Peter Meininger gave us a thoroughly entertaining lecture on his expeditions to Egypt to carry out survey work for the Egyptian Atlas project.

The final talk of the conference was given by Guy Morrison of the Canadian Wildlife Service. Following on from Saturday's insight into the reproductive behaviour of Ruffs, Guy's talk might have been entitled "All you ever wanted to know about sex in Arctic waders/shorebirds, but were afraid to ask". Amidst an abundance of perversion, pride of place went to a Pectoral Sandpiper *Calidris melanotos* indulging himself in "interspecific homosexual necrophilia", by copulating with a dead male Red-necked Phalarope *Phalaropus lobatus*!

Sunday afternoon brought the conference to a close, with a field excursion to local sites of interest; an opportunity taken by many to add Avocet *Recurvirostra avosetta* and Barnacle Goose *Branta leucopsis* to their "tick-lists".

The weekend was thoroughly enjoyed by the over 100 people who attended, including members from the Netherlands, Friesland, Britain, Portugal, France, West Germany, Belgium and Poland. We certainly had a good time. Many thanks to our hosts at the Delta Department, especially Henk Baptist and Peter Meininger, and all those who helped the smooth running of the meeting.

Steve Percival and Digger Jackson, Department of Zoology, University of Durham, South Road, Durham DH1 3LE. U.K.

THE EFFECTS OF PREDATORS UPON SHOREBIRD POPULATIONS IN THE NON-BREEDING SEASON

by D.J. Townshend

INTRODUCTION

This paper examines the sparse information available on the effects of predators on shorebirds, and how these might be quantified further. Predation on adult shorebirds is known to occur during both the breeding and non-breeding seasons, but little is known of its magnitude.

Anecdotal records of both avian and mammalian predators killing shorebirds are scattered through the scientific literature. (Many more surfaced at the 6th International Workshop on the Ecology of Shorebirds at Cardiff, September 1983, at which the need for further research on the effects of predators upon shorebirds was stressed.) From such records, lists can be compiled of the taxonomic range of predators on shorebirds, and of the shorebird species taken by each of these predators. These lists vary both seasonally, with different predators on the breeding and wintering grounds, and geographically, e.g. between different breeding areas. However, from these spot observations alone it is not possible to quantify the rates of predation upon shorebird populations. Intensive studies of the prey taken by predators in one site are required. Only one thorough study has been published, by Page and Whitacre (1975). They measured predation on shorebirds by raptors. Studies of predation at the same site in California have continued (J.P. Myers pers. comm.).

RAPTOR PREDATION

Page and Whitacre quantified the daily rates of predation by raptors (Falconiformes and Strigiformes) upon the shorebird populations of a small estuary in California, and extrapolated from these to estimate the number of shorebirds of each species killed by each predator species during a winter. Because of the abundance of raptors hunting over the estuary, and the specialization on shorebirds by a single Merlin *Falco columbarius*, raptor predation was a significant cause of mortality of shorebirds there (Table 1). It is probable that raptors take much smaller proportions of shorebird populations on European than on Californian estuaries because there are fewer raptors wintering on European coasts, at least in recent years (Table 2). However, calculations presented below using the rates of predation measured by other workers show that even single raptors could have a considerable effect upon the shorebird population of an estuary.

At Teesmouth, N.E. England, a single female Merlin is present through each winter, and has been seen capturing Dunlin *Calidris alpina* but no other species of shorebird. Over a winter this predator could kill between 10% and 23% of the Dunlin population (Table 3) if it took only this prey. This value is suspiciously high for a species with an overall annual mortality rate of 25-30%, of which over one quarter is known to occur during the four weeks of incubation in

Table 1. Raptor* predation on wintering shorebirds in California

	% of total wintering populations taken by raptors			
	1 MERLIN Falco columbarius	1-4 SHORT-EARED OWLS Asio flammeus	1 LONG-EARED OWL Asio otus	ALL RAPTORS
DUNLIN (N = 1900) Calidris alpina	5.6%	11.7%	3.0%	20.7%
LEAST SANDPIPER (1600) Calidris minutilla	7.1%	2.3%	1.5%	11.9%
WESTERN SANDIPER (350) Calidris mauri	7.5%			7.5%
SANDERLING (130) Calidris alba	13.5%			13.5%
DOWITCHERS (100) Limnodromus spp.				15.5%

(Data from Page and Whitacre 1975)
*Falconiformes and Strigiformes

Table 2. Raptors* hunting shorebirds over two estuaries in winter

	BOLINAS LAGOON, CALIFORNIA	TEESMOUTH, N.E. ENGLAND
Regular	1 Merlin Falco columbarius 3 American Kestrels F. sparverius 1-4 Short-eared Owls Asio flammeus 1 Long-eared Owl A. otus	1 Merlin F. columbarius
Occasional	1-2 Great Horned Owls Bubo virginianus 1 Hen Harrier Circus cyaneus 1 Cooper's Hawk Accipiter cooperii 1 Sharp-shinned Hawk A. striatus	1-3 Short-eared Owls Asio flammeus 1-2 Kestrels Falco tinnunculus
Rare	1 Red-tailed Hawk Buteo jamaicensis	1 Peregrine Falco peregrinus 1 Sparrowhawk Accipiter nisus

*Falconiformes and Strigiformes

Table 3. Possible impact of one Merlin upon Teesmouth Dunlin population

Teesmouth population of Merlins Falco columbarius	1 female
Present on estuary	August to mid-April = 260 days
Prey taken on mudflats	Dunlin Calidris alpina
Estimate of no. of Dunlin-sized birds killed per day:	
1) Brown 1976	1 or 2 birds/day
2) Page & Whitacre 1975	2.2 birds/day
If Dunlin are only prey* No. taken per winter:	
@ 1 bird/day	260
@ 2.2 birds/day	570
Tees mid-winter population of Dunlin	2500
% of Dunlin population taken by Merlin	
@ 1 Dunlin/day	10%
@ 2.2 Dunlin/day	23%

*Passerines probably constitute a part of this Merlin's diet.

the breeding season (Soikkeli 1967). The calculation, therefore, has very limited value as it stands, but it does serve to emphasise the necessity of considerable additional information on the foraging behaviour and prey selection of the predator(s) before realistic and reliable estimates of predation rates can be produced.

MAMMALIAN PREDATION

Page and Whitacre's excellent work did not consider predation by mammals. However, mammalian predators are abundant at their study site (J.P. Myers pers. comm.). Thus the total predation on shorebirds during a winter at their site was not known; nor are any other estimates available of the proportions of total mortality of shorebirds in either the breeding or non-breeding seasons that are due to mammalian predation.

At Teesmouth the maximum rate of mammalian predation on shorebirds was estimated by locating all the dead individuals from a cohort of Grey Plovers *Pluvialis squatarola* carrying radio-transmitters. Table 4 sets out the results of this study. (Birds dying during the first week after capture (item 5 in Table 4) were excluded in case of possible after-effects of handling.) The overall predation rate was 12% (at maximum); foxes *Vulpes vulpes* ate or cached 6 out of the 7 birds that died. It is not known how many were actually killed by foxes and how many were dead when found and eaten by them, but clearly foxes could be important (nocturnal) predators on shorebirds on some sites.

OTHER EFFECTS OF PREDATION

In addition to the direct effects of predation, changes in behaviour of shorebirds may occur which could indirectly increase mortality.

In autumn all adult shorebirds undergo a complete moult of body and wing feathers so that at this time their flight capabilities are impaired. Their distribution in Western Europe is much more restricted during the moult period than it is during the rest of the non-breeding season (e.g. Pienkowski and Prokosch 1982, Pienkowski and Pienkowski 1983). They use the largest estuaries, with wide expanses of inaccessible mudflats, e.g. The Wash and the Wadden Sea, probably to decrease risks from predators, particularly mammalian ones. Once moult has been completed, many shorebirds migrate from the moulting areas to a wide range of often smaller estuaries (Pienkowski and Pienkowski 1983).

The risk of predation may be a factor promoting flock feeding in many non-breeding shorebirds (Goss-Custard 1970). Watching for predators will reduce the time available for feeding. During cold weather this may lead to deaths of individuals either by starvation, because they have insufficient time in which to meet their food requirements, or, if vigilance is reduced in order to increase feeding time, by predation. It is extremely difficult to quantify this effect.

On many estuaries shorebirds are known to change roost site or behaviour between diurnal and nocturnal high tides. At night they prefer to roost standing in water or on offshore islands and other inaccessible sites, and often collect into larger flocks (*e.g.* Sanderlings *Calidris alba* , Myers 1984), probably to reduce the risk of predation by nocturnal ground predators. Changes in nocturnal roost site after the arrival of a night-hunting owl in an area have also been found (J.P. Myers pers. comm.). It is thus important to consider the availability of safe roosting sites, in addition to adequate feeding areas, when assessing how to manage estuaries for shorebirds.

Table 4. Maximum estimate of predation risk for radio-tagged Grey Plovers

	ADULT	JUVENILE	TOTAL
1. No. radio tagged	31	30	61
2. No. found dead at Teesmouth	8	8	16
3. Cause of death not predation	2	3	5
4. Cause of death possible predation	6	5	11
4. as % of no. tagged	19%	17%	18%
5. Tagged birds found dead in first week	3	1	4
6. Possible predation after first week	3	4	7
6. of % of no. tagged	10%	13%	12%
7. Possible predators of these 7 birds			
a) fox	max. 2	max .4	6(10%)
b) raptor	1	0	1(2%)

VARIABLES AFFECTING PREDATION RATES

(a) Geographical location - The types and abundance of predators hunting shorebirds over estuaries during the non-breeding season vary geographically. This may result in differential predation risks for large and small shorebirds.

(b) Local habitats - Differences and seasonal changes in the use by different predators of the available habitats within an estuary, such as high and low mudflats and saltmarshes, will result in differences in both the species of shorebird and the individuals within a species that are most at risk. Furthermore, the vegetation surrounding an estuary, especially a small one, can influence the predators hunting over the mudflats and saltmarshes. For example, Sparrowhawks *Accipter nisus* can cause substantial predation of shorebirds on narrow shores and coasts close to scrub and woodland (P. Whitfield pers. comm.).

Human habitation can also influence predation risk. For example in Greenland, predators concentrated around a research station to scavenge from rubbish tips, and thereby put nearby breeding shorebirds at greater risk (Pienkowski 1984).

(c) Accessibility of intertidal feeding sites - Although mammalian predators have been seen on mudflats 4 km from the shore, the risk of predation is probably much less for shorebirds feeding on softer substrates, and on more distant and lower tidal level sites. Shorebirds such as Grey Plovers which tend not to use such feeding sites are at greater risk to mammalian predation than, for example, Knots *Calidris canutus*.

Many raptors rely on surprise when hunting. If local topography permits an undetected approach to certain intertidal flats or marshes, shorebirds there are likely to be at greater risk of attack by, for example, Sparrowhawks (P. Whitfield pers. comm.).

(d) Shorebird behaviour - Within a single site at any one time the risk of predation may vary between individuals. At Teesmouth some Grey Plovers and Curlews *Numenius arquata* exclude conspecifics from their feeding sites (Townshend 1982). These solitary individuals are believed to be at greater risk of predation by foxes at night than are other individuals that feed in flocks on less accessible mudflats (Dugan 1981). Indeed, Sanderlings in California abandon territorial defence during winter when an avian predator takes up residence (Myers 1980), and Buff-breasted Sandpipers *Tryngites subruficollis* do so temporarily when a raptor is present (Myers 1980b).

Assessment of the effects of shorebird predators will be complicated by seasonal variation in the composition of the flocks of each shorebird species on a site. It is known from ringing recoveries and sightings of marked birds that individuals of many shorebird species visit several sites during the non-breeding season (e.g. Dugan 1981, Pienkowski and Pienkowski 1983). Also, geographical races of a species may visit the same sites but at different times, as is found in the Dunlin in N.W. Europe (Minton 1975, Hardy and Minton 1980).

(e) Weather and season - Page and Whitacre (1975) observed a dramatic increase in the number of raptors hunting shorebirds during cold weather.

THE IMPORTANCE OF DATA ON PREDATORS

A small increase in winter mortality in shorebirds can significantly decrease population size (Goss-Custard 1981). In European estuaries the increase in raptor densities following the bans on certain pesticides (Newton 1979, Ratcliffe 1984), could result in an increase in shorebird winter mortality, possibly up to the levels observed by Page and Whitacre (1975) in California. Furthermore, an increase in raptor density is occurring also in North America (Newton 1979). Thus information on predation rates is essential in interpreting observed changes in the sizes of winter populations of shorebirds.

Quantitative information is needed on (i) prey selection by each potential shorebird predator, (ii) the rates of predation by each predator upon each species of shorebird, and, ultimately, (iii) the total extent of predation on shorebirds at a site, by both avian and mammalian predators.

The methods of Page and Whitacre (1975) should be adopted. In addition, radio-tagging could provide information on predation. Firstly, the use of space by foraging predators, particularly nocturnal mammals and owls, could be investigated. Secondly, by extending the technique described earlier, the attachment of miniature radio transmitters to a sample of several shorebird species at intervals throughout the non-breeding season would enable corpses to be found and causes of mortality to be assessed.

SUMMARY

Present knowledge of the effects of both avian and mammalian predators on shorebirds is minimal. One intensive study revealed very high rates of predation by raptors in California. The situation in European estuaries is considered. Calculations show that even single raptors could have a significant effect upon shorebird populations. Data from the Tees estuary show that mammals may be important predators of some species. Predators may also affect shorebird behaviour.

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D. J. Townshend, Department of Zoology, University of Durham, South Road, Durham, DH1 3LE, U.K.

(We would welcome further articles providing quantative information on the effects of predation on shorebirds. *Eds.*)

RECENT RECOVERIES OF WADERS RINGED IN BRITAIN AND IRELAND

compiled by Nigel and Jacqui Clark

The following lists are compiled from data provided by the British Trust for Ornithology, from whom permission must be sought before using these data in publications. As usual, space does not allow us to detail all records in full. For the more rarely recorded species all records are given, For others, except Oystercatchers, all movements of over 100 km are detailed. Birds recovered more than 3,000 days after ringing are detailed unless otherwise stated.

Symbols: Age is coded according to EURING code. v = caught and released (i.e. controlled), vv = ring number or colour marks (dye or rings) read in the field, + = shot or killed by man, x = found dead or dying, ? = manner of recovery unknown. Co-ordinates are given generally only when the locality is first mentioned.

Oystercatcher Haematopus ostralegus

For recoveries not listed in full the durations are as follows: <500 days 7, 500-999 days 3, 1,000-1,999 days 2, 2,000-2,999 days 4, 3,000-3,999 days 4, 4,000-4,999 days 2, 5,000-5,999 days 9.

FV61169	7	8.9.79	Plymouth, Devon 50 19'N 4 6'W	v Lewis, Western Isles 58 20'N 6 39'W	16.4.83
SS10908	4	25.8.64	Llanfairfechan, Gwynedd 53 15'N 3 58'W	x Sandoy, Faeroes 61 50'N 6 39'W	1.5.67
FV44786	5	25.9.80	Thornham, Wash 52 58'N 0 35'E	x Karmoy, Rogaland, Norway 59 10'N 5 13'E	13.5.83
SS97749	6	25.10.69	Walney Island, Cumbria 54 5'N 3 15'W	x Eysturoy, Faeroes 62 17'N 6 51'W	15.5.80
ED54079	6	13.8.67	Snettisham, Wash 52 51'N 0 27'E	x Nordland, Norway 67 30'N 15 30'E	16.5.83
FV08396	3	23.9.79	Point of Air, Clwyd 53 21'N 3 19'W	+ Kleppe, Rogaland, Norway 58 48'N 5 36'E	22.5.83
FS99934	8	21.8.74	Friskney, Wash 53 3'N 0 15'E	v Karnoy, Rogaland, Norway	4.6.83
FV49776	4	22.9.83	Bangor, Gwynedd 53 14'N 4 1'W	x Streymoy, Faeroes 62 3'N 6 49'W	15.6.83
FV43110	8	17.8.77	Friskney, Wash	x Vanern, Skaraborg, Sweden 58 39'N 13 30'W	5.8.83
FV44871	5	22.8.82	Wolferton, Wash 52 50'N 0 26'E	+ Loon Plage, France 50 59'N 2 13'E	6.8.83
SS538--	2	7.9.68	Gower, Glamorgan 51 39'N 4 15'W	x Oban, Strathclyde 56 12'N 5 37'W	10.8.83
AT96350	2	11.11.62	Gower Glamorgan	x Vagar, Faroes 62 3'N 7 11'W	15.8.81
FV48702	5	23.4.77	Dawlish Warren, Devon 50 37'N 3 26'W	vv St. Nicolaasga, Friesland, Netherlands 52 55'N 5 44'E	15.8.83