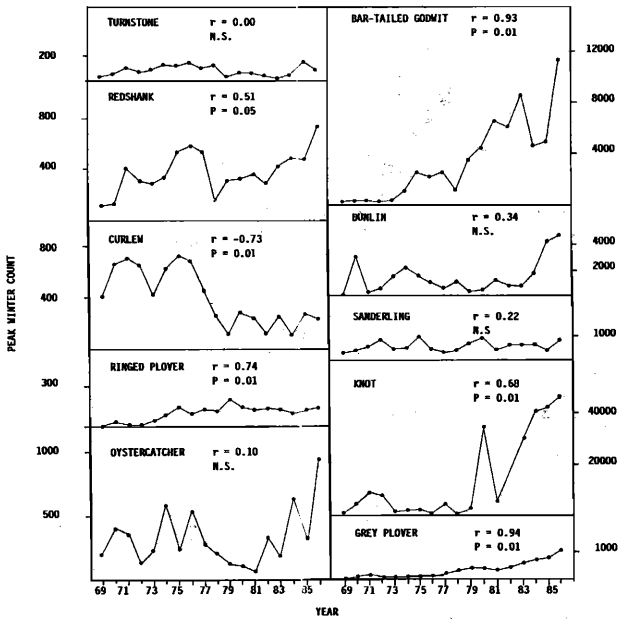

Figure 3. Trends in wintering populations of some wader species on the Alt estuary. Figures are peak winter counts. Trends were analysed by Spearman rank correlations.

Spatial distributions

During 1986/87, most of the waders roosted in front of the military firing range (Figure 5) where human disturbance was minimal. Their exact position depended on the height of the tide and the prevailing weather conditions. Tighly-packed flocks of Knot, Dunlin, Bar-tailed Godwit, Sanderling and Grey Plover formed the majority of roosting birds at this site. Smaller numbers including most Oystercatchers and Redshanks, frequently roosted further south, close to the river inflow at Hightown (Figure 5). Small numbers of Turnstones roosted at the landward end of the revetment and several hundred waders, in particular Ringed Plovers, roosted adjacent to the pools at Seaforth (Figure 5).

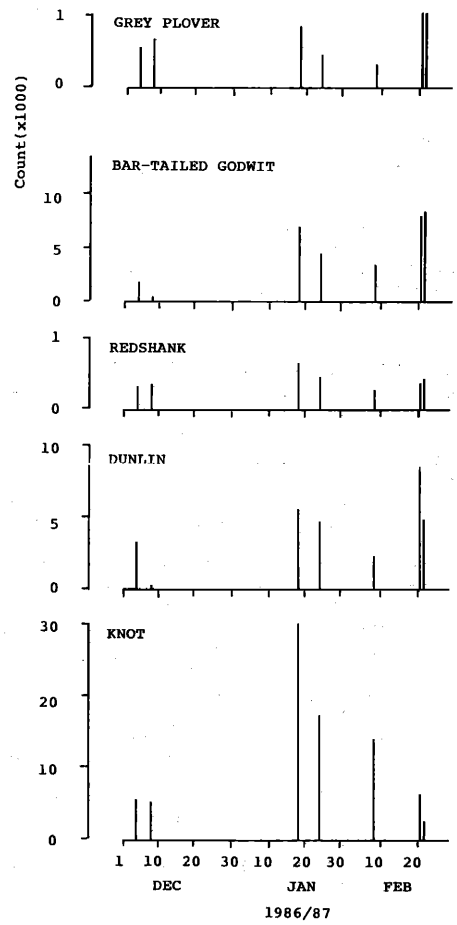

Figure 4. Numbers of some wader species feeding on the Alt estuary during winter 1986/87.

Table 1. The importance of the Alt estuary for wintering waders. Data are from 1982/83 to 1986/87.

	Average annual peak count (Nov-Mar)	Percentage of British Population	Percentage of European Population
Oystercatcher	485	0.2	0.1
Ringed Plover	131	0.6	0.3
Grey Plover	668	3.2	0.8
Knot	35 260	16.0	10.1
Sanderling	538	3.8	3.6
Dunlin	2 360	0.5	0.1
Bar-tailed Godwit	7 077	11.6	1.3
Curlew	201	0.2	0.1
Redshank	485	0.6	0.2
Turnstone	73	0.2	0.1

Table 2. Numbers of waders count on the Alt estuary in midwinter 1986/87.

Month	December			January			February		
Date	I (14)	II (14)	III[a]	I (18)	II (17)	III[a]	I (15)	II (21)	III[b]
All waders	10 302	11 969	-	27 698	44 561	-	56 831	25 859	-
Oystercatcher	693	393	89-393	350	273	273-405	952	930	430-992
Grey Plover	395	555	555-664	803	812	450-812	1 023	1 033	323-1 033
Knot	4 070	5 410	5 006-5 410	13 000	30 050	17 010-30 050	46 000	6 266	2 458-14 135
Sanderling	238	157	0-157	85	174	174-230	368	232	115-232
Dunlin	4 468	3 120	30-3 120	1 397	5 549	4 780-5 549	3 678	8 507	2 379-8 507
Bar-tailed Godwit	146	1 815	202-1 815	11 310	6 783	4 547-6 783	3 830	8 115	3 398-8 337
Curlew	14	201	40-201	152	220	42-220	244	306	6-306
Redshank	188	304	304-400	576	649	412-649	650	368	282-421
Turnstone	90	14	14-100	25	51	51-69	86	102	35-102

I = BoEE roost count; II = Feeding count on date closest to BoEE count; III = Range of feeding counts. [a] n=2; [b] n=3

The distribution of each species across the study area during the feeding period is shown in Table 3. Most birds fed in section B, particularly on the rising tide, when the birds were moving towards the main roosting areas (Figure 5). As the tide ebbed, a greater proportion of the birds moved into section C. This area is most free from human disturbance. At low tide, the majority of waders (about 70%) fed in sections B and D (Table 3).

Considering individual species, Oystercatcher, Curlew and Redshank were well dispersed, although section A generally held the smallest proportion of each (Table 3). Turnstone were much more restricted in distribution, and occurred mostly on the stony revetment in section C (Figure 5) at all stages of the tide. Grey Plovers and Sanderlings fed mostly in sections A and B, the former species generally occupying the muddy areas to the south-east of Formby Pool (Figure 5) and Sanderling mostly feeding close to the tide-edge. Dunlin occupied the muddy areas of sections B, C and D. The largest proportion of Bar-tailed Godwits occurred in sections A and B (Table 3), with Formby Pool and Taylor's Bank being the favoured feeding sites (Figure 5). On the rising and falling tide, however, a greater proportion were located in section D than was usual at low tide (Table 3). Knot were concentrated in section B on the rising tide, close to the main roosting area, and gradually moved into section C as the tide fell. At low tide, the majority of the Knot fed in sections C and D (Table 3).

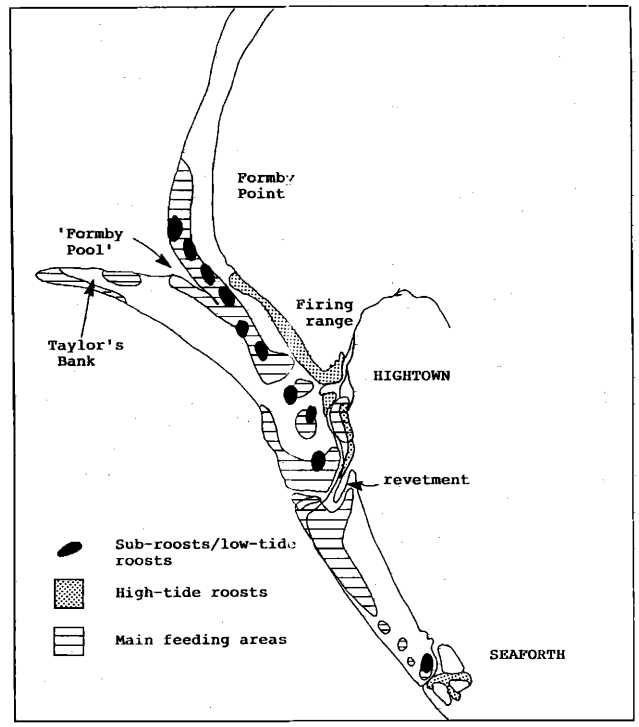

Figure 5. Feeding and roosting areas of waders on the Alt estuary during winter 1986/87.

Table 3. Percentage of waders recorded in each section of the study area during the low, rising and falling tide periods of mid-winter 1986/87.

	Tide period											
	low				rising				falling			
	A	B	C	D	A	B	C	D	A	B	C	D
No. of counts	3	4	6	9	3	2	5	4	2	2	2	3
Oystercatcher	4	30	46	20	1	56	19	24	1	17	58	24
Grey Plover	25	73	2	0	1	93	6	0	11	89	0	0
Knot	0	19	35	46	0	100	0	0	2	47	44	7
Sanderling	54	35	0	11	55	45	0	0	51	31	1	17
Dunlin	2	30	24	44	2	73	4	21	0	85	10	5
Bar-tailed Godwit	24	72	2	2	1	90	0	9	9	84	2	5
Curlew	20	35	35	10	6	57	7	30	17	0	0	83
Redshank	6	9	40	45	4	16	65	15	20	9	18	53
Turnstone	3	3	94	0	0	2	98	0	8	22	70	0
All waders	15	49	16	20	1	93	2	4	4	61	28	7

Table 4. Percentage distribution of Knot, Bar-tailed Godwit and Dunlin across roosts in Liverpool Bay, from December 1986 to February 1987 (BoEE data).

	Knot			Bar-tailed Godwit			Dunlin		
	Dec	Jan	Feb	Dec	Jan	Feb	Dec	Jan	Feb
Dee	17	35	9	2	0	0	36	49	26
Mersey	0	0	0	0	0	0	31	36	39
Alt	12	37	60	2	68	26	15	6	12
Ribble	71	28	31	96	32	74	18	9	23
Total Nos.	34 402	35 167	76 530	9 154	16 760	14 669	29 880	25 309	30 971

DISCUSSION

Mitchell *et al.* (1988) showed that significant declines in roosting populations of Knot, Bar-tailed Godwit and Dunlin have occurred on the nearby Dee estuary. Only for Dunlin have these changes occurred at the same time as a national decline in population size. Goss-Custard & Moser (1988) have linked this national decline in Dunlin populations to the spread over mudflat feeding areas of the estuarine cordgrass *Spartina anglica*. The Knot and Bar-tailed Godwit have not undergone such national declines, but rather have changed their behaviour to roost on the Alt estuary, whilst still making use of feeding areas on the Dee and north Wirral shore feeding areas. During the feeding period, we have observed movements of Knots and Bar-tailed Godwits from the Ribble to the Alt, and movements of Dunlins between the Alt, Mersey and north Wirral shore. Because the birds move between these estuaries so readily, the numbers of feeding Knot, Bar-tailed Godwit and Dunlin on the Alt on any particular day are not necessarily similar to the numbers of roosting birds on that day. Our direct observations, and the great variability in the numbers of birds feeding on the Alt, provide further evidence to that given for the Dee by Mitchell *et al.* (1988) of the considerable mobility of Knot, Bar-tailed Godwit and possibly Dunlin populations wintering in this Liverpool Bay area.

Similar high mobility of wintering waders has been recorded elsewhere in Britain. On the Firth of Forth, Symonds, Langslow & Pienkowski (1984) found that Knots, Bar-tailed Godwits and Dunlins ranged widely, whereas Grey Plovers, Turnstones, Oystercatchers and Redshanks tended to stay within the same part of that estuary throughout the winter. The behaviour of a single species does, however, vary between estuaries. For example, Minton (1975) found that Oystercatchers on the Wash ranged widely whereas Goss-Custard (1981) showed them to be remarkably sedentary on the Exe and east coast of the Wash. Similarly, Dunlin move considerably between feeding areas on the Forth (Symonds *et al.* 1984) but are largely sedentary on the Severn estuary (Clark 1983). In Liverpool Bay, the Dee and Mersey estuaries held most roosting Dunlin during the study period (Table 4). The proportion present on the Mersey seemed to remain relatively constant, suggesting that Dunlin populations roosting there may be largely site-faithful, as on the Severn (Clark 1983). The use of roosting sites outside the Mersey was however less predictable. The proportion roosting on the Dee (Table 4) was perhaps influenced by disturbance of roosts there as indicated by Mitchell *et al.* (1988): roosts on the Alt and the Ribble held more Dunlin when the Dee roosts had few birds. This suggests that Dunlins frequenting the Dee, Alt and Ribble estuaries, unlike those on the Mersey, are perhaps more mobile. Symonds *et al.* (1984) demonstrated differences in mobility of Dunlin between the outer and inner Firth of Forth.

Knot populations are known to be highly mobile, both within and between estuaries (Dugan 1981). Our study revealed that up to 35 000 Knot used the Alt feeding areas in December and January. This is almost all the Liverpool Bay population at this time (Table 4). These birds roosted largely on the Ribble in December but were spread out between the Dee, Alt and Ribble in January (Table 4). Greater numbers of Knot were present in February (> 76 000) than earlier in the winter, probably a consequence of influxes from continental Europe (Salmon *et al.* 1987). Relatively few of them fed in the Alt although most roosted there (Table 4).

Like Knots, Bar-tailed Godwits appeared to be very mobile, and mainly move between the Alt and Ribble estuaries (Table 4). Almost all Bar-tailed Godwits roosted on the Ribble in December and only relatively small numbers fed on the Alt at this time. A high proportion roosted on the Alt in January, and many of these birds also fed there. At the time of the February roost count, most birds had returned to the Ribble, although, many still fed on the Alt.

Our results suggest that at least for Knot, Bar-tailed Godwit and Dunlin, the Dee, Alt, Ribble and probably the Mersey estuaries should be considered as one intertidal complex. Each of these estuaries plays an important role in supporting the wintering populations of Liverpool Bay. Furthermore, our findings show that counts of waders at high water roosts cannot always be taken to reflect the numbers feeding on adjacent intertidal areas at low water. Satisfactory assessments of the importance of a particular site for wintering waders must take account of both feeding and roosting potential. Precisely which feeding areas are chosen in relation to which roosting site is used at any particular time is an interesting topic for further study. Certainly, further studies are needed of the Alt and its surrounding estuaries to better understand how this area is used by its internationally important populations of waders.

ACKNOWLEDGEMENTS

Data for the BoEE are collected by hundreds of volunteers without whom the Enquiry could not function. We are immensely grateful to them and to the BoEE organizers (British Trust for Ornithology) and co-sponsors (Nature Conservancy Council and Royal Society for the Protection of Birds). The firing range Superintendent, Mr. Addy, kindly granted permission to conduct counts in front of the

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ANTI-PREDATOR RESPONSES BY JACK SNIPE TO HUMAN INTERFERENCE

Michael Brinch Pedersen

Jack Snipe *Lymnocryptes minimus* are known to flush from the ground at a short distance when disturbed, often just before being stepped on. Instances have been recorded where birds are trampled to death or caught by hand (Sack 1965, Cramp *et al.* 1983). Although Jack Snipe may rely on the camouflage colouration of their back plumage (Hollyer 1984), this obstinate behaviour makes Jack Snipe vulnerable to terrestrial predators. Hence an avoidance response to intruders is required. A possible response is described by Glutz *et al.* (1977), in which the bird attempts to turn its back towards an intruder just before being flushed. Observations from Denmark verify this as a common response when birds are disturbed but not necessarily flushed.

In the years 1976-87 snipe studies were carried out in a 1.5 ha wetland in western Denmark. During the last two years of the study a total of 49 Jack Snipe were flushed. Of all individuals, 44 birds (90%) flushed in front of the observer. 42 birds (86%) flushed within 2 metres from the observer. All birds flushed at a distance of less than 6 m. Birds flew more or less direct away from the observer on 43 (88%) occasions.

Jack Snipe were regularly found when they were still hiding on the ground. On 7 March 1986 one Jack Snipe was found on a waterlogged mudflat on a riverbank, sitting with its back towards the observer. The bird was passed at close distance (<0.5 m) and remained on the ground. When the observer had passed the bird and was 3-4 metres beyond it, the bird turned so that its back again faced the observer. Shortly afterwards the bird was again approached. It had remained with its back towards the departure direction of the observer. Once again the bird turned to keep its back towards the observer after it had been passed. To check whether this behaviour was a regular response to the intruder, the bird was subsequently approached from a variety of directions. In almost every case the bird was found with its back towards the observer. Only when the bird would have been facing the sun did it turn its side towards the observer.

The back-turning behaviour may be a general defence against terrestrial predators. By turning its back in the direction from where an intruder is approaching or may be expected to approach, a Jack Snipe can fly away most directly and rapidly.

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