

# Scottish Birds

Winter 1994

THE JOURNAL OF  
THE SCOTTISH  
ORNITHOLOGISTS'  
CLUB



Vol. 17 No. 4

ISSN 0036 9144

# Scottish Birds

## The Journal of the Scottish Ornithologists' Club

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**Scottish Birds**, the official journal of the Scottish Ornithologists' Club, publishes original material relating to ornithology in Scotland. Papers and notes should be sent to The Editor, *Scottish Birds*, 21 Regent Terrace, Edinburgh EH7 5BT.

Two issues of *Scottish Birds* are published each year, in June and in December. *Scottish Birds* is issued free to members of the Scottish Ornithologists' Club, who also receive the quarterly newsletter *Scottish Bird News* and the annual *Scottish Bird Report*. These are available to non-members at a subscription rate (1992) of £30.

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## Research Progress Report

G. SHAW

### *A ten year study of Barn Owl conservation in conifer forests*

Twenty-five years ago, when I first became enthralled by this beautiful bird, Barn Owls *Tyto alba* were a common sight hunting at dusk over the young conifer plantations of Galloway in south-west Scotland. The afforestation of these upland grasslands, mainly during the 1950s and 1960s, involved the removal of grazing sheep, and this encouraged a rapid increase in the populations of field voles *Microtus agrestis* in the unchecked grass growth. Owls, and other vole-eating birds of prey, were quick to exploit this temporary glut of food.

Years of pastoral farming had left the Galloway hills treeless, and trees with potential nest-cavities simply did not exist, but the Barn Owls found a ready supply of nesting sites in the remote, and now abandoned, shepherds' cottages. When I first began to study the Barn Owls in Glentroot Forest in the early 1970s, I located ten breeding pairs, using 12 nesting sites, all in former dwellings. From the outset, it was clear that the affairs of man and owl were closely linked.

Lacking maintenance, the abandoned cottages had a limited life; slates blew off, rain rotted the roof timbers, and decay set in. The Barn Owl study became a sorry tale of diminishing numbers as nest sites were lost. At first this hardly mattered, since the conifers were growing up, shading out the grass and with it the voles. Many former territories became unviable anyway. By the mid-1980s only four buildings remained usable as nest sites.

Around this time the pendulum began to swing back to favour the owls; the earliest plantings had become productive timber. Clear-felling and re-stocking commenced; large areas within the forest were opened up, and were quickly re-colonised, first by grasses and then by voles. Now the opportunity was there for the owls also to re-colonise, and the loss of the derelict buildings had become an acute problem. The diminishing area of newly-afforested land provided no solutions; by the 1970s there had developed a ready sale for second homes and quiet country retreats, and any former tied houses entered the housing market.

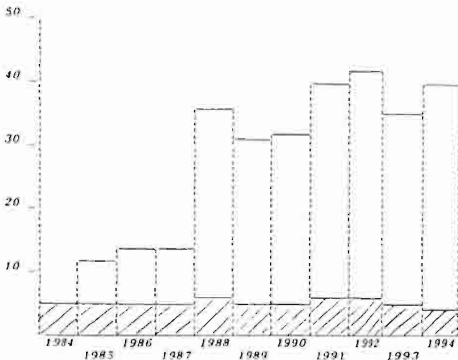
With this background, in 1984 the Forestry Commission in Newton Stewart Forest District initiated a Barn Owl Conservation Project; the proposition was simple - a food supply (field voles) existed, but nest sites were lacking. If artificial nest sites could be provided and accepted, there was the potential to increase the owl population many times over. A project team of Andrew Dowell and myself, aided and advised by Iain Taylor of Edinburgh University, and by Steve Petty from FC Research branch, set about designing and erecting a range of tree-mounted nestboxes throughout the Forest District.

Several nestbox designs were employed; the common feature was a large cavity space that could be fixed onto a tree. At the time the increasing interest in Barn Owl conservation, motivated by the realisation of a serious national decline, was at the stage of providing static nestboxes in suitable farm buildings.

Our aim was to go a step further, by taking the nest site out to where the prey was. Boxes were erected in pairs, to avoid competition from the earlier-nesting Tawny Owl *Strix aluco*. By the spring of 1985, 33 sites were in place and this was gradually increased to 89 by 1989, after which the number was kept constant.

Small numbers of Barn Owls began to use the nestboxes from the spring of 1985 onwards, with a huge increase in 1988 from nine to 31 pairs (Fig. 1). Since then the number has fluctuated between 26 and 37 pairs; the original study area in Glentool Forest (now a part of Newton Stewart Forest District) has regularly held 15-16 pairs in 'new' territories, in addition to the four sites remaining in old buildings.

The first conclusion from the project was that nestboxes do work, and that in the right place - where there is an abundant food supply of



**FIGURE 1. Number of Barn Owl pairs nesting in Newton Stewart Forest District, 1984-1994. Hatched part of column shows nests in old buildings, rest of column shows nestbox pairs.**

small mammals - it is feasible to create 'designer' owl territories, simply by providing a suitable nest site. A Forestry Commission Bulletin was published, describing the methodology, and encouraging many other Forest Districts in all six national FC Regions to develop similar conservation schemes. But within the original project we realised that in monitoring an annual sample of 30+ nests, there was an opportunity to develop a research programme to answer some of the questions that inevitably arose.

### **Where do they come from?**

The spectacular increase in the nest box owl population immediately makes one ask where they have all come from. If established pairs of owls had been persuaded to quit their territories to exploit voles in the forest, then the project might be counter-productive. We tackled this problem in two ways; firstly, all existing nest sites in the forest were monitored each year. The number of owls using these old buildings remained stable in the ten years from 1985 (Fig. 1). Secondly, in association with workers from the Hawk & Owl Trust, as many owl chicks as possible were ringed at established nest sites in a 50km radius surrounding the forest.

From 1986 we began to trap the breeding owls at their nestboxes, beginning with a small number and monitoring the degree of disturbance caused. Fortunately, no adverse effect could be detected, and by 1988 most female owls were routinely trapped each year. Males were more difficult, since they spent only a limited time at the nestbox, and the annual sample has always been small. However, we were able to show that 82% of females trapped in 1988 were first-time breeders, and that most had been hatched in farmland and forest nests the previous year. The remaining, older females had bred in the

nestboxes in earlier years. At ten newly-occupied nestboxes where the male was trapped, all were yearling birds. There was no evidence that older birds, which may have previously been breeding outside the forest, had switched nest sites. Surveys conducted in the surrounding farmland showed a stable occupancy throughout.

### ***How far do they come?***

The same ringing/recapture programme showed that in 1988, 18 first-year females had moved an average of 9.7km from their natal site to breed in a nestbox; seven marked males had dispersed an average of 6.1km. Many subsequent handlings over the years have not significantly altered these figures; the furthest movement for a female has been 22km, and half this distance for a male. Given the spread of the chick-ringing operations, it would have been possible to detect movements of 50km+, if any had occurred.

Once settled, the breeding owls were extremely site-faithful. During the period 1985-94, only a single established male changed nestboxes, and then merely to the nearest adjacent territory. Females were slightly more mobile; in 70 cases where a female was

trapped in two successive years, 50 (71%) were at the same site and 20 (29%) had moved boxes. None had moved more than three territories from their earlier breeding site, and most were on the adjacent territory.

The sedentary nature of Barn Owls has important implications for their conservation. Young owls disperse over short distances, and adults move hardly at all; once an owl population enters a decline, or is lost, it may be difficult to recover unless there is a source population close by. Nestbox schemes should work outwards from the source population, rather than in isolation.

### ***What do they eat?***

The forest habitats provided abundant field voles, and examination of owl pellets and prey caches at nests showed that the owls greatly favoured this one prey item. However in northern temperate latitudes, grassland voles exhibit cycles of abundance over a 3-4 year period. By sampling, using a vole sign index, we were able to define a roughly 3-year cycle in the Galloway forests; a year with high vole populations was followed by a low year, and then by a year with increasing numbers (Table 1). In low vole years, the owls brought

**TABLE 1. *Some aspects of breeding performance by Barn Owls using nestboxes in Newton Stewart Forest District, through two complete vole cycles 1989-94. Columns are totals over two years.***

Vole numbers	LOW 1989+1992	INCREASE 1990+1993	HIGH 1991+1994
Occupied nestboxes	63	57	70
Pairs laying eggs	39 (62%)	44 (77%)	68 (97%)
Pairs rearing young	19 (30%)	36 (63%)	59 (84%)
Average laying date	23 May	30 April	10 April
Young reared	33	103	189
Average Adult survival to next season	54%	64%	38%*

\*adult survival after high vole years based on 1988/89+1991/92

some voles to their nests, but also shrews and a variety of small woodland birds. These items seemed either small and unprofitable, or difficult to catch. In such years it was likely that the breeding owls experienced a shortage of suitable food, since there were no mice or other small rodents to switch to - as there might have been in more traditional farmland habitats.

The low vole years did not necessarily mean that there were fewer Barn Owls in the nestboxes (Table 1). However, what did happen was that in these years fewer birds (44-77%) laid eggs, and only a small part of the breeding population (11-35%) successfully reared young. By contrast when vole numbers were high, virtually all birds laid, and most (68-85%) were successful. In the early stages of the breeding attempt, from March onwards, the female owl was very inactive, and was always found at or in the nestbox. She depended on her mate to bring her food, and by conserving her energy she typically achieved a rapid body weight gain of around 30%, enabling her to produce a clutch of 5-6 eggs. In low vole years, some females showed only minor weight changes, and either produced small clutches (often later abandoned) or none at all. Those birds that did lay took longer to reach laying condition, resulting in a 6-week difference in average laying dates between high and low vole years (Table 1).

### **Population processes**

In good food conditions the Barn Owls laid large clutches and produced many young; a few pairs successfully reared two broods in high vole years. This ability to react quickly to changing conditions meant that the owls could establish a permanent population in the forest, provided that the breeding birds could survive the low food years and be ready to profit when the voles increased. On average, about half

of the females survived to the next successive breeding season; because we knew that adult dispersal was limited, most of these that disappeared can be assumed to have died, though few were ever found. When vole numbers crashed, adult survival sometimes dropped as low as 32%, and when vole numbers were increasing it exceeded 80%.

Barn Owls normally began to breed in their first year of life; at the extreme a young bird which became independent at the beginning of November was found sitting on eggs the following April. Each year there was a number of vacancies in the nestboxes, due to losses of adult birds, which could be filled by first-time breeders. However, recruitment of yearlings was not directly related to the opportunities available; 56 out of 78 yearlings arriving in the population had hatched in years when vole numbers were increasing. Only 18 (23%) came from the high vole years, when most chicks were produced, and a mere four (5%) had hatched in low vole years. This result was most likely due to young birds being better able to survive the winter when vole numbers were on an upward trend.

This pattern also meant that it was most profitable for adults to produce young in those years when voles were increasing, since they were more likely to contribute to future generations of owls. In this light, the very poor breeding output every third year was not such a disaster for the owls involved; adult survival in the low vole years (53-55%) was rather better than after a high year (32-44%). Survivors to the next breeding season would gain on two counts; next year's offspring would have the greatest chance of entering the future breeding population, and the adult birds themselves would have a high probability of surviving to reproduce again. Taken in isolation, these years of dismal breeding failure might seem worrying, but the more complete picture serves to emphasise the value of long term monitoring.

### ***Future Work***

The nestbox scheme was begun as a conservation project, and research developed out of monitoring the project. While the principle has been established, that nestboxes can be used to increase Barn Owl numbers, there remain some conservation objectives that can be met from long term monitoring. Most importantly, we have accumulated data from 89 'manmade' territories, many for a full ten years. Fifty-eight have been used by Barns Owls, some just once and some right through; for the other 31 at least, our idea of a suitable territory failed to match that of the owls. The challenge now is to combine all the

habitat features and the breeding records for each territory, so that in the future we can make the best possible use of our nestbox resources, by placing them more precisely in the places that have most of everything that a Barn Owl could need.

### ***References***

Methodology is outlined in:

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South Scotland Region,  
55-57 Moffat Road, Dumfries. DG1 1NP.***

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## Changes in breeding numbers of Kittiwakes in Shetland, 1981-1994.

M. HEUBECK & R.M. MELLOR

***Counts of Kittiwake nests indicate that the Shetland breeding population in 1991-94 was 26% lower than in 1985-87, and 30% lower than in 1975-81. The decline has been far from uniform. There has been only a slight, recent decrease at Fair Isle whereas 60% fewer nests were found in 1991-94 along the south-west and east coasts of Shetland than in 1980/81. This decline is considered to have been due mainly to two factors. Firstly six successive years of low breeding success in the late 1980s, caused by a scarcity of sandeels, resulted in few new recruits to the breeding population. At the same time, predation at Kittiwake colonies by Great Skuas increased considerably and has continued at a high level at many colonies, even though sandeel abundance has increased. Improved breeding success since 1991 may soon lead to a halt to, or a reversal of, the population decline although this may be offset by continued predation pressure, which is also likely to have local effects on nest site selection.***

### ***Introduction***

When the Shetland Oil Terminal Environmental Advisory Group (SOTEAG) began monitoring seabird populations in 1978, the Kittiwake *Rissa tridactyla* was selected as one species to be studied. The original aim was to count adults and nests in study plots established by the former Nature Conservancy Council (NCC) at four colonies in 1975-77, with the assumption that changes in numbers in these plots would reflect wider population change.

In 1981 the NCC made the first comprehensive census of Kittiwake colonies in Shetland, surveying virtually the entire cliff coastline from the sea (Richardson 1985). Also in 1981, SOTEAG made counts from land of nests in widely scattered colonies to detect changes since the 1969/70 'Operation Seafarer' counts (Cramp *et al.* 1974) and a 1974 survey by the Institute of Terrestrial Ecology (Harris 1976). The SOTEAG study

found: a) although counts in SOTEAG study plots had declined, there was no evidence of any overall population decline between 1974-81, b) numbers had increased at some colonies, decreased at others, some colonies had disappeared and some new colonies had formed, c) counts from land (rather than from the sea) underestimated numbers of nests by an average of 36% (Pritchard 1981). When further counts were made from the sea in 1985 for the Seabird Colony Register it became clear that inferring overall population change by extrapolation from counts at study plots within colonies was invalid; instead it was decided to count total numbers of nests from a Zodiac inflatable along entire stretches of coastline at the appropriate time of year (Heubeck *et al.* 1986). This paper presents the results of counts made in this way since the 1981 survey.



## Methods

Counts were made from a Zodiac inflatable boat usually crewed by three people, one handling the boat, another counting nests and the third counting adult Kittiwakes on the cliffs. Exceptions were at Sumburgh Head and Eshaness where some colonies were counted from land one or two days after the others had been counted from the sea. A few colonies were counted by landing on and climbing up rocks from which a better view of nests was obtained. All known colonies were visited and suitable cliff habitat was checked during surveys for new colonies. Two factors aided the ease of counting. Firstly, most Kittiwake colonies in Shetland are relatively small (only 11% in 1981 contained more than 250 nests (Richardson 1985)) and any large colonies were counted in sections, according to topographical features of the cliff. Secondly, counts tended to be made by the same observers (using tally counters) who rapidly gained experience, and knowledge of more problematic colonies. Counts were normally made during the first three weeks of June (but some in 1981 and 1985 were in the first few days of July) when the maximum number of nests might be expected.

Sea conditions were critical in determining which coasts could be surveyed each year; counts were made in winds up to Beaufort Force 5, as long as winds were offshore and there was little swell. Coverage was therefore more opportunistic than planned, although we tried to ensure that no more than three years elapsed between surveys of particular coasts. Where possible, nests were differentiated as 'incubating' (a well-built nest with an adult apparently incubating or brooding), 'AON' (a well-built but apparently empty nest, whether or not attended by an adult) and 'trace' (fragments of nest material only) (Harris 1987). The ability to see trace

nests varied with viewing distance and sea conditions; here we consider well-built nests only, i.e. 'incubating' and 'AON' combined and referred to hereafter as AONs. Sometimes we encountered colonies with apparent high proportions of early breeding failures (typically, many partially disintegrated nests would be seen). On these occasions it was particularly difficult to categorise nests; those that were essentially substantial were counted as AONs, but the difference between the actual numbers of nests that had been built and that recorded will have been greater than normal. All adult birds ashore were counted, those in well-defined roosts or loafing areas being recorded separately from those in breeding colonies, and the location of all colonies and roosts were recorded on 1:10,000 maps. Counting error was not quantified but was thought to have generally been small since most colonies were relatively small and surveys were usually made in favourable sea conditions. Occasionally, a combination of cliff topography and swell or tidal chop made counts at particular colonies difficult, when the tendency was probably to underestimate numbers, but such errors contributed little to the overall changes recorded.

Kittiwake 'colonies' have been defined variously as aggregations separated by more than 50 yards (Boyd 1960) or 200 yards (Coulson 1963) of cliff free of nests. Our definition, of groups of nests clearly separable on 1:10,000 maps and hence distinguishable by different observers on subsequent visits usually fell between these distances. We use Coulson's (1963) term 'breeding station' to refer to groups of colonies with less than a mile of unoccupied coast between each other or, in the case of islands, separated from the nearest colony by less than a mile of sea.

The large breeding stations on Fair Isle and Noss, counted by Fair Isle Bird Observatory and Scottish Natural Heritage staff respectively, were subdivided into sections of coast according to natural features rather than discrete colonies. Also, the 1992 survey of Foula (previously surveyed only in 1976 by Glasgow University and in 1987 by NCC) was the first occasion that colonies were recorded in the manner we used elsewhere so the history of changes at individual colonies at these major breeding stations could not be determined.

## Results

### Breeding stations

In addition to Fair Isle and Noss, 57 breeding stations were recorded between 1981 and 1994 (Fig. 1; Table 1). Over Shetland as a whole, the most recent counts of AONs were c.26% lower than in 1985-87 and c.30% lower than in 1975-81 (Table 1). Breeding had ceased by 1991-94 at seven small stations and only one new one was established, at Siggar Ness, where roosting adults but no nests were recorded in 1981. At stations surveyed in 1980/81 (i.e. all except Fair Isle and Foula), the number of AONs had decreased by 51% by 1991-94 while the number of adults decreased by 53% (Table 1).

The total counts of AONs at breeding stations on Foula suggested lesser changes, decreases of 22% between 1975 and 1987, and only 1% between 1987 and 1992. However, these counts may be less comparable than at other breeding stations as some colonies were counted from land in 1976, while the 1992 survey was conducted in perfect sea conditions with absolutely no wind or swell. Less favourable conditions in

1987 and 1976 limited access to some colonies (R.W. Furness & M.G. Richardson pers. comm.).

At Fair Isle, the numbers of AONs increased until at least 1988 but fell by 6% between 1988 and 1992, although some colonies were overlooked in 1988 and the actual decrease was probably c.10% (Harvey *et al.* 1992).

### Breeding areas

To examine regional and temporal trends in breeding numbers more critically, we used arbitrary geographical areas within which all breeding stations were counted in the same years (Fig. 1; Table 2).

*Area A:* At Sumburgh Head and Horse Island the number of AONs declined during the 1980s to a peak rate of -13% p.a. between 1989 and 1991, lessening slightly to -10% p.a. between 1991 and 1993; the number of AONs in 1994 was similar to 1993 and 56% lower than in 1981.

*Area B:* In the south-west Mainland there was little difference in the totals of AONs in 1981 and 1987, after which numbers fell with the highest rate of decrease (-14% p.a.) again between 1989 and 1991, a further decrease causing the 1993 total to be 46% less than in 1981.

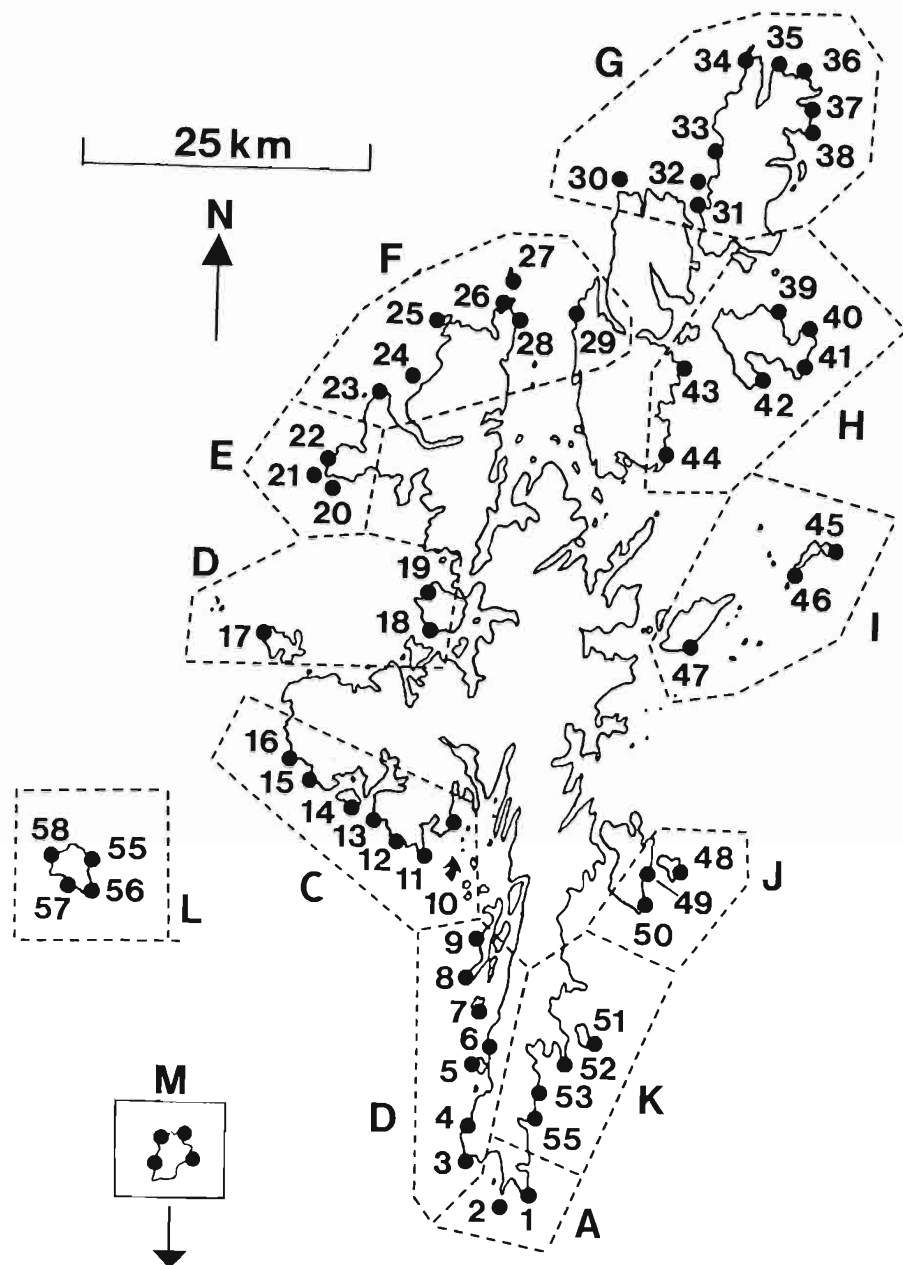
*Area C:* In the west Mainland the number of AONs fell between 1981 and 1986 but rose again by 1988, after which there was a steep decline with numbers in 1993 being 70% lower than in 1981.

*Area D:* At Papa Stour and Muckle Roe there was little change in totals of AONs until gradual decreases between 1989, 1992 and 1993, the last count being 18% less than in 1981.

*Area E:* At Eshaness, after a slight decrease in the early 1980s, numbers of AONs increased by 7% p.a. between 1985 and 1989, but thereafter fell substantially with the 1994 total being 32% lower than in 1981.

*Area F:* Many abandoned, disintegrated nests were noted on the 1985 survey of north-west Mainland and early breeding failures

FIGURE 1. The location of Kittiwake breeding stations in Shetland, 1981-94, and the areas within which all stations were counted in individual years.



**TABLE 1.** *The number of apparently occupied nests (AONs) at Kittiwake breeding stations in Shetland in 1981, 1985-87, and the most recent count (1991-94). Where counts were made in more than one year in 1985-87 both are given, consecutively, and the later count was used to calculate the total. In 1985-87 no count was made at Gruna Stack (No. 24) and those at Braga Ness (No. 15), Watsness (No. 16) and Tingon (No. 23) were made from the land. No counts were made at Fair Isle or Foula in 1981, those given were from 1975 and 1976, respectively. Indicated are the number of colonies known to have existed between 1981 and 1991-94, the number at which numbers of AONs increased or decreased between 1981 and 1991-94, the number of new colonies that formed, the number that disappeared and the number presumed missed by the 1981 survey. \* = some colonies formed since 1981 had disappeared by 1991-94.*

Breeding Station	1981 AONs	1985-7 AONs	1991-4 AONs	Cols.	Inc.	Dec.	New	Dis.	Missed 1981
1. Sumburgh Head	2641	2451	1366	25	4	18	0	2	1
2. Horse Island	594	516/327	62	7	0	1	0	6	0
3. Siggarr Ness	0	1	102	3	0	0	3	0	0
4. Fitful Head	500	258	177	6	0	4	0	1	1
5. St Ninian's Isle	47	65/77	140	3	2	1	0	0	0
6. Ness of Ireland	203	151	126	3	0	1	1	1	0
7. South Havra	29	9	0	1	0	0	0	1	0
8. Kettle Ness	280	315	48	2	0	2	0	0	0
9. West Burra	615	897	304	8	2	5	0	1	0
10. Reawick	272	197	41	4	0	3	0	1	0
11. Skelda Ness	186	64	58	5	1	2	0	2	0
12. Westerwick	454	284	133	10	0	5	1	4	0
13. Burga Stacks	58	3	17	1	0	1	0	0	0
14. Vaila	255	291	102	14	1	5	3	7*	0
15. Braga Ness	12	27	15	1	1	0	0	0	0
16. Wats Ness	11	0	1	1	0	1	0	0	0
17. Papa Stour	1059	1087	894	17	3	11	0	3	0
18. South Muckle Roe	96	99/69	33	4	0	2	0	2	1*
19. Swabie Stack	56	46/83	60	1	1	0	0	0	0
20. Dore Holm	375	328	197	2	0	2	0	0	0
21. Skerry of Eshaness	1266	1271	756	5	1	4	0	0	0
22. Mainland Eshaness	837	731	718	5	2	1	0	2	0
23. Tingon cliffs	35	21	3	4	0	0	1	3	0
24. Gruna Stack	50	-	81	3	2	0	1	0	0
25. Uyea	731	365	450	9	2	5	0	2	0
26. Fethaland	14	0	0	1	0	0	0	1	0

27. Ramna Stacks	1350	994/1047598	14	0	12	0	2	0
28. Trumba	2	1/11	16	1	1	0	0	0
29. Varnadil	56	10	10	2	0	2	0	0
30. Gloup Holm	78	7	81	3	1	1	0	1
31. Blue Mull	158	114	87	4	0	2	0	2
32. Lang Holm	32	2	0	1	0	0	0	1
33. South Holms	121	305	71	3	1	1	0	1
34. Hermaness	3872	3497	2280	51	8	25	0	15
35. Saxavord	141	186/432	447	13	4	5	2	3*
36. Virdik	84	72	23	1	0	1	0	0
37. Burgar	217	211	196	2	1	0	0	1
38. Mooa Stack	53	92	67	1	1	0	0	0
39. Clett Stack	30	26/50	0	1	0	0	0	1
40. Strandburgh Ness	273	129/51	49	3	0	1	0	1
41. South-east Fetlar	32	0/3	7	6	0	0	2	5*
42. Lambhoga	37	66/67	11	2	0	1	1	1*
43. Birrier	82	11/43	62	2	1	1	0	0
44. Burravoe	392	169/168	109	9	0	3	3	4*
45. Grunay	261	148	12	6	0	1	1	5*
46. North Benelip	23	24	22	1	0	1	0	0
47. Clett Head	25	8	33	2	1	0	0	1
48. Noss (1980)	(11050)	9348	4301					
49. Millburn Geo	19	27	0	1	0	0	0	1
50. Hole of Bugars	19	0	0	1	0	0	0	1
51. Mousa	148	14	0	2	0	0	0	2
52. Noness	1627	1489	614	8	0	5	0	3
53. Troswick Ness	716	520	187	3	0	3	0	0
54. Boddam	256	277	239	6	2	3	0	1

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Total AONs	31380	27518	15406	295	43	143	19	91	7
Total Adults	47292		22104						

55. Hodden Geo, Foula			19	2					
56. South-east Foula			76	6					
57. The Noup, Foula			523	2					
58. North-west Foula			3688	31					
Foula Total	(5570)	4350	4306	41					

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Total AONs	36950	31868	19739	335					
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59. Fair Isle	(17000)	19072	18159						
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Shetland Total AONs	53950	50940	37898						
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undoubtedly contributed to the low total count. Accepting this, the directions of changes recorded were similar to Eshaness although slower, the 1994 total being 48% less than in 1981.

*Area G* : There was little change in AON totals in Unst and north Yell until a decrease between 1987 and 1991, when 32% fewer were recorded than in 1981. Unfortunately, sea conditions in 1994 prevented counts in the Area.

*Area H* : The number of AONs on Fetlar and Yell more than halved between 1981 and 1985, with lesser decreases until a further substantial decline between 1989 and 1991. Numbers increased between 1991 and 1993 (mainly at the Yell colonies), when the total of AONs was 69% lower than in 1981.

*Area I* : The number of AONs fell throughout 1981-92 at colonies on Whalsay and Out Skerries, with the greatest rate of decrease (-20% p.a.) between 1986 and 1989. As on Yell there was a slight increase in 1993, when numbers were 78% lower than in 1981.

*Area J* : One small colony on Bressay disappeared by 1988, the other by 1993. Numbers of AONs on Ness fell increasingly rapidly throughout, the 1994 count being 61% lower than in 1980.

*Area K* : After a slight decrease in the early 1980s counts of AONs in south-east Mainland indicated periods of relative stability punctuated by steep declines between 1988-90 (-21% p.a.) and 1992-93 (-30%). As in Area A the 1994 count was similar to 1993 but 62% lower than in 1981.

### **Breeding colonies**

Breeding had ceased by 1991-94 at 91 colonies known to have existed since 1981 (30% of the total) while only 19 new ones were known to have formed, six of which had disappeared by 1991-94. It was commonplace

for changes in the number of AONs at nearby colonies to occur both in different directions and at highly variable rates. An example was at Noness, where counts of nests were also made from black and white and colour slide photographs taken from the sea in 1977 (Fig. 2; Table 3). There was some reduction in numbers at most colonies between 1977 and 1981 but by 1988 there had been substantial decreases at colonies 3 and 4, but large increases at colonies 5 and 6. By 1993, colonies 3 and 4 had disappeared completely and breeding was almost entirely confined to the four southern colonies, which in 1977 held only 53% of all AONs at the breeding station.

Some recorded changes in breeding distribution strongly suggested that established, breeding adults were moving from one colony to another. On the headland of Hermaness, the number of AONs in the central colonies between Saito and The Neap fell from 1,275 in 1981 to 694 in 1987 (-45%) and 223 by 1991 (68%). At other colonies on the headland to the north and south the respective decreases were only 2% and 23%, while there was a substantial (150%) increase at the South Holms immediately south of Hermaness between 1981 and 1987 (Table 1), and to the east at Saxavord where one colony (around a large cave entrance) increased from just two AONs in 1981 to 112 in 1985, 337 in 1987 and 361 by 1991. At Papa Stour, where there was little change in AON totals for the breeding station between 1981 and 1989, the numbers at colonies in relatively open situations on the cliffs of Papa Stour itself fell progressively from 27% of the total for the breeding station in 1981 to 17% in 1989 and just 8% in 1993, with corresponding increases in the proportion of the total of AONs occurring on the offshore stack of Fogla and Lyra Skerries, where colonies were mostly in large cave entrances. This tendency

**TABLE 2. Counts of Kittiwake AONs at colonies in breeding stations in the areas indicated in Figure 1, 1981-1994. Areas L and M were counted in 1976 and 1975, respectively, not 1981. Percentage changes per annum (%p.a.) between sets of counts are indicated.**

AREA	1981	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
A. AONs	3235	2967				2290		1750		1404	1428
%p.a.		-2%		-6%			-13%		-10%		+%
B. AONs	1675			1696		1448		1071		897	
%p.a.		< 1%			-8%		-14%		-8%		
C. AONs	1248		866		1028		613	526		367	
% p.a.		-7%		+9%		-23%	-14%		-16%		
D. AONs	1211	1232				1211			1042	987	
%p.a.		< 1%		< 1%			-5%			-5%	
E. AONs	2459	2330				3050		2469			1672
% p.a.		-1%		+7%			-10%		-12%		
F. AONs	2224	1468				1722			1651		1157
% p.a.		-10%		+4%			-1%			-10%	
G. AONs	4756			4732				3252			
% p.a.		< 1%				-9%					
H. AONs	845	401	382		337	333		192		264	
% p.a.		-17%	-5%	-6%	-1%		-24%		+17%		
I. AONs	309		180			91			57	67	
% p.a.		-10%		-20%			-14%			+17%	
J. AONs	11088	9465					7017				4301
% p.a.		-3%		-6%					-11%		
K. AONs	2747	2300			2436		1524	1570	1460	1025	1040
% p.a.		-4%	+2%			-21%	+3%	-7%	-30%	+1%	
L. AONs	5570			4350					4306		
% p.a.		-2%				< 1%					
M. AONs	17000		19072		19340				18159		
% p.a.		+1%		< 1%			-1%				

Notes: Area C Vailla counted 1985 (291 AONs), not 1986. Reawick Ness 1987 count (197 AONs) used to calculate both 1986 and 1988 totals. Most recent counts at Braga Ness (15 AONs) and Watsness (1 AON) in 1990 were used to calculate 1991 and 1993 totals. Area F Tingon counted 1986 (21 AONs) not 1985. Gruna Stack not counted 1985, AONs (67) calculated from 1981-89 % change p.a. Trumba counted 1986 (11 AONs), not 1985 and not counted 1992; 1989 count (14 AONs) used to calculate 1992 totals. Varnadii counted 1986 (10 AONs), not 1985 or 1992; 1991 count (10 AONs) used to calculate 1992 totals. Area J Noss counted 1980 (11,050 AONs), not 1981. Millburn Geo and Hole of Bugars counted in 1986 (27 AONs) and 1988 (18 AONs), not 1985 & 1990. Area K Mousa counted in 1986 (14 AONs), not 1985.

for a greater proportion of AONs at breeding stations to be concentrated in colonies in caves or other sheltered situations was noted elsewhere, e.g. at Boddam where of the six colonies, three in the entrances of deep caves held 41% of the total (256) in 1981 but 70% in 1994 (n=239). A possible explanation for this is given below.

### Discussion

Accepting uncertainties over current numbers in Unst and former numbers on Fair Isle and Foula, the breeding population of Kittiwakes in Shetland has declined by at least 30% since 1975-81. The greatest decrease occurred since the Seabird Colony Register counts of 1985-87 (Lloyd *et al.* 1991). This is the largest regional decline known to have occurred recently in Britain and Ireland; the only other significant regional decrease has been at colonies in south-east Ireland although substantial local declines have occurred, e.g. on the Isles of Scilly (Walsh *et al.* 1994). Even in Orkney, whose nearest Kittiwake colonies

are only 100km from Mainland Shetland, there has been no evidence of a recent, widespread decline in numbers although there was a 40% decrease between 1969/70 and 1985-87 (Lloyd *et al.* 1991), which mainly occurred between 1980 and 1984 and halted in 1985 (Benn *et al.* 1987). It is also notable that the decline on Fair Isle, mid-way between the two island groups, has been much less and more recent than elsewhere in Shetland. Within Shetland, the greatest proportional decrease occurred at colonies along the south-west and east coasts (Areas A-C and H-K), where the most recent total count of nests (8,364) was 53% lower than in 1985-87 (17,856) and 60% lower than in 1981 (21,147).

Oil pollution around Shetland is unlikely to have contributed much to this decrease since beached bird survey data indicate no significant recent increase in the proportion of birds found that were oiled, which anyway was low compared to other areas of the North Sea (Heubeck *in press a*).

**TABLE 3. Numbers of Kittiwake AONs at colonies at Noness, 1977 - 1994. Made from a Zodiac inflatable except those in 1977 which were made from photographs taken from the sea. The 1985 count was not plotted accurately enough for colony comparisons.**

**Dates : 25/6/77, 15/6/81, 20/6/85, 12/6/88, 15/6/90, 8/6/91, 13/6/92, 6/6/93, 2/6/94.**

Colony	1977	1981	1985	1988	1990	1991	1992	1993	1994
1	34	22		30	16	18	19	9	5
2	83	49		26	0	0	0	0	0
3	323	300		27	9	7	2	0	0
4	390	407		105	15	25	14	0	0
5	508	488		661	464	475	444	309	358
6	176	145		269	116	146	139	82	88
7	106	110		136	93	91	99	66	66
8	148	106		163	89	100	102	76	97
Total	1768	1627	1489	1417	806	862	819	544	614



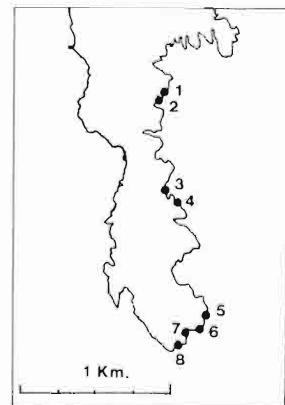
Instead, there are two more likely explanations for the population decline. Firstly, reduced abundance of lesser sandeels *Ammodytes marinus* around Shetland caused Kittiwakes to suffer progressively reduced breeding success from around 1985 onwards, culminating in 1990 when most colonies experienced virtually complete breeding failure (Walsh *et al.* 1992). Although some colonies in other parts of the British Isles also experienced moderate to poor breeding success during this period, in no other region was there such a loss of potential recruits to the breeding population as in Shetland and it is notable that high breeding success was maintained in Orkney in the late 1980s (Walsh *et al.* 1992). Within Shetland, moderate breeding success was maintained during the late 1980s at north-western colonies where proportional decreases in breeding numbers were less. Whether the stress of breeding in such adverse conditions affected adult survival rates is unclear, but brooding adults were significantly lighter in 1990 than in 1991 (Hamer *et al.* 1993), when there was a marked and broadly sustained improvement in breeding success after an increase in the abundance of sandeels spawned that year (Wright & Bailey 1993; Heubeck *et al. in press*).

Kittiwakes first breed when three, but most not until four or five years old (Wooler & Coulson 1977). The greatest effects of reduced recruitment to the breeding population might therefore have been expected at colonies between 1989 and 1994, which indeed corresponds to the years when the greatest proportional reductions in numbers of nests were recorded in most areas. Assuming no unusually low survival rates of immatures or increased dispersal to or from Shetland of potential recruits, it might also be expected that the benefits of improved

breeding success in 1991-94 (Heubeck *et al. in press*) will be reflected in nest counts from 1995 onwards. Large roosts of Kittiwakes, including many first-year birds, were noted around colonies in 1993 and 1994 and possibly most of these birds were not yet of breeding age.

The second factor likely to have contributed to population decline has been increased predation pressure. The main predators at Kittiwake colonies in Shetland are Great Skuas *Stercorarius skua*, Ravens *Corvus corax* and Hooded Crows *Corvus corone* (Great Black-backed Gulls *Larus marinus* and Herring Gulls *Larus argentatus* also sometimes take eggs or small chicks). Corvids predate eggs and in our experience their attentions are rather transitory and highly localised (Heubeck & Mellor 1994), with sometimes a large proportion of eggs being taken for a few years at a particular colony and then the predation ceasing, presumably as specialist individual birds die. This behaviour has long been recorded (Saxby 1876) and we have no evidence of a recent increase in corvid predation of Kittiwake eggs.

**FIGURE 2.** *The location of Kittiwake colonies at the Noness breeding station (Table III).*



Great Skuas predate eggs, nestlings, recently fledged and adult Kittiwakes, characteristically swooping into colonies and dragging birds from nests or catching them in mid-air, then falling to the sea where they are drowned and eaten. Predation by skuas has been known to occur for many years at some Shetland Kittiwakes colonies, e.g. Noss (Perry 1948) and Hermaness (Lockie 1952), and as the population of Great Skuas increased this century there was debate as to whether or not predation was reducing breeding numbers of Kittiwakes. Some authors believed it was (e.g. Venables & Venables 1955) but offered only anecdotal evidence, while Andersson (1976) believed that predation of nestlings may have reduced breeding success but was unlikely to cause decreases in breeding numbers (Andersson estimated that there were 600 pairs of Kittiwakes in his Hermaness study colony in 1972; the respective 1981, 1987 and 1991 counts were 370, 174 and six).

Furness (1981) reviewed the diet of Great Skuas of Foula in the mid-1970s and warned that any restrictions on the quantity of whitefish discarded from fishing boats or reductions in sandeel abundance close to their colonies could result in Great Skuas turning to predation as a main feeding technique, in which case "all Shetland seabirds would suffer" with the greatest influence on populations of, among other species, Kittiwakes. This proved prophetic, when sandeels became less available to seabirds during the 1980s. In 1983 there was a sudden, sustained increase in the proportion of birdmeat in the diet of non-breeding skuas on Foula, the occurrence of bird remains in regurgitated pellets during 1983-89 being on average five times greater than in 1973-82 (Hamer *et al.* 1991); the incidence of bird remains in pellets regurgitated by skua chicks increased markedly in 1988, when it was four times the

average values for 1983-87 and nine times those for 1974-82. Pellet analyses indicated that Great Skuas fed predominantly on seabirds on Fair Isle in 1989, principally Kittiwakes (Harvey *et al.* 1989). These findings accord with widespread but largely unquantified observations of an increase in skua predation at Shetland Kittiwake colonies around 1988 which, despite a marked increase in sandeel abundance from 1991 onwards (Wright & Bailey 1993), seems to have become progressively more widespread rather than abating (Heubeck *et al.* in prep.). Increased predation of adult birds, in particular, could result in a rapid decline in breeding populations.

Since Great Skuas characteristically circle around a colony before swooping in to attack a nest, and prefer to attack nests higher on the cliff, cliff topography is likely to determine which colonies and nests are predated and which are in too sheltered situations or are too low for skuas to manoeuvre effectively. Of 1,020 nests on Papa Stour colonies checked from a Zodiac on 14 July 1988, chicks were seen in only 94, virtually all of which were situated in recesses, under overhangs or in the backs of caves; none was seen in nests on 'open' cliff faces. At Kettlaness breeding success was monitored between 1987 and 1993 at a colony that, it transpired, suffered intense predation by skuas (only three chicks survived to fledging size during 1988-93). As the number of nests decreased (from 261 in 1987 to 42 in 1993) the upper parts of the colony were the first to be abandoned and typically, the chicks that survived longest were those in the lowest nests and under rock overhangs.

If the current levels of predation by Great Skuas are maintained, then the proportion of the Shetland Kittiwake population nesting in cave entrances or other highly sheltered

situations will probably increase, in which case censusing from the sea is essential as such colonies are usually difficult to view from land.

### Acknowledgements

The 1985-94 surveys were carried out under contract to the Shetland Oil Terminal Environment Advisory Group, with the assistance of staff of the former Nature Conservancy Council and Scottish Natural Heritage, who provided the Zodiacs used and also data from Noss. Fair Isle Bird Observatory provided data from that island, gathered under contract to the Joint Nature Conservation Committee. P. Kinnear and M. Richardson made available the 1977 photographs of Noness and field maps of the 1981 survey, respectively. We are indebted to those who assisted on surveys : D. Bird, E. Danchin, C. Dore, A. Douse, V. Egan, P. Ellis, P. Evans, B. Fox, H. Harrop, P. Harvey, M. Leopold, J. Morton, D. Okill, K. Osborn, A. Prior, P. Reynolds, M. Richardson, I. Robertson, R. Schofield, E. Stuart, D. Suddaby, J. Swale, R. Wynde. Earlier drafts of the manuscript were improved by comments from G. Dunnet, P. Harvey, J. B. Nelson and M. Richardson.

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(Revised Typescript received 10 September 1994)

## Densities of breeding Magpies and Carrion Crows in south-east Scotland in 1992-93.

H.E.M. DOTT

*Densities of breeding pairs of Magpies and Carrion Crows, based on nests found in 2km X 2km squares, are reported for different habitats in Lothian and Borders Regions in south-east Scotland. Differences in density are discussed in relation to habitat and other factors.*

### Introduction

The distribution and numbers of Magpies *Pica pica* and Carrion Crows *Corvus corone* in Britain have undergone changes in the past, and recently both species have increased nationally. The increases have not been the same in different parts of Britain or in all habitats (Thom 1986, Marchant *et al.* 1990, Birkhead 1991).

The populations of both Magpies and Carrion Crows have two components: a breeding component comprising pairs of birds holding nesting territories, and a non-breeding component of mainly younger birds which usually form loose groups or flocks and do not hold defined territories (Goodwin 1986, Birkhead 1991). Most population studies have been based on numbers of breeding pairs (e.g. Parslow 1973, Sharrock 1976, Tatner 1982a, Marchant *et al.* 1990, Gibbons *et al.* 1993). In Scotland there are few published records of population densities, particularly for the Magpie. This article reports on the densities of breeding pairs in selected parts of south-east Scotland obtained by an easily repeatable method which will provide a basis for future comparisons.

### Methods

Densities were recorded in sample areas of a constant size in 1992 and 1993. The whole of each sample area was surveyed, during February - June. These sample areas were 2km x 2km squares (tetrads) taken from Ordnance Survey maps, in a variety of geographical locations and habitats in south-east Scotland. 'Habitats' sampled in this study are broad ones such as suburban or farmland, rather than components of these such as garden, park, tree line or field. Individual Magpie or Crow territories could span more than one of these components. Tetrads were considered to be a better size than 1km x 1km squares for sampling these broad habitats, as smaller units would be more strongly biased towards particular features such as woodland strip or field within farmland, or housing scheme or school ground within cities.

Within each tetrad, a search was made for all nests of Magpies and Carrion Crows. Searching was done in late winter and spring, as nests are easier to locate before trees are in leaf, and checks were made after this time. Care was taken to distinguish nests from a previous year, and to distinguish those of

Magpies, Carrion Crows, Rooks *Corvus frugilegus*, raptors, squirrels *Sciurus* spp. or other species. Two nests built in the same or neighbouring trees were taken to represent one breeding pair, as pairs are known to build close to old nests or to new, abandoned nests (Picozzi 1975, Hewson & Leitch 1982, Birkhead 1991). Differences in habitat affected the ease of discovering nests, that requiring most time-effort being suburban habitat for Magpies with numerous garden boundaries and thick evergreen trees. The method was kept constant and was done by the same observer in each tetrad, so that the results should be comparable with each other.

Observations outside the tetrads were also made very widely throughout Lothian and Borders Regions in connection with fieldwork for the breeding bird atlas for this area (in prep.), so giving an impression of how similar or otherwise sampled tetrads were to surrounding areas.

## Results and Discussion

### Magpie

Table 1 shows the numbers of Magpie nests found in each tetrad, and the densities of breeding pairs. The densities ranged from 1.5 to 2.25 per km<sup>2</sup>.

City and suburban Magpies tended to nest near the tops of medium sized deciduous trees with thick twig-growth such as hawthorn, silver birch and whitebeam, and evergreen spruce. Wider observations suggested that the Edinburgh and Dalkeith tetrad results were typical of much of the north, west and south of the city and suburbs. The Riccarton tetrad was mainly rural, with University campus (which resembles suburban habitat) filling a quarter of the tetrad. The tetrad near Broxburn was typical of much of West Lothian, with undulating hills and hollows, small farms with stock on pasture, some grain crops, shelter belts, and numerous hedges of hawthorn both trimmed and well-grown. Magpie nests were mainly in lines or patches of hawthorn, with some in taller trees near farm buildings.

In town and country, Magpies showed a distinct preference for nesting in hawthorn. This occurred even in places where hawthorns were very scarce and a range of other suitable tree species was present. Other trees used for nesting were beech, alder, larch, pine, yew, holly and once (at Cramond in 1993) in the top of a monkey puzzle tree; this may be one of the few records of any British wildlife using this introduced species of tree, though J.B.Reid (*in litt.*) has recorded Rooks nesting in a monkey puzzle tree in Fife.

**Table 1 Annual densities of breeding Magpies in south-east Scotland, 1992-93**

Tetrad: map ref. to centre point	Location	Habitat	Number of Nests	Density of breeding pairs per km <sup>2</sup>	Higher density within tetrad of nests per km <sup>2</sup> (see text)
NT 230690	Edinburgh	urban	6	1.50	16.00
NT 330670	Dalkeith	suburban	9	2.25	-
NT 170690	Riccarton	rural and suburban	8	2.00	-
NT 070740	nr Broxburn	rural	7	1.75	4.00

The results indicate a higher density in suburban habitat of about 2.25 pairs per km<sup>2</sup>, and lower in city and rural habitats of 1.5 to 1.75 pairs per km<sup>2</sup>. Interestingly, in the Edinburgh city tetrad some clumping of nests occurred; four of the nests were within one quarter km<sup>2</sup> - a density of 16 nests per km<sup>2</sup> for this group. Part of this tetrad comprised playgrounds and playing fields, but there was much garden and tree-line habitat apparently suitable for Magpie nests but lacking them, and so the clumping could not obviously be explained by habitat variation. A possible explanation was that Magpies may have been avoiding nesting near places with Crows' nests; Crows are known to interfere with Magpie breeding success (Baeyens 1981, Tatner 1982b). In the rural tetrad near Broxburn, five of the Magpie nests were spaced at about 4.0 per km<sup>2</sup>, but this did seem to be related to habitat; hawthorn hedges and scrub with small trees were more abundant in this part of the tetrad than in the remainder.

Over Britain as a whole, sample plots in 1972 gave mean densities of 2.3 pairs per km<sup>2</sup> for farmland, and 2.8 for woodland (Sharrock 1976), but these have risen since to over five pairs per km<sup>2</sup> for farmland, and over ten for both woodland and suburban habitat (Gooch *et al.* 1991). In Manchester, Magpies occurred at six to seven pairs per km<sup>2</sup> in the city, but less than this in the surrounding farmland (Tatner 1982a). In Manchester central city parks, Groom (1993) recorded up to 49 pairs per km<sup>2</sup>, but suggested that this should be 'compared cautiously' with other studies due to his small sample areas. In Sheffield city densities were about 1.3 pairs per km<sup>2</sup> in 1946, 4.1 in 1976 (Roberts 1977) and up to a maximum of 32 recently, but much lower just outside the city (Birkhead 1991). One published density for Scotland is 0.22 pairs

per km<sup>2</sup> for farmland with few hedges in Aberdeenshire (Love & Summers 1973). The wide variation in published densities may result from different size of study areas as well as genuine differences in Magpie densities.

As at Manchester and Sheffield, this study shows Magpie densities in south-east Scotland to be higher in suburban areas than in surrounding rural habitat. These south-east Scotland densities are much lower than the recent ones for English cities, but much higher than rural Aberdeenshire in the 1970s. The New Atlas (Gibbons *et al.* 1993) shows that from the 1970s to the 1990s the main Magpie breeding distribution has changed very little, but that the abundance within this range has continued to increase, and that England, Wales and Ireland have widespread high abundance compared to Scotland. In West Lothian, Magpie density may be lower than it potentially could be due to Carrion Crows, because some Crows there nest in lines of well-grown hawthorn which would otherwise be favoured Magpie habitat.

Throughout Borders Region, East Lothian District, and Midlothian District except for Edinburgh satellite towns, Magpies are still too scarce as a breeding species for density sampling to be meaningful, although records show their range to be increasing in recent years (Borders Bird Reports, Lothian Bird Reports, 1979-1992). Interestingly, Magpies in Borders and perhaps in eastern East Lothian tend to nest in patches of dense conifer plantation, thus differing from those in West Lothian and west of there (*pers. obs.*). Magpies were present generally through south-east Scotland until the 1840s, and keeping is accepted to be the main reason for their disappearance (Thom 1986). There is no record that Magpies were ever absent

from West Lothian, and round the western parts of Edinburgh they were judged to be more plentiful than in other parts of Scotland in the 1930s (Rintoul & Baxter 1935). In the 1950s they were still very scarce in central and eastern Edinburgh (Edinburgh Bird Bulletins 1950-1958) where they are now widespread. However, there has been no quantitative assessment until now.

The sampling of whole tetrad squares over rural, urban, or other broad habitats should provide a useful method for future comparison. This could be more meaningful for this species than sampling smaller component habitats for example woodland strips, where a 'woodland density' obtained might be based on nests of pairs whose territories were largely in the surrounding habitat.

Magpies have been increasing steadily in Britain as a whole over several decades, and faster in suburban than in rural areas (Parslow 1973, Marchant *et al.* 1990, Birkhead 1991). This increase has included the colonisation of new coniferous plantations and cities (Watson 1948, Prestt 1965, Sharrock 1976). There are signs that the national population may now be stabilising (Stroud & Glue 1991), but locally, as in East Lothian and Borders Region, the spread is continuing.

### **Carrion Crow**

Table 2 shows the numbers of Carrion Crow nests found in each tetrad and the densities of breeding pairs. The highest densities were some ten times greater than the lowest.

In Edinburgh city and its suburbs, Crows nested very conspicuously, mainly choosing sites high in tall deciduous trees such as sycamore, beech, elm, poplar and lime. In farmland preferred nest sites were in high,

mature trees, growing singly or in spaced-out lines and, in contrast to Magpies, usually not close to houses. Lower trees were also used, and in West Lothian Crows nested in lines of tall hawthorns (often former railway routes) where, as suggested earlier, they may have been excluding Magpies. No Crow nests were seen on man-made structures, perhaps suggesting that Crows are not under pressure from lack of nest sites in south-east Scotland (see Marchant *et al.* 1990).

The Edinburgh and Dalkeith tetrads showed densities of 2.5 and 1.75 pairs per km<sup>2</sup>, and wider observations suggested that these would be typical of most of Edinburgh and its satellite towns. Such high densities are of interest as urban habitat is one which Carrion Crows have only colonised relatively recently (Prest 1965, Parslow 1973, Sharrock 1976). The other high figure of 2.5 pairs per km<sup>2</sup> was for rural West Lothian where, as described for the Magpie, the farmland is mixed stock and arable with many well-grown hawthorn hedges, scrub, tree-lines and shelter strips. A much lower density averaging 0.21 pairs per km<sup>2</sup> was found for six contiguous tetrads in East Lothian around Elphinstone. This area has a flatter landscape of larger farm fields mainly of grain, fewer hedges usually trimmed very low, and fewer shelter belts, but some boundary lines of tall, spaced trees where most of the Crow nests were situated. In an area overlapping these tetrads, da Parto (1985) obtained a rather higher density of one pair per km<sup>2</sup> for farmland, but his study area probably included more varied habitat.

The hill and moor tetrads south-east of Teviothead were mainly devoid of trees (apart from coniferous plantations), except for a few growing at isolated and mainly derelict farmhouses where Crow nests occurred. Elsewhere in Borders Region single small



**Table 2 Annual densities of breeding Carrion Crows in south-east Scotland, 1992-93**

Tetrad: map ref. to centre point	Location	Habitat	Number of nests	Density of breeding pairs per km <sup>2</sup>	Higher density within tetrad of nests per km <sup>2</sup> (see text)
NT 230690	Edinburgh	urban	10	2.50	-
NT 330670	Dalkeith	suburban	7	1.75	-
NT 170690	Riccarton	rural and suburban	5	1.25	-
NT 070740	nr Broxburn	rural	10	2.50	-
NT 370690	nr Elphinstone	mainly rural	1		
NT 390690	nr Elphinstone	rural	2		
NT 410690	nr Elphinstone	rural and suburban	0	0.21	-
NT 390710	nr Elphinstone	mainly rural	0		
NT 410710	nr Elphinstone	mainly rural	1		
NT 430710	nr Elphinstone	rural	1		
NT 710690	eastern Lammermuir Hills	low hills and valleys	4/6*	1.0 / 1.50*	44.0
NT 430050	s.e. of Teviothead	hill, moor & coniferous plantation	1	0.25	-
NT 450050	s.e. of Teviothead	hill, moor & coniferous plantation	1	0.25	-
NT 450030	s.e. of Teviothead	hill and moor	2	0.50	-

\* Four nests were found, but a small part (0.04%) of the tetrad was not surveyed and was likely to have held 1-2 additional nests.

stunted rowan, birch or willow trees in remote gullies were used for nesting. Certain narrow valleys in treeless hills hold long, narrow thickets of trees such as birch, willow and alder. This was the case in the tetrad surveyed in the eastern Lammermuir Hills, where the four Crow nests found gave a density of 44 nests per km<sup>2</sup> if calculated for the wood alone. However, these Crows would use the area of the surrounding hills so that the tetrad density of 4-6 pairs per km<sup>2</sup> gives a more realistic picture.

Dense or extensive woodland is one habitat in which Carrion Crows do not normally nest

(Goodwin 1986), though they have spread into some 'sparsely wooded country' (Parslow 1973), and more recently into some upland conifer plantations (Marchant *et al.* 1990). In south-east Scotland, Crows still do not normally nest in woods larger than narrow shelter strips, nor in coniferous plantations, although on 24 April 1993 a Carrion Crow nest was found in a spruce tree in a 1.5 X 1.5km plantation of 3m tall spruces and pines on a valley slope south-east of Teviothead, 0.25km in from the forest edge.

Published Crow densities do not compare

easily with the present data due to differing study areas and methods. For Britain generally, mean densities for 1972 are stated as 3.2 and 4.7 pairs per km<sup>2</sup> for farmland and woodland respectively (Sharrock 1976). However, the 'woodland' figure must include mainly pairs whose nests were on the edges of woods but whose territories were mainly in surrounding habitats. In East Lothian, da Prato (1985) recorded one pair per km<sup>2</sup> for farmland, and 19 per km<sup>2</sup> for woodland and scrub but these were based on stands of only 27 and 10ha respectively, where again the Crows would use adjacent habitats. In Kincardineshire, Picozzi (1975) recorded Crows at 2.3 - 3.0 pairs per km<sup>2</sup> on farmland and woods not including adjacent moorland which the Crows used. Hewson & Leitch (1982) in Argyll found 26 pairs per km<sup>2</sup> in a coastal strip of wooded habitat which excluded the adjacent moor occupied by the Crows, and Rebecca (1985) found six pairs in 25ha (=24 per km<sup>2</sup>) of trees surrounded by farmland in Aberdeenshire. Petty (1985) recorded 0.17 and 0.67 pairs per km<sup>2</sup> in two areas of moor with newly planted conifers in Argyll. Most of the above published densities are not comparable with the tetrad densities here, as they concern nests in confined patches of habitat where the Crows would be largely occupying the surrounding areas as in the right-hand column of Table 2. The tetrad method should be good for sampling general habitats such as urban, mixed farmland, hill-sheep land, or others.

The present results suggest that in south-east Scotland, the highest Carrion Crow densities are found in urban habitats and in West Lothian mixed farmland, and lowest densities are found in arable land and in hill country of East Lothian and Borders Region. To what extent these different densities are due to habitat alone, or to a combination of habitat and human interference, is not known.

Persecution of Crows has lessened greatly since the two World Wars and has enabled a national increase in Crows which is still continuing (Prestt 1965, Parslow 1973, Marchant *et al.* 1990, Stroud & Glue 1991). However, shooting and trapping still occur widely on kept estates and on hill-sheep land, which in south-east Scotland occurs mainly in East Lothian District, Midlothian District, and Borders Region.

### Acknowledgements

I thank Dr. Stan da Parto and Mark Holling for help with improvements and production of this article.

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(Revised typescript received 18 June 1994)

## The breeding performance of Ravens from a sample of nesting territories in Shetland during 1984-1993

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***This paper summarises the breeding performance of some Raven territories in Shetland during 1984-93. There were no significant annual differences. Shetland Ravens showed broadly similar breeding performance to that found during previous studies from various areas of Britain, Europe, North and Central America. However breeding success (the percentage of nesting pairs which fledged at least one young) in Shetland was lower than that found in all but three of 18 other studies cited.***

### **Introduction**

After a retreat since mediaeval times from much of lowland Britain, particularly during the era of intensive game preservation, the population of the Raven *Corvus corax* had not declined seriously in many areas until the 1960s (Ratcliffe 1962). However, since then it has declined in south, south-west and central Scotland, mainly as a result of changes in land use (Marquiss *et al.* 1978, Mearns 1983, Mitchell 1981), in Speyside possibly due to human persecution and in particular the illegal use of poisoned baits (Weir 1978) and the English Pennines, also probably due to illegal poisoning (D.A. Ratcliffe pers. comm.). Its status is of sufficient concern for it to have been included in a list of candidate species for inclusion in 'Red data birds in Britain' (Batten *et al.* 1990). However over much of the western Highlands and Islands, Shetland and Orkney the Raven remains widespread (Thom 1986, Booth 1979, Ewins *et al.* 1986).

In Shetland, Ewins *et al.* (1986) carried out a survey of breeding Ravens during 1982-83. He investigated diet by examining pellets and also gathered some data on breeding performance from a sample of c. 60 nesting attempts. This paper presents data on breeding performance gathered at 43 Raven territories from widely distributed localities throughout Shetland which were visited annually and involved 311 nesting attempts during 1984-1993.

### **Study area**

Shetland is an archipelago of over 100 islands lying at the northern end of the North Sea at latitude 60° north. It has a cool maritime climate influenced by the relatively warm waters of the North Atlantic Drift. The rugged 1,450km long coastline has many high seacliffs, with no point in the islands more than 5km from the sea (Flinn 1974). Much of

the land area of 1,468km<sup>2</sup> is rough grazing, carrying about 380,000 sheep (Anon. 1993).

This study was carried out during the course of other ornithological work, particularly the annual monitoring of Peregrine Falcons *Falco peregrinus* and Merlins *Falco columbarius*. The monitored Raven sites were not chosen randomly, but were chosen to be relatively near to the routes to the monitored falcon breeding sites (so that this work fitted in easily with higher priority raptor monitoring), or were on the islands of Fetlar and Yell where RSPB nature reserve wardens were resident during the summer. Nevertheless, the sample of 43 territories included in this study represents 21% of the known Raven territories in Shetland and there was a deliberate attempt to include sites from a wide area; 11 (26%) were on the island of Fetlar, two (5%) on the island of Yell, six (14%) in the north Mainland, 12 (28%) in the central Mainland, four (9%) in the west Mainland and eight (18%) in the south Mainland.

## Methods

Each year, the monitored territories were visited at least once and all suitable nesting habitat within about one kilometre of any past nesting site was searched. During 1984-1986 suitable territories were still being located, but during 1987-1993 the same 43 territories were visited each year. Any sites occupied on the first visit were visited a second time and any active nests were visited subsequently to ring or record any young and to check if young had fledged. Twenty-three (c. 50%) of the nest sites were relatively accessible, but were usually climbed to only in order to ring young when they reached an estimated ten days of age. A territory was recorded as occupied if it contained at least one displaying individual, birds showing alarm,

a pair regularly seen in suitable breeding habitat, or a nest which had been built up and lined that season or containing eggs or young. A breeding attempt was recorded if a nest with eggs or young was located or an empty nest that had been built up and lined.

## Nest sites

In 34 (79%) of the nesting territories monitored during this study, nests were usually located on seacliffs, although in five of these territories at least one alternative site was not on a seacliff. In the other nine territories (21%) nests were always in inland locations up to 1.7km from the coast. Inland sites varied from the bank of streams (one nest being only 3m above the stream bed), active or disused quarries, roadside cuttings to, in one case, a tree.

## Results

Table 1 gives the breeding data for the monitored Raven territories. During 1984-93 there was a significant difference between the percentage of nests which were occupied each year ( $X^2 = 16.972$ ,  $df = 9$ ,  $p < 0.05$ ). This was because during 1984-86 a small number of occupied, but previously unknown nesting territories, were located and these were subsequently included in the monitoring programme. This resulted in a bias in the percentage of occupied sites during the first three years of the study. Consequently, unless otherwise stated, further discussion refers only to data gathered during 1987-1993.

## Annual breeding performance

The average proportion of sites occupied each year was 79.7%, (range 67%-93%) and there was no significant difference between years ( $X^2 = 10.28$ ,  $df = 6$ ,  $p > 0.05$ ,  $n = 43$ ). The average proportion of territorial pairs which

TABLE 1. *Breeding data for a sample of Raven territories in Shetland during 1984-1993.*

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Sites checked (%) of known sites	26 (13)	39 (19)	41 (20)	43 (21)	43 (21)	43 (21)	43 (21)	43 (21)	43 (21)	43 (21)
Sites occupied(all by pairs) (%) of sites checked	24 (92.3)	34 (87.1)	37 (90.2)	32 (74.4)	40 (93.0)	36 (83.7)	35 (81.4)	33 (76.7)	35 (81.4)	29 (67.4)
Nesting pairs (%) of all pairs	21 (87.5)	33 (97.1)	36 (97.3)	32 (100)	35 (87.5)	34 (94.4)	33 (94.3)	31 (93.9)	30 (85.7)	26 (89.7)
Successful pairs (%) of nesting pairs	13 (61.9)	19 (57.6)	23 (63.9)	20 (62.5)	24 (68.6)	16 (47.1)	18 (54.5)	19 (61.3)	17 (56.7)	14 (53.8)
Young fledged	40	56	79	62	73	49	47	63	57	33
Mean brood	4.0	3.11	3.43	3.10	3.17	3.06	2.76	3.32	3.35	2.54
Standard deviation	1.333	1.323	1.441	1.210	1.302	0.854	1.522	1.376	1.618	0.967
number in sample	10	18	23	20	23	16	17	19	17	13
Productivity (young fledged per pair)	1.90	1.70	2.13	1.94	1.87	1.36	1.38	1.91	1.63	1.18
S.d.	2.234	1.845	2.030	1.795	1.866	1.641	1.758	1.958	2.030	1.442

nested was 92.1%, (range 87%-94%) and there was no significant difference between years ( $X^2 = 2.595$ ,  $df = 2$ ,  $p > 0.05$ ). (The degrees of freedom were reduced because the expected frequency per cell was below the permitted minimum of five, therefore several years were aggregated together; 1987-88, 1989-91 and 1992-93). There was no significant difference in mean brood size between years (Kruskal-Wallis analysis of variance = 5.319,  $df = 6$ ,  $p > 0.05$ , mean brood size 3.07, range 1-6,  $sd = 1.30$ ), nor was there any significant difference over the entire ten years of the study (Kruskal-Wallis analysis of variance = 10.485,  $df = 9$ ,  $p > 0.05$ , mean brood size 3.18,  $sd = 1.33$ ). There was no significant difference in productivity between years (Kruskal-Wallis analysis of variance = 5.555,  $df = 6$ ,  $p > 0.05$ , mean productivity 1.62 young fledged per pair,  $sd = 1.80$ ) and there was also no significant difference in the proportion of successfully nesting pairs between years ( $X^2 = 4.045$ ,  $df = 6$ ,  $p > 0.05$ ). The mean proportion of successful pairs (nesting pairs which fledged at least one young) was 57.9%, (range 47%-69%).

### Clutch size

Table 2 shows the frequency distribution of clutches and mean clutch size for a sample of 43 complete clutches recorded during 1984-1993. The mean clutch size was 4.63,  $sd = 1.35$ , range 1-7.

### Number of known nesting territories and nesting density

Ewins (1986) documented 196 Raven territories in Shetland. Between 1984 and 1993 an additional ten territories were located, nine of which were in inland locations. This brings the number of known Raven territories in Shetland to 206, giving a density of 14.0 territories/100km<sup>2</sup>, but with a mean occupation rate during 1987-93 of 80% this would produce a density of 11.2 occupied territories/100km<sup>2</sup> and with a mean of 73% of territories holding nesting pairs during 1987-93 give a density of 10.2 nesting pairs/100km<sup>2</sup>.

**Table 2. Clutch size data for a sample of clutches from Ravens nesting in Shetland during 1984-1993, all years combined.**

Clutch size	1	2	3	4	5	6	7	Total clutches	Mean size	S.d.
Number of clutches of each size recorded	1	2	6	8	13	12	1	43	4.63	1.35

## Human persecution and nesting failures

Definite proof of persecution was recorded on several occasions at five of the 43 sites (12%), and was suspected at several others. All but one of the persecuted territories were inland sites. One nest was shot into, one was dislodged with a length of pipe, one was pushed off a small cliff and two had rocks dropped into them. Of the 127 nest failures recorded during 1984-93 only six (4.7%) definitely occurred after young had hatched, and three of these were due to human persecution. The reason for most nest failures was unknown.

## Discussion

Although the sample of Raven territories involved in this study was not chosen randomly, they were from a wide geographical area of Shetland and from both seacliff and inland sites, so were likely to give a reasonably representative indication of the breeding performance of Ravens in Shetland between 1984 and 1993. It appears that, although Shetland Ravens show annual variations in breeding performance, these are relatively small and in this study were not significant.

## Comparisons with other areas

Table 3 shows breeding data from this study compared to those found in several other areas of Britain, Europe, North and Central America. Nineteen of these studies showed a range of mean clutch sizes of 4.2-6.0, average 4.9, 27 studies showed a range of mean brood sizes of 2.5-4.0, average 3.1, 19 studies gave a range of mean breeding success of 47.4-89%, average 71% and eight studies gave a range of mean percentage of pairs nesting of 64-95%, average 87%.

Although the mean clutch size, mean brood size and mean percentage of pairs nesting found in this study was similar to those found elsewhere, breeding success was towards the lower end of the range. Lower nesting success than the present study (58%) or that of Ewins *et al.* (1986) (52%) was reported from only two areas: 57% in Orkney during 1983-85 (Booth 1985) and 47.4% in Utah during 1967-70 (Smith & Murphy 1973). Dorn (1972) found a mean nesting success of 58% (equal to the present study) in Wyoming in 1971.

## Possible reasons for the low breeding success of Ravens in Shetland

The use of illegal poisoned baits has never been recorded in Shetland by the RSPB and during 1984-93 no cases of egg collecting involving Ravens was known to the RSPB (PME pers. obs.). The Raven is one of the few species in Shetland which is persecuted by man (pers. obs.). Although definite proof of persecution was recorded at only a few sites, it is possible that the actual amount was substantially higher. However it seems unlikely that this is the main reason for such a high number of nest failures.

Breeding performance may be related to the food supply in spring and early summer (Ewins *et al.* 1986). Ewins *et al.* (1986) described the diet of Shetland Ravens obtained from the examination of 540 pellets. Since there is much sheep carrion, and rabbits and birds apparently available as prey (pers. obs.), food shortage would seem to be an unlikely reason for poor breeding success.

Ravens in Shetland nest at relatively high densities: only seven of the 38 studies cited by Skarphedinsson *et al.* (1990) and Nogales





Young Sand Martin *Riparia riparia* ready to fledge.

Bobby Smith

**Winning Photograph of the SOC Photographic Competition 1994.**



***Snipe preening, Kinloch, Grampian.***

***S.M.D. Alexander***



***Rose-coloured Starling Sturnus roseus, at Meigle, August, 1994.***

***Rae Taylor***



*Barn Owls Tyto alba at forest nestbox.*

*Don MaCaskill*





*A Long-billed Dowitcher Limnodromus scolopaceus on Fair Isle, September 1990.*

*One was seen at Montrose Basin, September 1994.*

*Bob McCurley*



*Kittiwakes Rissa tridactyla.*

*A-M. Smout*

**TABLE 3. A comparison of Raven breeding performance and nesting density in Shetland with previous studies (adapted from Skarphedinsson *et al.* 1990 and Nogales 1994).**

Location and study period	Mean clutch size	Mean brood size	Mean nest success	Mean % of pairs nesting	Nesting pairs /100km <sup>2</sup>	Source
Britain and Ireland						
Shetland 1987-93	4.6	3.1	58	92	10.2	Present study
Shetland 1982-85	4.7	3.2	52		11.2-12.8	Ewins <i>et al.</i> 1986
Orkney 1972-77	5.1	3.1			4.0-4.8	Booth 1979.
Orkney 1983-85		2.9	57		5.2	Booth 1985.
Coastal Scotland 1961-62		3.0				Mearns 1983.
Inland Scotland 1981		3.2	74			Mearns 1983.
S. Scotland and Northumberland 1974-76	5.1	2.7				Marquiss <i>et al.</i> 1978.
Various areas of Scotland, England and Wales 1945-61		4.6	2.6 c		2.2-5.9	Ratcliffe 1962.
Various areas of Britain	5.2					Holyoak 1967.
Isle of Man 1941		3.2			6.0	Cowin 1941.
Isle of Man 1967-77					5.6	Cullen 1978.
Isle of Man 1982	4.5	2.75	89		4.3	Elliot & Nuttall 1983.
N. Wales 1946-67	5.2	3.3	80			Allin 1968.
N. Wales 1978-81		2.5	65		4.2-10.5	Dare 1986.
C. Wales 1975-79	4.5	2.8	67	89	13.314.2	Netwon <i>et al.</i> 1982.
Cambrian Mountains, Wales 1975-79	4.2	2.8	67	88	8.8-20.6	Davis & Davis 1986.
Dublin/Wicklow, Ireland					2.0	Noonan 1971.

Location and study period	Mean clutch size	Mean brood size	Mean nest success	Mean % of pairs nesting	Nesting pairs /100km <sup>2</sup>	Source
Europe						
SW. Iceland 1982-84	5.1	3.5	82	95		Skarphedinsson (1990).
NE. Iceland 1981-85	4.5	3.2	77	87		Skarphedinsson (1990).
E. Iceland 1981-85	4.6	3.3	89	90		Skarphedinsson (1990).
Iceland seven areas combined 1981-85					1.5-6.8	Skarphedinsson (1990)
Sweden 1913-76		3.6 a				Strandberg 1980.
Mecklenburg, Germany 1975	4.3	3.1			4.7	Prill 1982.
North Germany 1951-60					1.2-5.5	Looft 1965.
Schleswig, Germany					2.1	Looft 1971.
W. Mecklenburg, Germany					3.2	Looft 1971.
North Germany 1950-80					0.7-2.1	Looft 1983.
SE Holstein					1.9	Warnke 1960.
NE Schleswig-Holstein					4.7	Simson 1966.
Wolgast, Germany					18.7	Söllin 1987.
Bemes, Switzerland 1958-73		2.6			1.7	Blanc 1974.
Jura, Switzerland					1.5	Bohmer 1974.
Switzerland (Wallis) 1977-85					2.9-3.0	Oggler 1986.
Botosani, Rumania 1972					9.6	Andriescu & Corduneau
Tula Forest, URSS					7.5	Likhachev 1951.
Sicily, Italy					3.1	Giudice & Mascara 1985.

Granada, Spain				5.8	Zuniga <i>et al.</i> 1982.
Tenerife, Canary Islands				3.4-3.9	Martin 1987.
El Hierro, Canary Islands 1986-87				34.2-35.6	Nogales 1994.
North America					
Nova Scotia	5.0				Tufts 1961.
Virginia 1972-74		2.5	63		Hooper 1977.
Virginia 1973-74				2.6	Hooper <i>et al.</i> 1975.
Jackson Hole, Wyoming 1971		5.4	3.0	58	Dorn 1972.
Jackson Hole, Wyoming 1975				64	Craighead & Mindell 1981.
Utah (Eastern Great Basin) 1967-70	5.3	2.57	47.4	1.9	Smith & Murphy 1973.
Snake River, Idaho 1974-81	5.0	4.0	72	91	Kochert <i>et al.</i> 1980. 1981.
Snake River, Idaho 1984		3.9	88		Kochert 1984.
Snake River, Idaho 1986				72.6	Kochert <i>pers. comm.</i> in Nogales 1994.
Snake River, Idaho 1975-78				35-43	US Dept. of Interior 1979.
Snake River, Idaho 1975-78				2.9-3.8	US Dept. of Interior 1979.
Malheur, Oregon 1976-77	6.0	3.9	60	4.0-4.6	Stiehl 1985.
NWT (central arctic Canada) 1983-86		3.24	86	0.35-0.6	Poole & Bromley 1988.
Central America					
Los Esesmites, El Salvador				6.0	Dickey & Van Rossem 1938.

(1994) found higher densities (table 3). The mean nesting density from the 38 studies cited was 9.4 nesting pairs/100km<sup>2</sup>, range 0.35-72.6. The differences between the densities found in this study and those found by Ewins et al. (1986) may in part be due to that authors use of a lower figure for the area of Shetland and a different method of calculating the proportion of territories occupied by nesting pairs. In addition flocks of failed breeders or non-breeding Ravens occur in Shetland. During 1975-1992 in most years, the largest flocks of Ravens reported were published in the annual Shetland Bird Report (Shetland Bird Club 1975-92). In nine of the 18 years, the largest flocks were recorded during the breeding season. The mean size of these large flocks of failed breeders or non-breeding Ravens was 60, range 19-80. As such a high population density recorded in Shetland, it is possible that density dependent effects on breeding are operating (D.A.Ratcliffe pers. comm.). The reasons for the poor breeding success of Ravens in Shetland are worthy of further investigation.

### Population trend

The non-random selection of the sample of sites used in this study precludes any conclusions on population trends. However, casual observations suggest that no major changes have occurred since 1982-83, although a repeat survey would be required to confirm this.

### Acknowledgements

We would like to thank all those who assisted with fieldwork since 1984, particularly A. Aitken, G.W.Allison, G.W.Anderson, F.M.Beveridge, D.R.Bird, I.D.Bulloch, J.N.Dymond, P.J.Ewins, I.Hawkins,

M.Heubeck, W.Horn, R.Lidstone-Scott, R.Matthews, R.J.Nowicki, M.A.Peacock, M.Preece, T.Prescott, J.S.Rowe, S.Smith, C.E.Vawdrey, M.I.Walker, D.J.Weaver, R.M.Wynde, D.A. Ratcliffe and M. Marquiss commented on earlier drafts. We would also like to thank all those who over the years gave us information about nesting territories, particularly P.J.Ewins, and those Shetlanders who allowed us to wander so freely over their land.

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(Revised typescript received 7 July 1994)

## Breeding seasons and nesting success of Snow Buntings in north-east Scotland

R.D.SMITH & M. MARQUISS

*The timing and success of breeding Snow Buntings was monitored over a six year period and two montane areas in north-east Scotland. Successful first broods were initiated slightly earlier on the more eastern massif in two of four summers, perhaps as a result of its more continental climate. Successful second broods were found more frequently on the eastern massif, but clutch and brood sizes and nest failure rates were similar. On the western massif, early summer snowfalls appeared to limit the early production of first brood fledglings, and this, in turn, was associated with a reduction in the frequency of successful second broods. Little difference in productivity was noted between summers, except in 1992 when clutch and brood sizes were low. This poor breeding success occurred in a snow-free summer, and followed a particularly mild winter in which losses of breeding adults were unusually high.*

### Introduction

The Snow Bunting *Plectrophenax nivalis* is one of Britain's rarest breeding birds, existing here on the southern margin of its circumpolar Arctic distribution. It is confined to the Scottish Highlands where it breeds in the high corries and boulder fields. Numbers have increased in the past 20 years, and the estimated total of 50-100 Scottish territories in some recent summers (Watson & Smith 1991, Smith 1993) far exceeds the single figure estimates previous to this (Nethersole-Thompson 1966).

Although Nethersole-Thompson's (1966) Snow Bunting monograph provided many novel observations on the behaviour and distribution of the Scottish population, low numbers of birds at that time (mainly 1930s -

1950s) restricted the collection of data on breeding biology. Also, the behaviour and breeding ecology of Scottish Snow Buntings may have changed in association with, or as a result of, the population increase.

In this paper we describe aspects of the timing and success of breeding in north-east Scottish Snow Buntings during 1987-1993. Higher population levels have also allowed us to look for variation in the timing and success of breeding between summers. Finally we have been able to compare breeding biology on the main Scottish breeding area with that of a small number of pairs on a lower nearby massif.

## Methods

The main study area (A) was the central and western parts of the Cairngorms (57°N, 4°W), approximately 32km<sup>2</sup> of granitic mountain plateaux and corries between 1000 and 1300m in altitude, divided by a deep mountain pass, the Lairig Ghru. Observations began in 1987, but were confined to a census of pairs east of the Lairig Ghru and the monitoring of four nests found by chance. In 1988 we censused the whole area, and attempted to locate all successful breeding attempts east of the Lairig Ghru. Also, six nests were found west of the Lairig Ghru. From 1989 to 1993 we monitored nests and broods throughout the whole study area. Snow Buntings were rarely reported in the 5km band surrounding area A in the breeding season, suggesting that the area chosen held a discrete Snow Bunting population. Nests were also found on a second, smaller area (B) in the south-eastern Grampian mountains (approximately 30km from area A) from 1990 to 1993. In this area Snow Buntings nested mainly in large granitic corries between 900 and 1100m in altitude. Area A held 26-40 pairs of Snow Buntings during 1989 to 1993 and a total of 256 active nests or fledged broods were located. On area B there were 2-5 pairs and 23 nests/broods were found.

Most breeding sites were visited on four or more occasions. Breeding pairs were usually identified within two visits although some could be more elusive. In the first years of our study it was possible to differentiate between pairs on the basis of plumage differences, at least in males. Later, this became less necessary because up to 80% of the breeding birds were individually marked with coloured leg rings.

Before 1992, attempts to find nests were

biased towards times when nestlings were expected to be present. This was possible because nesting behaviour was fairly synchronised at the start of the breeding season, or on other occasions after heavy snowfalls had caused widespread nest failure (see Results). Second breeding attempts were begun soon after (and sometimes probably before) the first brood fledged, allowing us to predict the best time to search for second broods. In 1992 and 1993 effort was spread more evenly, so more nests were found during incubation or soon after hatching.

Two hundred and twenty-nine active nests and an additional 50 fledged broods were found during 1987-1993. Thirty-three percent of nests were initially found with eggs, 19% with small young (oldest chick less than five days old), 33% with medium-sized young (5-9 days old), and 14% with large young (10 days or older). We tested for differences in breeding parameters (e.g. clutch or brood size) between these four nest stages where appropriate, to allow for the possibility that eggs or young were removed from (or left) some nests. First egg dates were back-calculated from estimated chick (youngest) or fledgling ages assuming that one egg was laid each day, that incubation lasted for 12 days, the nestling period for 14 days, and that young became independent at two weeks after fledging (Nethersole-Thompson 1966, pers. obs.). Two failed clutches of three eggs were omitted from calculations of clutch-size because they may have been deserted before the clutch was complete.

Criteria used for estimating nestling ages were similar to Maher (1964): size relative to the egg in the first three days after hatching, length of growing primary sheath in days four to seven (when the feather emerged from the sheath), and wing-length/emerged primary

length until fledging. At 16 days old the fledglings were still relatively immobile with very short tails. Chicks of this age often crouched when approached, flights were hesitant, and they retreated under boulders if possible. By 20 days they made short flights in pursuit of their parents, attempted to feed themselves, and often took flight when approached. Over the nest week pursuit of parents became well-developed and families could range over large areas in a short space of time. By the end of the second week after fledging, the wings and tail were of similar length to those of adults (primaries full-grown when about 35 days old - unpubl. data), the chicks spent most of their time feeding themselves (although often in the company of a parent), and the frequency and success of begging behaviour was reduced.

The contents of nests were last counted on the day the nestlings were ringed so as to reduce the likelihood of chicks departing prematurely. The young could be ringed when only four days old, although 6-8 day old young were ideal and most were done at this stage. The number of young alive in the nest when they were ringed is referred to as the brood size at ringing. Subsequently, it was not possible to count the number of chicks accurately without handling them. However, as most nests were revisited after the young had fledged, we could also calculate the fledging brood size by subtracting the number of dead chicks in the nest from the brood size at ringing. This measure will inevitably be an overestimate because, on a few occasions, nestlings known to have died were not found and must have been removed from nests by the parents or by predators.

Of the 229 nests found, 31 definitely failed (contents deserted or disappeared long before fledging could have occurred) while 161 almost

certainly fledged chicks. Evidence for successful fledging was considered sufficient if the nestlings were known to be alive in the nest at 12 days old or older (at this stage they could evade a predator by scrambling out of the nest and hiding in cracks within the nest cavity), or if they were seen after fledging. This was aided from 1989 onwards by colouring coded broods, or individuals (in 1992 and 1993). A further 37 nests were treated as failures because most of the young, especially the oldest, were found dead in the nest on a follow-up visit after the expected fledging date or because the young appeared emaciated on the final visit. The main reason for the unproven outcome of the remaining 31 nests was too few follow-up visits. They were hence treated as successful because of the advanced age and obvious health of the chicks on the final visit, and the low nest failure rate (see Results).

First and second broods were separated by date (first egg date before or after 1 July respectively) or whether the pair were known to have already successfully produced a fledged brood. Second attempts invariably involved the construction of a new nest, usually within 10-500m of the first. On only one occasion, when a snowfall forced a female to abandon a full first-brood clutch, was a nest re-used within the same summer: the second attempt was started several days later (still, by definition, a first brood) and the new clutch, which later produced fledged young, was laid directly on top of the first.

## **Results**

### **Laying dates**

First egg dates for individual clutches ranged from 21 May to 23 July, apart from one exceptionally early nest on area B (newly fledged young on 6 June, estimated first egg

date 9 May). Peaks of egg-laying occurred in late May/early June and in late June/early July (Fig. 1). The average first egg date of successful first broods was 29 May on area B, but 6 days later on area A. This varied between summers, however: successful first brood nests on area B fledged 12-18 days ahead of those on area A in 1990 and 1991, but fledging dates were similar in both areas in 1992 and 1993.

On area A alone there was considerable annual variation in first egg dates of first broods (one way ANOVA  $F_{5,161}=4.62$ ,  $P<0.001$ ). This was associated with the occurrence and extent of snowfalls during May and early June (Fig. 2) which apparently delayed egg-laying in one year and led to

failure of initial nesting attempts in others. In 1988 and 1992, the second half of May and June was mild with little fresh snow. These laying seasons were synchronised and largely successful with a low proportion of late first clutches. In 1993 there was no snow during the laying season, but a heavy and prolonged period of snow just prior to it (13-17 May). Although some birds initiated breeding attempts on expected dates (before the end of May, as in 1988 and 1992), half of the pairs did not lay until after this, perhaps as a result of energy deficiencies incurred during the snowstorm. 1989, 1990 and 1991 all had two peaks in the distribution of first egg dates of first broods, and in each case a snowfall occurred between early and late first nests. In both former years, nests with early first egg dates were successful but the nests themselves were mostly found during the nestling stage. The behaviour of other pairs seen prior to these snowfall (females carrying nest materials, or males resuming singing with no signs of their mates) suggested that other females also initiated early first nests, but were forced to abandon them during the snow. Hence they were never detected. The later mean first egg date of successful first broods in these three years therefore probably represents the second nesting effort of the summer for many pairs, rather than simply a weather-induced delay to the first efforts. In 1991 this was confirmed to some extent: only two out of seven nests located prior to snowfalls on 2-5 June survived. Three of the five females which failed laid the first egg of their next nesting attempts during 9-12 June, the peak of the second wave of nesting attempts in that summer.

FIGURE 1

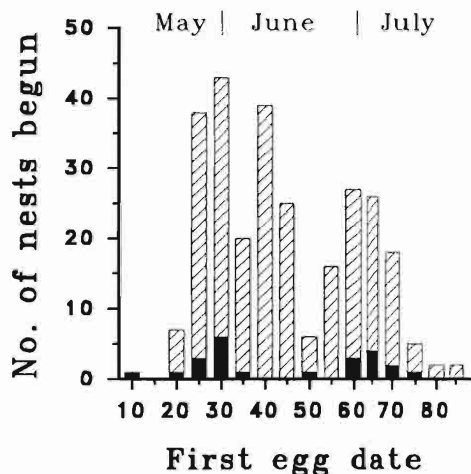
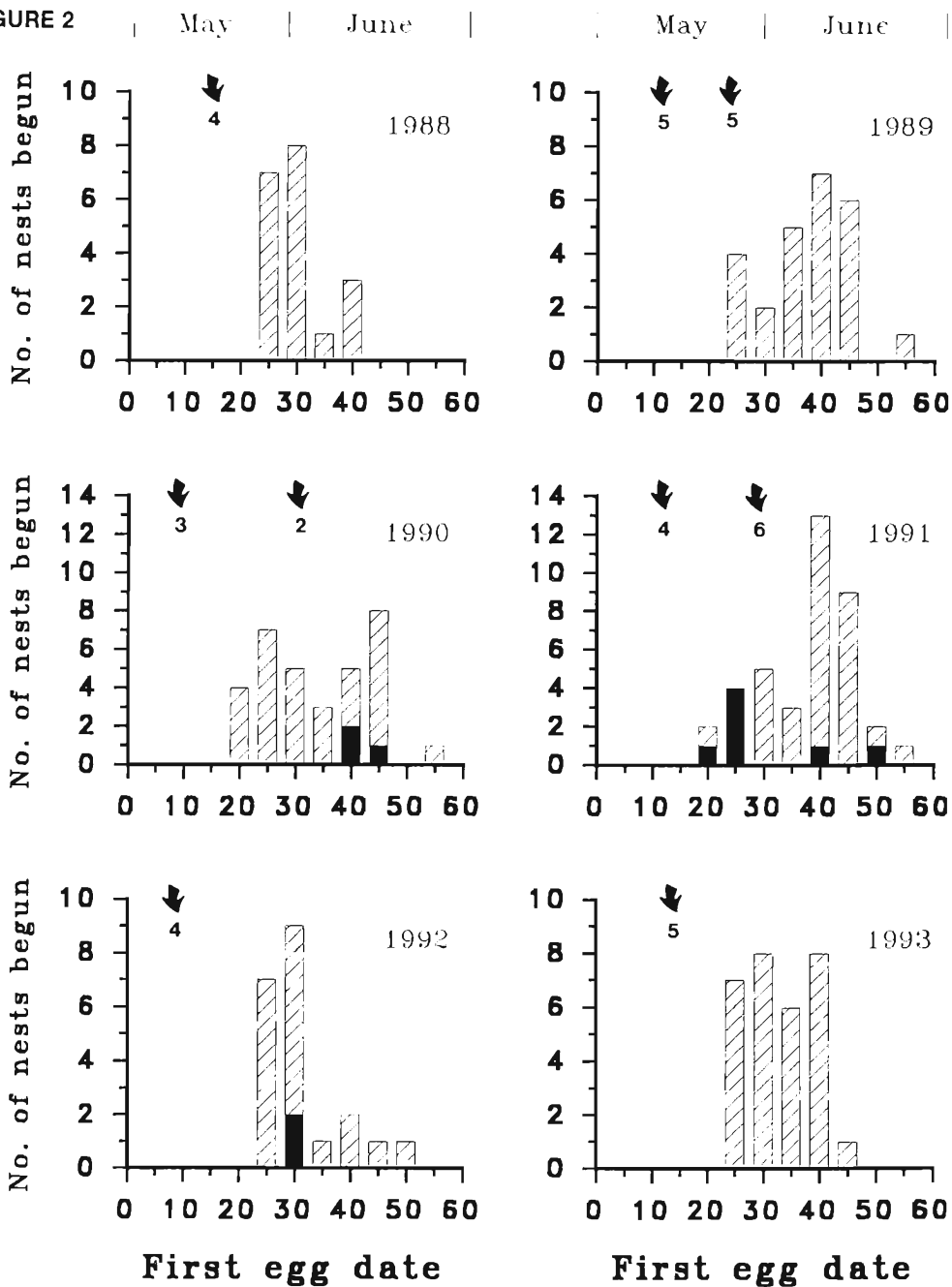


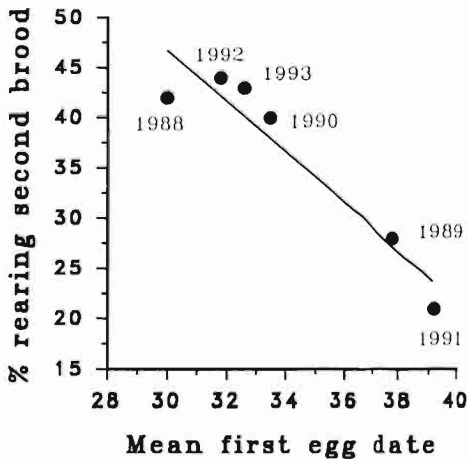
FIGURE 2



### Number of broods

Snow Buntings on area B successfully reared more broods (1.69 per pair) than did those on area A (1.20 per pair; log-linear model taking into account annual variation,  $X^2_2=9.36$ ,  $P<0.01$ ). On area A, an average of 60% of pairs reared one brood each summer, 30% reared two broods and 10% apparently failed completely ( $n=174$ ). Pairs were more likely to rear two broods successfully if their first successful brood was initiated early in the nesting season (mean 29 May,  $n=52$ ). Pairs which attempted but failed to rear a second brood initiated their first successful clutches on 2 June ( $n=18$ ) on average, whilst those in which no second brood was detected were later still (mean 8 June,  $n=78$ ; ANOVA taking into account annual variation in first egg dates of successful first broods:  $F_{2,130}=35.0$ ,  $P<0.001$ ). Similarly, amongst females which successfully reared first broods, the proportion which went on to successfully rear a second was higher in years when successful first broods were initiated early in the season ( $R_s=-0.83$ ,  $n=6$ ,  $P<0.05$ ; Fig. 3).

FIGURE 3

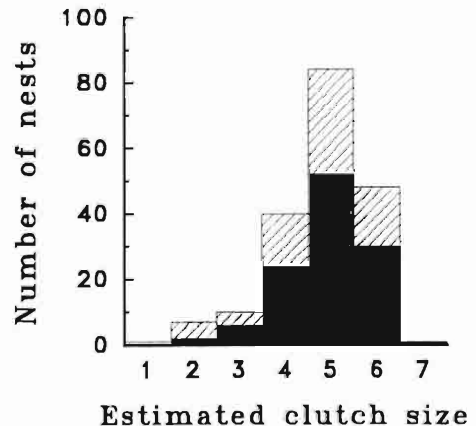


The inter-nest interval of a pair, defined as the number of days between laying the last egg of their first successful brood and laying the first egg in a second brood, averaged 30 days (s.d.=6 days,  $n=81$  pairs), although it peaked at 26-29 days, perhaps indicating that long intervals were due to a failure of an intermediate nesting attempt. We noted nest-building by several females which still had young in the nest, enabling a small overlap of broods.

### Clutch size, brood size and partial nest losses

The mean number of eggs in 71 nests observed during incubation was 4.83 (s.d.=0.96). The total contents (number of eggs or young) of 44 nests first counted when the oldest chick was no more than four days old was slightly, but not significantly, higher ( $5.05 \pm 0.89$  eggs+young; ANOVA,  $F_{1,92}=0.99$ , n.s.). This indicates that losses of contents during incubation and early brood rearing were negligible. The overall mean of  $4.91 \pm 0.93$  eggs or young in these 115 nests is therefore the best estimate of clutch size (Fig. 4).

FIGURE 4





**TABLE 1. Annual variation in Snow Bunting breeding parameters. Broods fledged per female includes data from Area A only, otherwise data from Areas A and B are combined. Clutch size is calculated from nests containing eggs or small young. Brood size at ringing age excludes nests failing before this. The percentage of nests losing small young, may include cases where unhatched eggs were removed by the parents. Daily nest failure rate in 1991 excludes the five nests lost in a snowstorm at the beginning of the breeding season.**

Parameter	1988	1989	1990	1991	1992	1993	Mean
Broods fledged per female (no. of females)	1.42 (12)	1.26 (27)	1.22 (37)	1.02 (41)	1.08 (26)	1.39 (31)	1.20 (174)
Clutch size (no. of nests)	5.21 (14)	5.62 (8)	4.71 (17)	5.27 (15)	4.47 (32)	5.00 (29)	4.91 (115)
% nests with unhatched eggs (no. of nests)	65 (20)	44 (25)	24 (38)	25 (40)	52 (33)	43 (47)	39 (207)
% nests losing small young (no. of nests)	30 (10)	14 (7)	27 (15)	33 (9)	38 (26)	26 (27)	30 (94)
First brood size at ringing (no. of broods)	3.92 (12)	3.69 (13)	4.38 (24)	4.57 (28)	3.68 (19)	4.33 (27)	4.20 (125)
Second brood size at ringing (no. of broods)	3.40 (5)	3.60 (10)	3.27 (15)	3.67 (12)	2.57 (14)	3.26 (19)	3.27 (77)
Daily nest failure rate (%) (no. of days at risk)	2.3 (215)	1.4 (218)	1.5 (324)	2.2 (185)	1.6 (510)	1.1 (454)	1.7 (1936)

The total contents of nests with medium-sized young was significantly lower (mean=4.67±1.17, n=76; ANOVA taking into account annual variation,  $F_{2,153}=3.24$ ,  $P<0.05$ ), while the total contents of nests with large young were smaller still (3.94±1.27, n=32). This was probably due to removal of some addled or infertile eggs, death and removal of some young, increased mobility of young within the nest cavity (scrambling into inaccessible cracks between rocks to avoid being caught, an anti-predator strategy), or early fledging of some brood members (which can occur from 12 days old; Maher 1964).

There was no difference in mean estimated clutch size of first and second broods (ANOVA with nest stage and year:  $F_{1,174}=2.70$ , n.s.), or between Areas A and B (ANOVA with nest stage and year:  $F_{1,157}=0.05$ , n.s.). However, there was variation in clutch sizes between summers (Table 1; ANOVA with nest stage and brood category, i.e. first or second brood, effect of year:  $F_{5,174}=3.10$ ,  $P<0.02$ ). This was mainly a result of low clutch sizes in 1992 (mean=4.47) compared to the other five summers during 1988-1993 (mean=5.08).

In 39% of nests which hatched, one or more eggs were infertile or addled, amounting to 13% of all eggs. On average 1.6 eggs failed to hatch in nests with incomplete hatching. There was no significant difference in hatching rate between areas. Between year, the proportion of nests with unhatched eggs varied substantially, from 24% in 1990 to 65% in 1988 (Table 1).

In 1992 and 1993, in nests with partial hatching success, eggs which failed to hatch were broken to record their stage of development. Twenty nests had eggs with no signs of

embryonic development, five had limited signs of development, one embryo was half developed and three were well-developed. Most eggs failing to hatch were therefore infertile or 'died' during the egg-laying or early incubation periods.

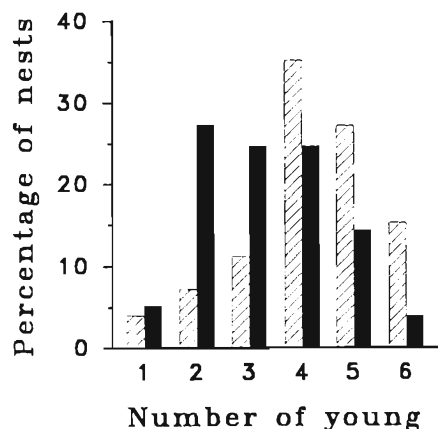
Further losses occurred between incubation and the day when the chicks were ringed. The majority of this appeared to be due to deaths of chicks rather than loss of viable eggs or removal of addled eggs. In some cases dead chicks were left in the nest, but probably most were removed by the parents (inferred in some nests by higher counts of chicks close to hatching than present when the chicks were ringed). Partial predation was suspected on only one occasion, when the nest was virtually destroyed. Losses prior to ringing occurred in 30% of 94 nests found with eggs or small young, and were independent of site, year or nest stage.

The mean brood size at ringing was 3.85 young (s.d.=1.34, n=202). There was no difference between study areas (ANOVA correcting for brood category:  $F_{1,198}=0.23$ , n.s.) but, as with clutch size, brood-size was smaller in 1992 (Table 1; ANOVA correcting for brood category:  $F_{5,186}=2.43$ ,  $P<0.05$ ). The most obvious difference, however, was that first broods were larger than second broods by an average of almost one chick per nest (Fig. 5). Dead chicks were found in the nest or nest-cavity on 20% of post-fledging visits to nests where fledging was known or assumed. However, mortality of young post-ringing was probably under-estimated due to removal of bodies by the parents.

### Total nest failure

As well as partial losses of nest contents, complete nest failures occurred as a result of the accumulation of partial losses or

FIGURE 5



instantaneously through nest desertion or predation. We quantified the rate of nest mortality (percentage of nests failing per day) using the Mayfield method (Mayfield 1961, Johnson 1979).

Nest mortality rates, although ranging from 1.1% of nests per day for nests with small young to 2.1% nests/day for nests with eggs, did not differ significantly between stages of the nesting cycle (maximum ratio of difference in mortality rates to their standard errors,  $z=1.21$ , n.s.). From the daily mortality rate averaged across all stages (1.8% nests/day), we can calculate that typical nests (5 eggs hatching asynchronously over a one-day period) would have a success rate of 60%, i.e. at least one chick fledged in 60% of nesting attempts (95% confidence interval 50-71%). Nest mortality rate was similar between sites ( $z=1.17$ , n.s.), and did not vary between years except in 1991 when five nests were lost in an early season snowstorm (Table 2).

Reasons for nest failure are listed in Table 2. Most failures were due to starvation of young (as evidenced by thin or emaciated condition on the penultimate visit, gradual disappearance of the youngest brood members, or all chicks dead in the nest at a variety of ages) and perhaps reflected a poorer food supply toward the end of the season. Several cases where the nest was deserted

TABLE 2. Causes of failure of first and second brood Snow Bunting nests.

Cause of failure	No. occurring in:	
	First Brood	Second Brood
Weather (desertions in snow)	5	0
Desertion (eggs)	3	5
Desertion (young)	1	3
Starvation of young	1	12
Predation	0	1
Unknown	1	2

or the cause of nest mortality was unknown may also have been due to seasonal food shortage.

Five nests were deserted because of a heavy snowfall. These all occurred in 1991, but the double peak of first egg dates of first broods (Fig. 2) in 1989 and 1990 suggested that snowfalls caused widespread desertion of undiscovered clutches in these summers also. This factor is therefore probably underestimated in Table 2, because few nests were found at the egg-laying/incubation stages. Three periods of snow occurred during the brood-rearing periods: on 29 June 1989, 18 June 1991 and 9 July 1993. No fall deposited more than 5cm of snow and all had largely gone within a day. There was little evidence of nest failure during these periods.

Predation was unequivocal on only one occasion; the remains of the female and her young were found dead in the nest hole and were most likely the victims of a stoat or weasel. The contents of two other nests disappeared completely, possibly predated, but removal of starving young by the parents was equally plausible. The other nest which failed in unknown circumstances may have been a result of death or predation of the female. The male continued to visit the partially incubated clutch in her absence.

### Survival of adults

Just over half of individually colour-ringed breeding adults returned to the study area to breed the following year. The return rate was similar on areas A and B (means for 1990 to 1993: 50% & 58% respectively,  $n=136$  &  $12$ ;  $X^2_1=0.06$ , n.s.), and also during four of the five years (range 59-64%,  $n=15-49$ ) but was lower from 1991 to 1992 (37%,  $n=57$ ; loglinear  $X^2_4=9.23$ ,  $P=0.056$ ).

## Discussion

### Variation between sites

Area A in the Cairngorms is almost certainly the most extensive and most consistently used area of suitable Snow Bunting habitat in Britain. We might therefore have expected that breeding success would be higher there than on area B where 4-5 pairs in 1992 and 1993 represents an all-time high, and which may be devoid of birds in some summers (only single pairs were seen on any eastern Grampians hills during 1970-87, Watson & Smith 1991).

However, egg-laying dates of successful first broods were on average almost six days earlier on area B than on area A. First egg dates of first nesting attempts (rather than first *successful* attempts) may have been similar on both areas because it is believed that many pairs on area A failed at an early stage in 1990 and 1991 due to snowfalls (Fig. 2). These setbacks may account for the lower frequency of double-brooding on area A. The risk of nest failure as a result of early season snowfalls may be lower on area B because, within Britain, montane areas further to the south and east have a warmer and drier summer climate (Thompson & Brown 1992). The differences in altitude between the two sites may be less important: no overall relationship was found between first egg dates of successful first brood nests and altitude *within* area A (Smith & Marquiss, unpubl. data).

Some of the difference in the number of broods reared between areas may, however, have been artificial because broods were more likely to have been missed on the larger site, and follow-up visits to nests on area B, especially to second brood nests, were less

frequent. In conclusion, however, there is certainly no evidence to suggest that area B was any *less* productive than area A. Because return rates of adults and settlement rates of their offspring are similar between the two sites (Smith & Marquiss in prep.), previous low counts of breeding birds on area B may result from periodic extinctions associated with a small population size, although the lack of thorough searching in previous years could not be entirely excluded.

### Annual variation

Spring and early summer snowfalls appeared to delay the early fledging of first brood young, hence reducing the chances of rearing two broods successfully. However, snowfalls did not cause all extant nests to fail. The ability of some females to continue incubation in such conditions may have been due to fortuitous nest-site choice rather than depletion of energy reserves during snow, because the duration of 100% snow cover was short. Also the ensuing snow thaw may have provided rich feeding conditions: Snow Buntings were often seen feeding along the edges of melting snow patches, perhaps on invertebrates flushed to the surface. Three of the five females known to lose clutches in 1991 laid the first eggs of replacement clutches within ten days of losing their initial attempts, despite the snow persisting for the first two of these days. Witness also the peak of presumed replacement clutches only 5-10 days after snowfalls (Fig. 2).

Our data on the causes of nest failure in second broods suggest that the end of the breeding season is set by food shortage: 12-14 out of 23 failures could directly be attributed to starvation of the young, while a further eight pairs may have deserted nests because they could not find sufficient food.

Clutch sizes were unusually low in summer 1992, and as there were slightly greater than average losses due to unhatched eggs and the disappearance of small chicks, brood sizes were also smaller (Table 1). Twenty-three percent of the 26 females known to summer on area A were not known to rear even one brood, in 1992: this was the highest rate observed during the six summers despite our greater efforts to find nests and broods in 1992 and 1993. The poor 1992 summer followed upon a year in which the adult return rate was only 60% of that averaged across the rest of the study period, leading to the largest population decrease on area A during the study period, from 40 pairs in 1991 to only 26 in 1992. Recruitment of 1991 chicks was also lower in 1992, although not significantly so. Interestingly, this drop in overwinter return rates and productivity followed a particularly snow-free winter and spring in Scotland (46 snow-free days in the Cairngorm mountains during January to April 1992, compared to a mean of 18 days during the rest of the five winters from 1988 to 1993, R.D. Smith unpubl. data) and much smaller summer snow beds than usual (Adam Watson pers. comm.). Nethersole-Thompson (1966) also noted an association between higher Snow Bunting numbers in the Cairngorms and cold winters/snowy springs although he attributed this to an increased rate of immigration rather than to enhanced survival/breeding success. If the association between decreased productivity and reduced snow lie is correct, this may reflect adverse effects on the Snow Bunting invertebrate food supply and therefore be of wider conservation and biological significance.

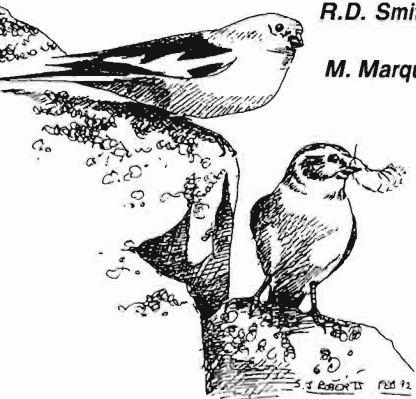
### Acknowledgements

We gratefully acknowledge help with fieldwork from Ann Marquiss and Keith Duncan. Bob

McGowan (Royal Scottish Museum) provided details of the degree of incubation of unhatched eggs. A long list of other observers made useful contributions. Neil Metcalfe and an anonymous referee commented extensively on earlier drafts, while discussion with Adam Watson, Des Thompson, Hector Galbraith and Phil Whitfield also generated enthusiasm, ideas and criticism. Substantial financial assistance was received by RDS from SNH through the Mountain Plateau Ecology Project, HIBD, BOU, ASAB and BES. We are also grateful to Cairngorm Chairlift Company for providing access to the study area via their chairlifts. Thanks are also due to the RSPB and other landowners on whose ground we worked.

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(Revised typescript received 15 August 1994)

## Short Notes

### ***Kestrel predation of Ring Ouzel nestling***

On 19 May 1993 during a survey of Ring Ouzels *Turdus torquatus* in Glen Mark, at the head of Glen Esk, I witnessed a male Kestrel *Falco tinnunculus* remove a Ring Ouzel pullus from a nest site. I was trying to count Ring Ouzel pairs present when I saw a male Kestrel flying straight towards a ledge. The Kestrel was about 400m from my position when it landed and momentarily appeared to entangle its wings in the surrounding heather. After a few seconds, it flew off, carrying a nestling in its beak. Just seconds prior to and during the attack, at least 5-6 adult Ring Ouzels mobbed the Kestrel and made frantic efforts to distract it with loud alarm calls. The pullus appeared to be 5-8 days old.

Until the attack the nest was unknown to me, although I had earlier seen a male Ring Ouzel perched on a stunted birch nearby. When I approached the site about an hour later, I

found the nest on a rocky ledge about 4m above ground level and apparently undamaged. I could not see whether any pulli remained in the nest, as it was inaccessible. During a visit eight days later, both parents were seen to carry food into the nest site, suggesting that some of the brood had survived.

In several years of observing Ring Ouzels in Glen Esk, the main cause of alarm has been the appearance of a hovering Kestrel, and this kind of predation is probably understated. In Derbyshire, Fox (1900. *Zoologist* 4: 1-10) described how he observed a pair of Ring Ouzels drive a Kestrel from their territory or nest site. Very few instances appear to have been recorded of nestling predation by raptors, and Cramp & Simmons (1980. *BWP* Vol. II) found that raptors seldom preyed on nestlings.

**David Arthur, 12 Dundee Street, Carnoustie, Angus DD7 7PD**

### ***Interaction between Red Grouse and Osprey***

On 6 June 1991, I watched an Osprey *Pandion haliaetus* hunting over a highland loch at 300 metres a.s.l., surrounded by heather moorland. The Osprey caught a large trout and then flew over nearby moorland at a height of about five metres, disturbing a pair of Red Grouse *Lagopus lagopus* which may have had a brood nearby. The male grouse flew up at the Osprey and appeared to strike it, causing the Osprey to drop its prey. The

Osprey circled quickly, dropped to the ground and having retrieved its fish flew off in its original direction.

Brood defence interactions between Red Grouse and Hen Harrier *Circus cyaneus* are well documented (S.M. Redpath. 1992. *Ornis Scand.*). In this case, it seems probable that the low-flying Osprey may have been mistaken for a quartering harrier.

**Allan Mee, 70 Busby Road, Carmunnock, Glasgow G76 9BL.**

### ***Merlin follows prey underground***

On 13 August 1993 I was driving along a country road near Cabrach, Banffshire, which passed through rough grazing on the fringe of heather moorland, when an adult male Merlin *Falco columbarius* flew from a roadside fence post 100 metres ahead of me across the rough grass and landed behind a stonewall. The road at this point turned at right-angles, so I drove round the corner and stopped my car at a point directly adjacent to where I had seen the Merlin land on the ground and cautiously looked over the fence. There was a drop of about one metre to the field below but no sign of the Merlin. However, on closer inspection, to see if there were any signs of a kill, I heard a fluttering noise coming from the entrance of a rabbit burrow at the base of the wall and the Merlin appeared, but on seeing me it immediately flew off across the field, calling in alarm.

A few seconds later, an immature Starling *Sturnus vulgaris* flew away from the base of the wall in an erratic manner as though

impaired in one wing. I climbed over the fence, down into the field, and checked the place from where the Starling had flown, thinking that the Merlin had flushed it from the main rabbit burrow through a 'pophole' or an escape tunnel, in the manner of a ferret. There were holes in the turf-topped wall, but none appeared to go any distance. Getting down on my hand and knees, I looked into the main rabbit burrow to check for other exits and was surprised to see another juvenile Starling at the end of the short tunnel, approximately 45cm long and 10cm in diameter at the entrance. The Starling was standing up on its feet at the far end of the tunnel and there were no other exits from the tunnel. I reached in and removed the now screeching Starling, which appeared perfectly healthy and unharmed and when released, it flew strongly away.

There is no mention of Merlin pursuing prey underground in BWP.

***James K Craib, 5 Rashcrook Walk, New Elgin, Elgin, Moray IV30 3EZ***

### ***Sparrowhawk exploiting a Sand Martin colony***

In 1975, the late Tom Irvine guided me to a Sparrowhawk *Accipiter nisus* nest in coniferous woodland near to the river Tarras at Langholm, Dumfriesshire. The hawks were rearing four young and prey items collected at the nest and from the male's plucking post indicated that at this stage the hawks were significantly exploiting a Sand Martin *Riparia riparia* colony, located some 440m distant.

During the initial visit the remains of 22 adult

martins were collected, ten days later a further 13 were retrieved and subsequently four more were found. A feature of the prey at the male's plucking post was that the wings were not plucked out and remained attached to the sternum, while debris at the nest indicated that the female typically took them apart. A watch at the colony showed that only the male hawk attempted to catch martins; of 14 observed passes within 37 hours of observation only three resulted in kills. Usually



the martins avoided capture by twisting in flight and by 'towering', by this time of course the colony had been depleted and fewer martins were available to the hawk. The mode of attack was similar in all cases: a swift low level approach. Although being more visible, the hawk made no attempt to attack the martins while they fed at higher altitudes. I was unable to ascertain if juvenile martins were more vulnerable as, quite dramatically, the whole prey spectrum changed at this stage with the female bringing in larger items to feed the brood and the male hawk reverting to typical woodland species. Juvenile Sand

Martins are known to be vulnerable and were seen to be taken by a male Sparrowhawk at Barbush near Dunblane in the early 1980s as they sat at the burrow mouths. (I. MacGowan *pers. comm.*)

At the Dumfriesshire site, I estimated from counts of occupied burrows that the hawk killed 58% of the available adult martins. To put this record into perspective, I have not found Sand Martin remains at any of the other 1247 active Sparrowhawk nests I have visited during the past two decades.

**John G. Young, SNH, West Lodge, Airlie, by Kirriemuir, Angus.**

### ***A successful artificial Sand Martin banking***

Sand Martins *Riparia riparia*, conventionally, as the name implies, prefer to excavate breeding tunnels in soft sand or in lighter, loamy soils. Over the years, there has been a proliferation of records where they have been seen to excavate into more difficult or unusual strata. They have, for example, utilised temporary dumps of building materials and compressed heaps of coal spoil, sawdust, manure, as well as exposed peat banks (T. Holden, J.G. Young *pers. comm.*).

Sand Martins are also known to have exploited man-made or eroded holes in masonry in, for example, harbour walls and especially in the support walls of buildings and railway embankments where clay drainage or 'weep' pipes have been inserted to alleviate a build-up of hydrostatic pressures. At one such site in the centre of Cumnock, Ayrshire, up to 12 pairs have bred intermittently in large clay pipes since at least 1967 (J.G. Young *pers. comm.*). It has also been noted from trials at Loch Leven and New Cumnock, Ayrshire, that where visual stimuli are induced by

forming holes either neatly with a soil auger, or even crudely with a walking stick, Sand Martins will be attracted to breed provided that the exposed strata are conducive to further excavation and that the vital insect food sources are within reasonable flying distances. (A. Allison, T. Holden, J.G. Young *pers. comm.*) I know of no other examples, other than by the deliberate exposure of planes in sandy bankings, where an artificial site has been especially constructed to house Sand Martins.

While developing a small private aquatic nature reserve near Lockerbie in Dumfriesshire, I experimented with a reinforced concrete banking. The mode of construction was simple. On a stable foundation relevant to height, were built some seven courses of high density concrete blocks, on top of which concrete was poured into shutters (see photo). Martin holes were preformed within the shuttering using either removable tubes or by the insertion of clay drainage tiles at the diameter, length, angle

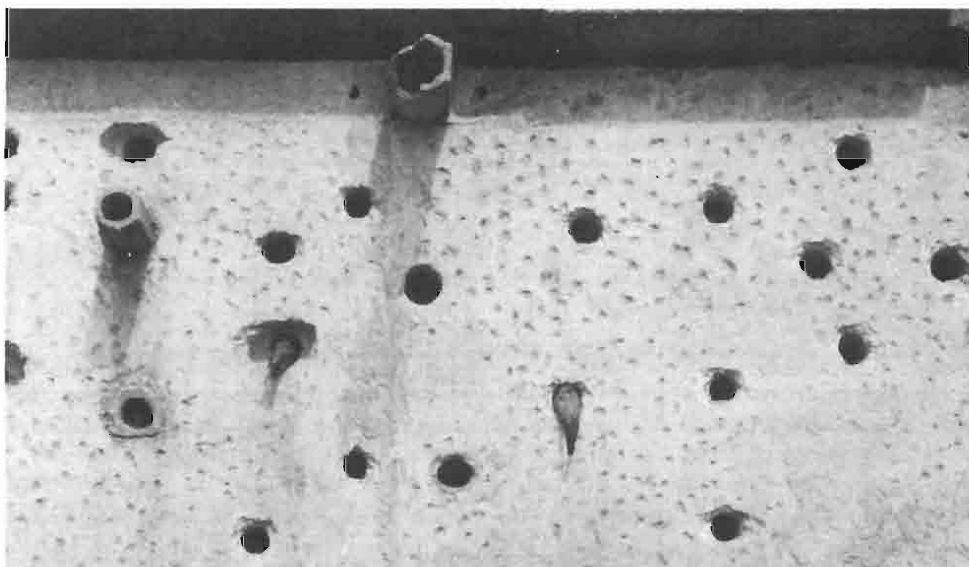
and distribution normally found in a natural site. Behind the concrete were also formed, a compact area of coarse grained, riverside sandy soil was firmly packed to allow the Martins to complete excavation and to form nest chambers. Other apertures of different dimensions to encourage occupation by water shrews, Swifts *Apus apus*, Pied Wagtails *Motacilla alba* and bat species.

The banking was completed in the autumn of 1989. The next season two pairs of Sand Martins bred in it. Sixteen broods were raised successfully in 1991, and in the three seasons since then, all the available holes have been occupied. At 136 pairs, the size of the colony is higher than the British average (37.6) for natural sites. (*BWP* Vol. V). The concrete banking is stable and not prone to the erosion which destroys many river and lochside sites. Natural sites are known to be suffering increasingly from overgrazing and trampling by farm stock, and from damage by rabbits, which may burrow into soft soils. Because of

the tendency to severe, rapid flooding at many sites, natural colonies are continually at risk. An important additional feature of the site is that there is smooth concrete for some two metres below the nest holes, which makes it extremely difficult for ground predators such as rats, stoats, weasels, mink and feral cats to gain entry to the nest chambers, while laterally placed, small mesh netting inhibits vertical burrowing.

During the winter of 1993, the number of nest sites has been doubled with significant modifications to the design. Should these prove successful, a more detailed note on construction currently being prepared will be available from the North Solway Ringing Group. The provision of relatively safe and stable artificial breeding areas, strategically placed for Sand Martins, may well prove significant in the conservation of a species that shows strong site fidelity and is declining markedly in Scotland.

**Robert T. Smith, Knowetop, Applegarthtown, Lockerbie, Dumfriesshire.**



## Correspondence

### ***The influence of the weather on seabird movements across central Scotland.***

It is surprising that during their discussion of seabird movements across central Scotland neither C.J. Henty nor R.D. Murray (*Scott. Birds* 17: 107-110) consider whether they may be due to the weather. I have discussed the main features of seabird migration elsewhere (in Cramp, S., Bourne, W.R.P. and Saunders, D., *Seabirds of Britain and Ireland*, Collins, London, 1974: 28-30). In general, birds of the coast and inland waters, such as the pelicans, cormorants, smaller skuas, gulls and terns, may regularly perform long journeys overland, which are liable to be missed because, as in the case of the massive eastward spring migration of the Common Gull *Larus canus* across Scotland, they tend to fly high over land (*Scott. Birds* 2: 3-17); it has since emerged from observations at oil installations that the autumn migration is in turn missed by radar because at that season the birds fly lower over the sea. The more marine species, including the tubenoses, tropicbirds, gannets and boobies, larger skuas, Sooty Tern *Sterna fuscata* and kittiwakes *Rissa* sp., normally avoid the land except when visiting the breeding places or carried there by the wind, as discussed for the north-east coast of Scotland by Bourne (*Ibis* 124: 81-88) and for Islay by Verrall & Bourne (*Scott. Birds* 12: 3-11).

On a number of occasions in the autumn coastal birds have flown south-west from the north-east coast, ascending as they went

inland, including small skuas from the Moray Firth, and parties of terns from the Ythan estuary. Further inland I have also seen *Larus* gulls flying south over the Grampian mountains, and traced what from the timing of the movement appeared to be shore and water birds flying south to south-west for long distances with radar. But, as deduced by Henty, there was no reason to suspect that Kittiwakes *Rissa tridactyla* were included. If one examines the daily maps in the journal *Weather* there is usually some meteorological explanation for the appearance of such species offshore or inland. For example, the movements of 500 Kittiwakes per hour west in the Firth of Forth on 16 November 1973 and 1000 per hour west on 28-29 October 1974 described by Sandeman (*Scott. Birds* 8: 77-78, 324-325) both occurred with the cold northerly airstream behind a depression. This is normally associated with massive southward movements of seabirds down both coasts of Britain at this season, and may have led to an accumulation of birds in the Firth of Forth. Similarly, the eastward movement up the Clyde on 11 March 1990 occurred with the west winds during the passage of a depression to the north which were also associated with some of the largest movements past Islay. The accumulation of birds in the Forth on 18 October 1990 occurred with the east winds associated with misty, overcast weather north of an occluded front. Some birds taking part in such movements have been seen to continue overland in such places as the Wash in the past (*Seabird* 5: 18-21), though if watched carefully most eventually appeared to follow the coast back out to sea.

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## Items of Scottish interest

Most of the following papers and report on birds in Scotland are available in the Waterston Library at 21 Regent Terrace for reference, and include all that have come to notice in the period March to September 1994. The librarian would be glad to learn of anything that has been missed, and to receive reprints or copies of papers on any aspect of ornithology or natural history. Bird reports marked with an asterisk are available from the SOC at the prices quoted, but please add 50p per order for postage and packing.

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- Composite report**
- Davidson, N. & Rothwell, P. (eds). 1993. Disturbance to Waterfowl on Estuaries. *Wader Study Gp. Bull.* 68: 106pp. A collection of 15 papers, two of which are listed above. Available from RSPB, Sandy for £15 inc. p&p.
- Bird reports**
- Arran Bird Report for 1993*. Audrey Walters (ed) 1994. 24pp. Includes an updated checklist of the island's birds by Tristan ap Rheinallt.
- Ayrshire Bird Report for 1993*. Angus Hogg & Andrew Stevenson (eds). 68pp. \* £2.75. A new addition to this long-running series is an Ayrshire butterfly report.
- Clyde Birds* (Clyde Bird Report for 1992). Iain P. Gibson (ed) 1994. 78pp. Available from Iain Gibson, 2 Fulton Crescent, Kilbarchan, Renf. PA10 2EB.
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- Islay Bird and Natural History Report for 1993*. Malcolm Ogilvie (ed). 32pp. \* £1.50. Covers birds, mammals, butterflies, moths, dragonflies and flowering plants.
- Livingston Bird Report for 1993*. Livingston Countryside Ranger Service (ed). 33pp. Includes a 24-page species list.
- Moray and Nairn Bird Report for 1993*. Martin Cook (ed). 1994. 87pp. \* £3.75. Includes a 60-page systematic list, a ringing report and two short papers.
- Orkney Bird Report for 1993*. Chris Booth, Mildred Cuthbert & Eric Meek (eds) 1994.

83pp. A 58-page systematic list and several short reports including "Corncrake survey in Orkney in 1993", and a North Ronaldsay Bird Observatory Report. \* £3.50.

*Perthshire (Central/Southwest) Peregrines and Ravens in 1993.* P. Stirling-Aird

1994. 3pp. An unpublished report. *Shetland Bird Report for 1993.* Kevin Osborn (ed). 126pp. Includes reports on the Braer Oil Spill, on the 1992 survey of Arctic and Great Skuas in Shetland, and on the rise and fall of the Fuimar in Shetland.

**William G. Harper.**

## European journals in the Waterston Library

The following selection of articles appeared in European journals received in the Waterston Library between March and August 1994 inclusive, thus following on the list published in Vol. 17 No. 3. Articles are arranged in species order; square brackets indicate that the article is in the original language, other articles being in English. Journals quoted are as follows :

Belgium: *Oriolus, Aves*

Netherlands: *Dutch Birding, Limosa*

France: *Ciconia, Le Bievre, L'Oiseau,*

*Alanda, Le Cormoran*

Switzerland: *Der Ornithologische*

*Beobachter, Nos Oiseaux, Ornis*

Germany: *Limicola, ökologie der Vögel,*

*Corax, Vogelwelt, Seevögel*

Poland *Acta Ornithologica, Zprávy MOS*

Croatia: *Larus*

Italy: *Rivista Italiana di Ornithologia,*

*Avocetta*

Spain: *Ardeola, Butlleti del Grup Català*

*d'Anellament* (in Catalan)

Iceland: *Náttúrufrægingurinn, Bliki*

Denmark: *Journal of Avian Biology, Dansk Ornitologisk Forenings Tidsskrift*

Norway: *Vår Fuglefauna*

Sweden: *Vår Fågelvärld, Ornis Svecica*

Finland: *Linnut, Ornis Fennica, Suomen Riista*

### General

Kjellén, N. Moulting in relation to migration in birds - a review. *Orn. Svec.* 4: 1-24.

Hazevoet, C.J. Species concepts and systematics. *Dutch Birding* 16: 111-16.

Kempenaers, B. [Mating behaviour among birds: an overview of the pair system]. *Oriolus* 59: 25-30.

Vansteenwegen, C. *et al.* [A comparison of census methods: quadrant mapping and capture-ringing-recapture]. *Aves* 30: 105-108.

Radovic, D. *et al.* [Results of bird ringing and recoveries of ringed birds in 1991 and 1992]. *Larus* 44/45: 1-32

Vansteenwegen, C. [Geographical variation in sedentary behaviour of partial migrants in France: an analysis of ringing results - Part 1]. *L'Oiseau* 63: 163-177.

Saurola, P. [Trans-Saharan recoveries of Finnish-ringed birds]. *Linnut* 3/94: 8-14

### Divers to ducks

Walser, B. & Barthel, P.H. [Plumages of Red-necked Grebe]. *Limicola* 8: 101-120

Lang, B. [Geese in Normandy 1971-1993]. *Le Cormoran* 9: 29-36

Markkola, J. & Peltomäki, J. [The threatened Lesser White-fronted Goose]. *Linnut* 3/93: 27-30

Aarvak, T. & Oien, I.J. [The Lesser White-fronted Goose : a threatened species. Developments in Norway 1987-93]. *Vår Fuglefauna* 17: 70-80

Leivo, M. *et al.* [Migration of Arctic water fowl in north Baltic , Spring 1993]. *Linnut* 2/94: 12-19

Samwald, O. *et al.* [Pochard x Ferruginous Duck hybrids in Austria]. *Egretta* 37: 28-32

Staaav, R. [Arctic Eiders in North Norway]. *Vår Fågelvärld* 2/94: 24-25

### Birds of prey

Various. [Papers presented at raptor and Owl conference at Prerov in 1991]. *Zprávy MOS* 50: 7-74

Müller, W. [A European brings it off : the Red Kite on the increase]. *Ornis* 4/94: 35-39

Steen, O.F. [The Hobby in SE Norway 1979-93]. *Vår Fuglefauna* 17:81-90

### Grouse to cranes

Valkeajärvi, P. & Ijäs, L. [Comparison between breeding success of artificially fed and unfed Black Grouse in central Finland]. *Suomen Riista* 40: 98-109

Grandjean-Thomsen, A. [Significance of some factors on display activity of Black Grouse in Denmark]. *Dansk Orn. For. Tidss.* 88: 85-90

Parr, R. *et al.* Changes in the numbers and interspecific interactions of Red Grouse and Black Grouse. *Avocetta* 17: 55-59

Schäffer, N. [Methods of ascertaining breeding in Corncrake]. *Vogelwelt* 115: 69-73

Jedraszko-Dabrowska, D. & Debinska, D. Ethological and ecological aspects of adaptation of Coot to breeding in urban conditions. *Acta Ornith.* 28: 91-96

### Waders to auks

Pérez-Hurtado, A. *et al.* [Importance of the bay of Cadiz for wintering shorebird populations]. *Ardeola* 40: 133-142

Ullman, M. [field identification of pratincoles in flight]. *Vår Fågelvärld* 4/94: 28-30

Brunner, H. [Juvenile development of Dotterel]. *Limicola* 8: 15-27

Gudmundsson, G.A. Spring migration of Knot over S Scandinavia, as recorded by radar. *J. of Avian Biol.* 25: 15-26

Mouritsen, K.N. Day and night feeding in Dunlin : choice of habitat, foraging technique and prey. *J. of Avian Biol.* 25: 55-62.

Brathel, P.H. [Identification of Great Black-headed Gull]. *Limicola* 8: 64-78

Hario, M. Reproductive performance of nominate Lesser Black-backed Gull under pressure of Herring Gull predation. *Orn. Fenn.* 71: 1-10

Volet, B. [Arctic Terns in the port of Geneva : notes on bill colouring in juvenile plumage]. *Nos Oiseaux* 42: 335-340

Lyngs, P. [The Great Auk : a 150-year



memorial]. *Dansk Orn. For. Tidss.* 88: 49-72

### Pigeons to woodpeckers

Various. [Papers on owls presented at Raptor and Owl conference at Prerov in 1991]. *Zprávy MOS* 5: 7-74

Lode, T. [Seasonal variations in Long-eared Owl diet in relation to variations in population densities of small rodents]. *Alauda* 62: 91-100

Sudmann, S.R. *et al.* [Short-eared and Long-eared owls as predators in Common Tern colonies]. *Vogelwelt* 115: 121-126

### Passerines

Shirihai, H. Field identification of Dunn's, Bar-tailed Desert and Desert larks. *Dutch Birding* 16: 1-9

Weggler, M. [The Black Redstart]. *Ornis* 2/94: 30-32

Rebstock, H. & Maulbetsch, K-E. [Observations on juvenile development of Whinchat]. *ök. der Vögel* 15: 137-153

Flinks, H. [Ageing of *rubicola* Stonechats by plumage characteristics]. *Limicola* 8: 28-37

Sandberg, R. [Wheaters and the Earth's magnetic field]. *Vår Fågelvärld* 3/94: 18-19

Spaar, R. & Hegelbach, J. [Nest site and breeding biology of the Song Thrush in the Zürich area]. *Orn. Beob.* 91: 31-41

Alström, P. *et al.* [Identification of small *Acrocephalus* warblers from the Far East]. *Limicola* 8: 121-131

Mild, K. [Field identification of 'black and white' flycatchers]. *Vår Fågelvärld* 3/94: 29-36

Kooiker, G. [Influence of Magpie on urban bird populations in Osnabrück, north west Germany]. *Vogelwelt* 115: 39-44

Senar, J.C. *et al.* Wing shape variation between resident and transient wintering Siskins. *J. of Avian Biol.* 25: 50-54

Thorstenson, S. & Peterson, Æ. [Breeding biology of Redpolls in north Iceland]. *Bliki* 14: 1-13

Borras, A. *et al.* Simultaneous capture of several Common Crossbills with whitish wing bars]. *B. del Grup Cat. d'Anellament* 10: 15-17

ólafsson, E. [Vagrants in Iceland part 10 : buntings, vireos and icterids]. *Náttúrufræ ingurinn* 63: 87-108

Kempnaers, B. [Extra-pair relations and paternity in Blue Tit]. *Aves* 30: 167-172

Alström, P. [Field identification of Pechora Pipit]. *Vår Fågelvärld* 5/94: 29-30

Hillström, L. & Olsson, K. Advantages of hatching synchrony in Pied Flycatcher. *J. of Avian Biol.* 3: 205-214

**Michael Murphy**

## Advice to Contributors

Authors should bear in mind that only a small proportion of the *Scottish Birds* readership is science-trained, and should aim to present their material concisely, interestingly and clearly. Unfamiliar technical terms and symbols should be avoided wherever possible and if deemed essential should be explained. Supporting statistics should be kept to a minimum. All papers and Short Notes are accepted on the understanding that they have not been offered for publication elsewhere and that they will be subject to editing. Papers will be acknowledged on receipt and will be reviewed by at least two members of the editorial panel and in some cases also by an independent referee before being accepted. They will normally be published in order of acceptance of fully revised manuscripts. The editors will be happy to advise authors on the preparation of papers.

Reference should be made to recent issues of *Scottish Birds* for guidance on style of presentation, use of capitals, form of references, etc. Papers should be typed on one side of the paper only, double-spaced and with wide margins; **two copies** are required and the author should also retain one. Headings should NOT be underlined, nor typed

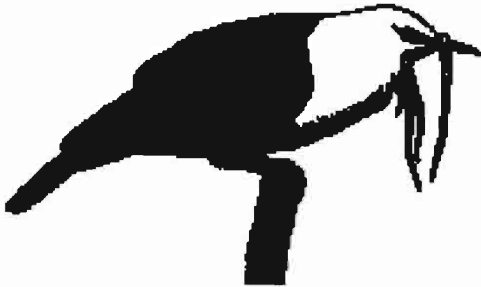
entirely in capitals. Scientific names in italics should follow the first text reference to each species and should follow Voous 'List of Recent Holarctic Bird Species' as given in the *The British Birds' List of Birds of the Western Palearctic (1984)*. Only single quotation marks should be used throughout and numbers one to ten should be written out whereas 11 and above should be written as numerals. Dates should be written:.....on 5 August 1991.....but on the 5th (if the name of the month does not follow). Please note that papers shorter than 700 words will be treated as Short Notes where all references should be incorporated into the text, and not listed at the end, as in full articles.

Tables, maps and diagrams should be designed to fit either a single column or the full page width. Tables should be self-explanatory and headings should be kept as simple as possible, with footnotes used to provide extra details where necessary. Each table should be on a separate sheet. Maps and diagrams should be in Indian ink and be camera ready, but drawn so as to permit reduction to half their original size.

For details of writing Research Progress Reports, please contact the editor in advance.

**ERRATUM:** Caption for colour print of female Mandarin *Aix galericulata* in Summer 94 issue should read first breeding record in Argyll.

Unfortunately space was restricted and the Research Index which normally appears in December issue will now appear in the June issue.



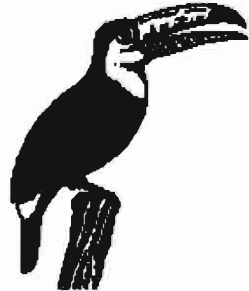
## NEOTROPICAL BIRD CLUB

### Neotropical bird club launched

A club has been launched to promote the study and conservation of the birds of the Neotropics (South America, Central America and the Caribbean). It is currently seeking founder members to help reach the launch budget of £2000, which is required to get the club running and to publish the two first issues of its intended journal 'Continga'. Founder members will be asked to pay a minimum of £25, and will be formally acknowledged in the first issue of 'Continga', planned for January 1994. 'Continga' will provide a colourful and much needed forum for exchange of information on the avifauna of this extremely rich and diverse area, and will contain papers and features on the birds and their conservation as well as news of recent observations and discoveries (at present, new species are still being discovered at the rate of more than two a year). It is hoped that in due course the club will be able to provide direct funding and support for practical conservation programmes.

*For further details and membership forms,  
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