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Scottish Snow Bunting numbers in summer 1970-87

A. WATSON AND R. SMITH

More summering Snow Buntings were recorded in Scotland in 1970-87 than in previous decades. Birds are known to have reared young on eight hills in the Cairngorms and east Mounth, on 12 in Inverness-shire and Ross-shire, and two in Sutherland. Adult sightings were made on 9 other hills in the Cairngorms and east Mounth, and on 31 other hills west and north of the Cairngorms. Cock numbers found on a regularly studied area in the Cairngorms fluctuated over the study period but were higher than previous counts there.

Introduction

The Snow Bunting *Plectrophenax nivalis* is one of Britain's rarest regularly breeding birds (Sharrock 1976), and in the Scottish Highlands is at a southern margin of its largely arctic breeding distribution. Nethersole-Thompson (1966) summarized his own and most other Scottish summer records up to the early 1960s, and later (1976) some notes by a number of other observers. Thom (1986) briefly mentioned some observations from all of Scotland. Milsom & Watson (1984) summarized their records from part of the central Cairngorms in 1971-77, and A.W. studied a larger area there in 1970-86. In 1987, R.S., A.W. and others increased the effort there, and R.S. began an intensive study with marked birds in 1988. This paper summarizes the frequency and distribution of breeding and summering records for Scotland in 1970-87. It also considers the evidence for changes in numbers since previous work and during 1970-87.

Methods

The records came from:– a) our own observations, mostly in the Cairngorms and east Mounth, b) unpublished notes for all of Scotland, made by various observers and given to A.W., and c) published annual bird reports, which we followed up by requesting further details from regional recorders and original observers. Only our own observations in the central Cairngorms were made regularly, thus allowing comparisons between years. Elsewhere, records were sporadic, and on many hills the bird's presence was recorded in only one summer.

A few wintering birds stay on Scottish hills until early May (R.S., unpublished data from marked birds). We have therefore only included observations of single adults or pairs after the middle of May as summering birds. Nearly all observations were in June-August.

To protect the birds we give no precise locations. A "hill" is a separate, distinct hill, not a subsidiary top or summit; above 3000 ft (914 m), this means a "Munro" as in Donaldson (1984). Some hills, where an adult or pair was seen in summer, had only one known site each such as a corrie or part of a plateau. On other hills, Snow Buntings were seen in two or more such sites per hill, often in the same year. In this sense, the term "site" is in any one summer effectively equivalent to a territory.

Results

Summering birds were seen at 62 hills and 104 sites during 1970-87, and fledged young

at 35% and 39% of these respectively (Table 1). There were also many records of nests and of adults carrying food, but adding these to Table 1 does not increase the figures there. Many hills had only one or two recorded sites each, occupation of which was found only sporadically. This does not mean that occupation was sporadic, as we have no reports of 'nil observations' except for our own data from the Cairngorms (without these one cannot say whether a lack of records for a site is due to observers going there and finding no birds, or to no observers going there).

On the fairly intensively covered area in the central Cairngorms, numbers fluctuated considerably from year to year (Fig. 1). When the number of cocks there in 1971-87 was compared with year, there was no significant trend. Annual cock numbers seen in 1970-87 there exceeded those recorded in 1929-66 in the whole Cairngorms massif (Nethersole-Thompson 1966).

The number of hens seen in the central Cairngorms in 1971-87 was far less than the number of cocks (Fig. 1). Cocks may have been in excess, but the far less conspicuous hens are easily overlooked unless observations are intensive.

Discussion

The figures of 62 hills and 104 sites where summering birds were found in 1970-87 are much higher than the figures in previous estimates of Scottish breeding numbers (Nethersole-Thompson 1966, Thom 1986, 6-21 pairs Nature Conservancy Council 1989). If the maximum percentage occupancy of sites (79%) in the intensive area in the central Cairngorms (Fig. 1) is extrapolated to all of Scotland, up to 82 sites would be occupied in peak years. However, hills with only one or two known sites may be marginal, with lower occupancy than the Cairngorms, so the figure of 82 is probably an overestimate. On the other hand, this effect would be counter-acted by birds being on hills or parts of hills not visited by bird watchers whose reports on sightings came to us. The records are therefore far too incomplete to estimate breeding numbers

TABLE 1. Number of hills and sites where adult Snow Buntings were recorded summering (feeding fledged young in summer), and maximum number of cocks recorded on any hill in any one summer during 1970-87, (a) west and north of the Cairngorms, and (b) in the Cairngorms and east Mounth.

		Number of hills where summering (fledging)	Number of sites where summering (fledging)	Maximum no. of cocks
(a)	Inverness-shire	14 (6)	22 (7)	3
	Inverness-Ross march	3 (2)	3 (2)	1
	Ross	11 (4)	11 (4)	2
	Sutherland	10 (2)	10 (2)	1
	Shetland	3 (0)	3 (0)	1
	West Perth	2 (0)	2 (0)	1
	Argyll	2 (0)	2 (0)	1
(b)	Cairngorms west	6 (4)	21 (8)	6
	central	4 (2)	19 (15)	13
	east	1 (1)	5 (2)	2
	East Mounth	6 (1)	6 (1)	1
	Total	62 (22)	104 (41)	

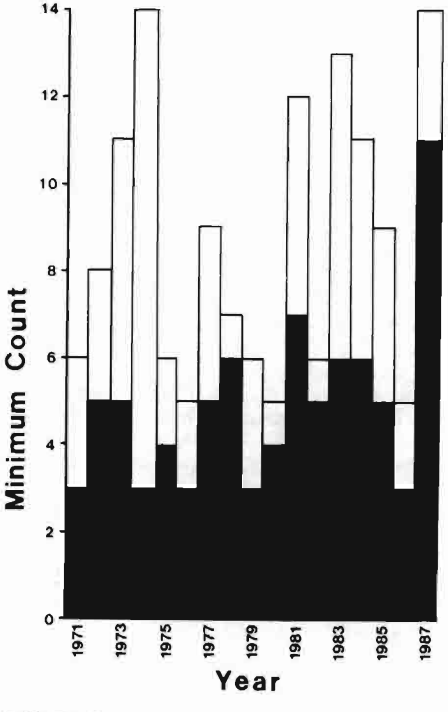

FIGURE 1.

accurately, but the number of sites occupied may have been up to 50 in some years.

The higher numbers seen in the central Cairngorms since 1970 have led to the suggestion that numbers in all of Scotland have increased (Nethersole-Thompson 1966, Thom 1986). Although our records for the central Cairngorms and elsewhere in Scotland are consistent with this suggestion, the scale of the presumed increase may be an overestimate due to an increase in observer effort. With easier and faster road access and transport, more leisure time, and higher incomes, the number of summer hill walkers and bird watchers has increased greatly in recent decades (Nethersole-Thompson & Watson 1981; Watson 1984, 1991; Aitken 1985). A similar argument has been put forward to explain higher counts of Dotterel *Charadrius morinellus* in Scotland in recent years (Watson & Rae 1987).

Nethersole-Thompson (1966) gave details of earlier records back into the last century. This indicated more records in decades around the turn of the century than in the 1920s and 1930s. His own observations in the Cairngorms showed fewer records in the 1930s than in the 1940s-early 1960s. He suggested (1966, 1976) that these differences related to climatic variation, with low numbers during warmer periods such as the 1930s, but he did not expand on which climatic factors were involved, apart from mentioning snow cover. The possibility that the number of cocks on part of the central Cairngorms in 1971-77 was related to snow cover there at the beginning of June has been rejected (Milsom & Watson 1984); if anything, the association was negative. However, the statistical drawbacks of small sample size due to the small number of birds would make any analysis of doubtful reliability.

A human cause of changes in numbers (e.g. Watson 1979) cannot be ruled out. A possible confounding factor is artificially increased food in summer (scraps from hill walkers) and in winter (scraps and reseeded areas at ski centres, upland car parks and roads, scraps from hill walkers, and feeds left outdoors for deer, sheep and cattle). The frequency of predators may also be lower, due to their avoidance of walkers and skiers.

Human-induced climatic change through global warming is a serious threat, and there is much interest in climatically sensitive species as indicators. The Snow Bunting is a possible indicator, especially in Scotland at a southern margin of its breeding range. In addition to future annual observations on the main breeding areas of the Cairngorms and Ben Nevis massifs, observations should include some hills where birds have been seen only irregularly, to establish whether irregular sightings are due to sporadic visits by observers or to birds being present in some years but not

others. Annual visits to such hills are essential if a more reliable estimate of trends in Scottish summering numbers is to be obtained.

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(Ms received February 1991)

Snow Buntings in Caithness

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Snow Buntings spend up to five months of the year in Caithness typically between November and late March. They occupy a variety of habitats including sand dunes and rough pasture mostly at altitudes less than 100 m asl and within 10 km of the sea. Over the period 1976-88 the wintering population is estimated to have varied between 100 and 2500 birds with a mean of 1100. The wintering flocks, which usually consisted of 10-300 birds, were distributed mainly in clusters of key sites to which birds returned year after year. Ringing also showed there to be appreciable site fidelity between seasons although differences between sites were apparent. These and other observations on the social biology of wintering Snow Buntings are discussed in terms of a simple model, the principal features of which are extensive movement between flocks within restricted areas of 10-50 km^2 in extent, high site fidelity to these areas between seasons and little interchange between such areas within seasons.

Introduction

The winter distribution of the Snow Bunting *Plectrophenax nivalis* in the British Isles shows a pronounced easterly bias, the most important areas being Shetland, Orkney, the east coast of Britain from Caithness to Kent and the Cairngorms (Lack 1986). The species' winter biology is still poorly known though recent progress, based in part on our earlier studies in Caithness and elsewhere, has been made on winter weights, pre-migratory fattening, biometrics, population structure and the birds' origins and movements (Bakker *et al* 1978, Rae & Marquiss 1989, Banks *et al* 1989, 1991). In this paper we describe some further results concerning the timing of occurrence, social biology, habitats and population size of Snow Buntings wintering in Caithness.

Materials and Methods

Data for this study were obtained from two main sources. Information on site fidelity and movements is based on ringing activities at Keiss Links (58°31'N, 3°03'W) on the east coast of Caithness over the five winter seasons 1985/86-89/90 and at Dunnet (58°35'N, 4°01'W) on the north coast of Caithness in the winters of 1986/87 and 1987/88. Birds were caught in "whoosh" nets regularly baited with grain, and were aged and sexed according to methods described in Banks *et al* (1990). Most of the birds caught at Keiss were colour-ringed. Data on flock sizes and distribution in Caithness were taken from the Caithness Bird Report (1976-82) and from records made available to us by the Caithness Bird Recorder, Mr E.W.E. Maughan, for the period 1983-88. These were supplemented by our own field surveys carried out between 1985/86 and 1989/90. Snow Buntings appear to have been much more numerous in some seasons that others (see below) and so for some parts of the analysis only data

collected in the period 1983-88 have been used. The biasses inherent in these data are unknown, but we assume that they provide a reasonable representation of the Snow Bunting's occurrence in Caithness in the winter months.

Results

Timing of occurrence

Snow Buntings are present in Caithness for about 5 months of the year, typically from November to late March, though small numbers are usually seen in September and/or October and early April in most years. The mean date of first sightings in 1983-88 was 7 October (6 seasons; range 4 September – 22 October) and mean last date 20 April (5 seasons, range 8 - 30 April). There is also a remarkable record of a freshly dead female found on 14 May 1972 on Morven (Collett & Manson undated). No systematic counts have been made in the early part of the season but it is evident that the build up in numbers tends to be a fairly gradual process extending over a period of 4-8 weeks. The departure, by contrast, is much more rapid lasting usually little more than 2-3 weeks. Immediately prior to their departure the birds gain weight through the deposition of sub-cutaneous fat and most leave as soon as sufficient reserves for migration have been accumulated (Banks *et al* 1989). There appears to be a fair degree of synchrony in the commencement of pre-migratory fattening, ringing evidence from Dunnet in 1986/87 suggesting that males begin on average *ca* 9 days ahead of females. Estimated mean departure dates were 17 March for males and 26 March for females (see Banks *et al* 1989 for details).

Flock sizes

Snow Buntings are social birds and in Caithness form flocks of typically between 10 and 300 individuals. The largest recorded were 900-1000 in March 1979, 1000-1500 in March 1987 and 2000 in 1975 (Collett & Manson undated). These are amongst the largest ever seen in the British Isles, though flocks up to 5000 strong have been noted in Orkney (Booth, Cuthbert & Reynolds 1984). Flocks usually consisted entirely of Snow Buntings; even at particularly favourable sites where other species such as Skylarks *Alauda arvensis*, Reed Buntings *Emberiza schoeniclus* and finches occured, Snow Buntings remained somewhat apart.

The seasonal variation in flock size over the years 1976-88 is shown in Fig. 1. Not surprisingly flock sizes were much smaller on average in the main arrival and departure periods but remained roughly the same throughout the winter months. The median flock size was appreciably larger in

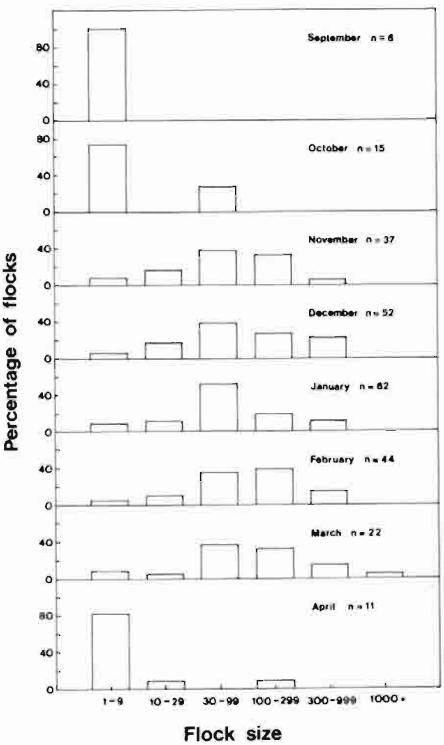

FIGURE 1. Seasonal variation in flock sizes of Snow Buntings wintering in Caithness, 1976-88. *(n = number of flocks).*

the winters of 1986/87 and 1987/88 than in the other seasons considered.

Distribution

The distribution of sightings of Snow Buntings in Caithness in the period 1976-88 is shown in Fig. 2. Most were from the north coast between Reay and Dunnet Head and the Wick area on the east coast. The main inland records were from the Calder area. There have been few records from the agricultural land between Thurso and Wick, the high coastal areas south of Lybster and between Dunnet Head and Keiss, or the

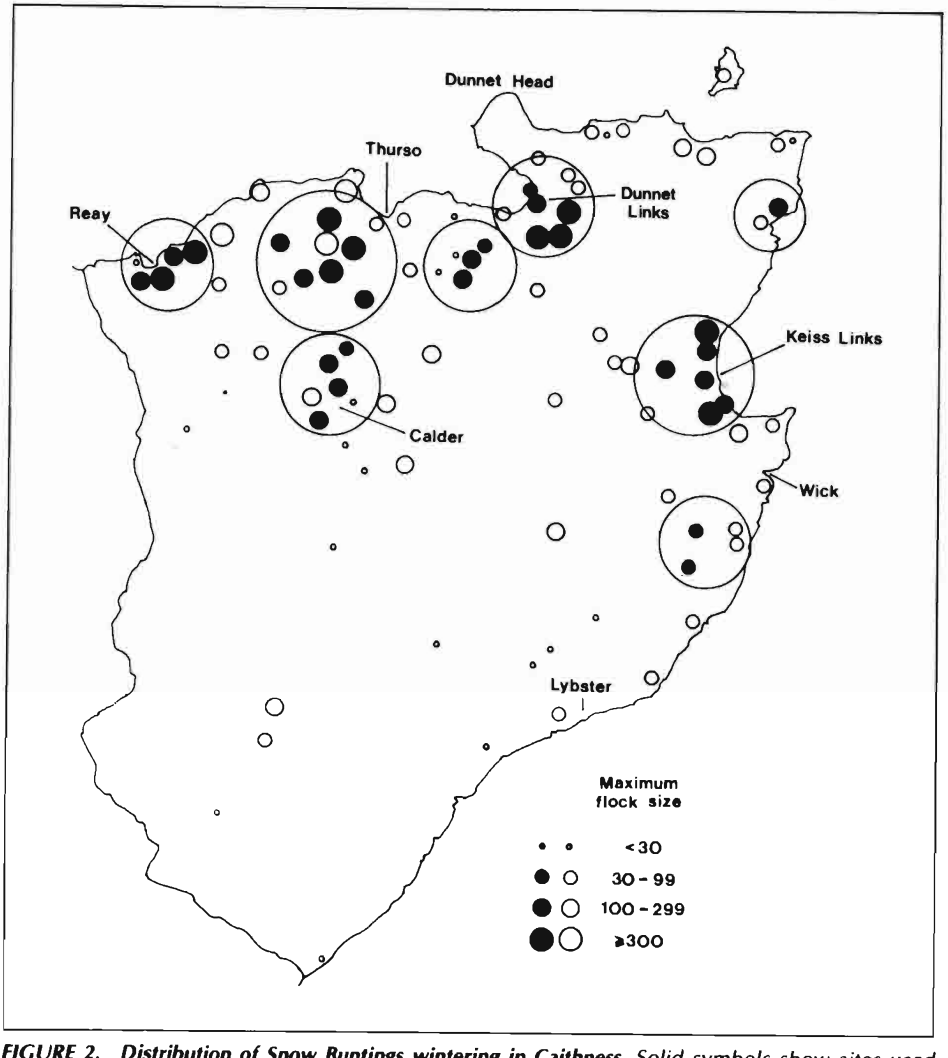

*FIGURE 2. **Distribution of Snow Buntings wintering in Caithness.** Solid symbols show sites used regularly in the period 1983-88, open symbols other records, 1976-88.*

flow county of west Caithness. The absence of sightings from the latter area could simply be a result of the difficult access to this part of Caithness in the winter months. However there is only one record from the Causey Mire (A895 between Georgemas and Latheron) from which we have ourselves made a number of unsuccessful searches for Snow Buntings, so we doubt that this is an important wintering area for the species.

In Fig. 2 we have differentiated between sites used regularly in the period 1983-88 (for which we have most data), and all other sites for the entire period, 1976-88. Regular is used here to mean occurring in at least four of the six winters 1983-88. Many of the records from earlier years also relate to these sites. The regularly used sites seem to form a number of clusters (the large circles in Fig. 2), covering areas of 10-50 km^2. Such a pattern could arise from a single flock moving locally between a number of feeding sites or several flocks exploiting locally favourable conditions. Our field observations suggest, however, that the situation may be more complex than either of these two simple pictures. Based mainly on observations of birds at Keiss, Dunnet and Glengolly (near Thurso) we have noted on a number of occasions two flocks coalescing or a large flock dividing into two smaller ones which then flew off in different directions. It was also quite noticeable at these and other sites that flock sizes varied appreciably within a particular season. We have also been able to locate flocks feeding simultaneously at two or more sites within a particular cluster.

Site fidelity

The observation that birds return repeatedly to particular sites implies some degree of site fidelity both within and between seasons and we have been able to investigate this directly on the basis of our ringing at both Dunnet and Keiss. A summary of the number of birds handled is given in Table 1.

Site fidelity between seasons

The numbers of Snow Buntings retrapped at the same time in successive winters were relatively small. At Keiss, for instance, only 3.7% of the birds ringed in the first winter were caught again in the second, and only 2.2% of birds ringed in the second winter were retrapped in the third. Of the birds ringed at Dunnet in the second winter only 4.4% were retrapped there the following winter. If, however, the number of retraps is expressed as a percentage of the number of individuals caught in that season then a significant difference between the two sites becomes apparent. Thus in the 1986/87 and 1987/88 seasons 0.7% and 3.3%

TABLE 1. Numbers of Snow Buntings caught in Caithness.

Site	Period of trapping	No. ringed	No. colour ringed	No. controlled	No. retraps from earlier season(s)	Total No. individuals caught
Keiss	Jan 86 – Mar 86	162	0	0	—	162
Keiss	Dec 86 – Apr 87	837	802	3	6	846
Keiss	Nov 87 – Apr 88	520	516	5	18	543
Keiss	Nov 88 – Mar 89	142	0	3	21	166
Keiss	Dec 89 – Mar 90	41	0	1	6	48
Dunnet	Jan 87 – Mar 87	411	0	5	—	416
Dunnet	Dec 87 – Mar 88	114	0	2	18	134

respectively of the birds caught at Keiss had been ringed there the previous winter, while at Dunnet 13.4% were retraps from the previous year, a highly significant difference.[i] Males were slightly more likely to be retrapped in the following season than females (4.8% males v. 3.0% females at Keiss in 1987/88 and 20.4% males v. 11.7% females at Dunnet in the same season). Given that probably no more than a third to a half of the birds present in winter 1986/87 were ringed, that many of these birds will have died in the subsequent breeding season and roughly half of the birds caught in 1987/88 were first-years (which cannot, of course, be retraps from the previous winter) it is clear that in some years a substantial proportion of the birds returned. This is perhaps of the order of 5% and 20% of birds caught at Keiss in 1985/86 and 1986/87 respectively and well over 50% of those marked at Dunnet in 1986/87. We conclude, therefore, that the Snow Bunting can show a fair degree of site fidelity between seasons but that this varies between sites and between years.

Site fidelity within seasons

On a number of occasions in the second winter of the study when no trapping was being done, flocks of Snow Buntings on the ground near the bait at the Keiss ringing site were scrutinised from a distance through binoculars and the number of ringed birds present counted. The proportion of ringed birds present in the flocks on these occasions is given in Table 2 together with the total number of birds ringed for the winter at this site prior to the dates specified. There was no trend for the percentage of ringed birds in these flocks to increase in proportion to the total number ringed. Similarly at Dunnet in the 1986/87 season retraps of birds ringed earlier in the season remained constant at about 30-45% throughout the winter.

i. (χ^2 = 20.69; P < 0.001; test made using 2×2 contingency table comparing birds ringed with retraps from the previous season at the two sites)

TABLE 2. Percentage of ringed birds in flocks of Snow Buntings wintering at Keiss Links, Caithness, 1986/87.

Date	Cumulative total ringed	Size of flock	% with rings
24 Dec 86	240	200	10
26 Dec 86	240	40	30
29 Dec 86	253	150	10
4 Jan 87	413	100	18
15 Feb 87	696	102	12
23 Feb 87	713	24	17
30 Mar 87	813	20	10

TABLE 3. Mean number of handlings for Snow Buntings caught in Caithness.

Site	Season	No. individuals	No. handlings	Mean No. handlings per bird
Keiss	1985/86	162	183	1.13
Keiss	1986/87	846	956	1.13
Keiss	1987/88	543	600	1.10
Keiss	1988/89	166	210	1.27
Keiss	1989/90	48	55	1.15
Dunnet	1986/87	416	578	1.39
Dunnet	1987/88	134	156	1.16

A further insight into the turnover rates of birds at both Dunnet and Keiss can be obtained from the number of times individual birds were handled (Table 3). At Dunnet in 1986/87 some birds were caught up to six times, with a mean number of handlings per bird of 1.39. Males were more likely to be retrapped here than females. Over the same period at Keiss the mean number of handlings per bird was 1.17, an appreciable difference.[ii] We infer that the

ii. (χ^2 = 15.41, P < 0.001; test made using 2×2 contingency table comparing number of birds handled once, with those handled more than once)

turnover rate of birds at Keiss was higher than at Dunnet especially during the 1986/87 winter when sample sizes were largest. During the same period there were 25 "same day" retraps at Dunnet and only one at Keiss.

In the winter of 1986/87, when catches were highest, the number of Snow Buntings caught far exceeded the biggest flocks ever recorded at either site. Thus 846 and 416 birds were ringed during this winter at Keiss and Dunnet respectively whereas the largest flock sizes were 250 and 150 respectively. Superficially these results seem to indicate a regular turnover of birds throughout the winter at both sites, but this is to neglect the part played by trap-shyness. It would be possible, for instance, to interpret our findings in terms of a comparatively large and relatively sedentary local population (such as the clusters in Fig. 2) in which new birds were much more likely to be trapped than those which had already been ringed. Whatever the true position regarding site fidelity within seasons it seems clear that our two ringing sites differ appreciably in this respect.

Movements

Despite having ringed over 2000 birds and colour-ringed almost half of these (all at Keiss) we have had remarkably few recoveries, retraps or sightings of our birds away from where they were ringed. No birds ringed at Dunnet have been found elsewhere in Caithness, and only 7 birds from Keiss have provided information on local movements. These included 4 birds, all adult males, which moved from Keiss to Dunnet, a distance of 15 km NW (no movements in the opposite direction were recorded), an adult male from Keiss to Scrabster Hill, near Thurso (28 km WNW), a female from Keiss to Kirkwall, Orkney (60 km N), and a first-year male from Keiss to John O'Groats (14 km NNE).

We have also recorded a number of longer distance movements (>100 km) the timing of which suggests that they were birds of passage making their way southward in late autumn or northwards in late winter (further details in Banks *et al* 1991). About 80% of the birds in Caithness are identified on plumage grounds as being of the Icelandic race, *P.n. insulae* (Banks *et al* 1991). Ringing recoveries are consistent with this, our ringing having generated twelve movements between Caithness and Iceland.

Habitats

Snow Buntings utilise a variety of habitats within Caithness of which the most important are sand dunes and the strand line (Dunnet, Keiss), weedy fields (especially turnip fields), stubble, pasture, unimproved grassland and heather moorland. Unfortunately the bulk of the records we have give no details about habitat so we are unable to quantify their relative importance though we suspect that most of the sites would be classified as rough grassland.

It is apparent from Fig. 2 that the bulk of the sites used were near the coast: overall 70% were within 5 km and 90% within 10 km of the sea. In terms of altitude, 52% of sites were less than 50 m asl and 89% less than 100 m sl. Only two sites were above 200 m asl.

Size and variability of the winter population

To estimate the size and variability of the wintering population we have taken the largest flock size from each of the "clusters" shown in Fig.2 and summed these for each of the 14 seasons for which we have data. Some allowance has been made for birds seen away from the main wintering sites. The wintering population estimated in this way varied between 100 and 2500 birds with a mean of 1100 (all figures rounded to nearest 100) as shown in Fig. 3. Of particular note are the high counts in 1986/87 and 1987/88, seasons when there were also unusually high numbers wintering in Orkney (Orkney Bird Report 1986-88), and also the very low counts in

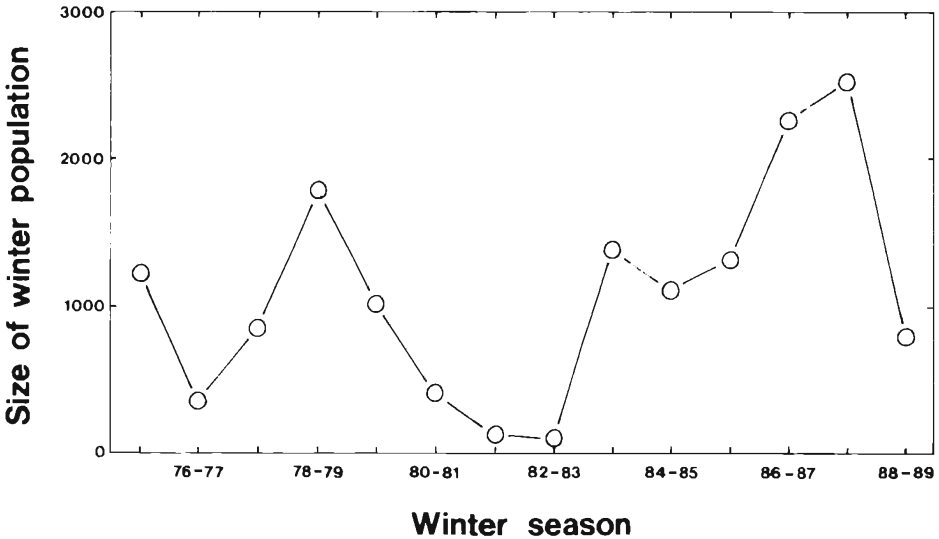

FIGURE 3. Variation in the numbers of Snow Buntings wintering in Caithness, 1975/76-88/89.

1980/81-82/83. It should be emphasised that the counts on which these figures are based were not collected in a systematic way and we consider it likely that some birds will have been overlooked. Double accounting is also a potential problem but, by choosing only one count within each cluster, albeit the highest, any error from this source is likely to be minimal. At the very least we believe that these figures give a reasonably reliable index of relative abundance as well as an indication of absolute abundance.

Discussion

Flocking and site fidelity

The picture of the Snow Bunting's social biology which emerges from this study is a complex one. In general the birds appear to occupy a fairly extensive area or "super-territory" within which they form into one or more flocks. The choice of feeding sites seems to be quite conservative, with flocks returning repeatedly to favoured spots both within and between seasons. Evidence on the extent to which individual birds are site faithful within seasons is more equivocal. Retrap data suggest fairly low site fidelity within seasons, though this may result from trap shyness rather than a significant turnover of birds. There is, however, definitely some movement between "super-territories" as shown by retraps or sightings of ringed birds (movements up to 60 km have also been recorded elsewhere in Britain – see Banks *et al* 1991), though the very small number of such movements we have found in Caithness suggest that comparatively few birds undertake such movements.

This pattern is presumably a consequence of the abundance and distribution of the Snow Bunting's food, which we take to be relatively predictable. Social birds with a much less predictable food supply tend to be more nomadic in the non-breeding season, feeding where food is locally abundant, and moving on when it is exhausted.

A striking feature of the present results is the difference between the Dunnet and Keiss study sites. Thus site fidelity between seasons was comparatively high at Dunnet,

but moderate to low at Keiss, recapture rates within seasons were higher at Dunnet than at Keiss and females were more abundant at Keiss than Dunnet. The reasons for these differences between sites only 15 km apart are uncertain, but we suspect that they are connected with the local food supply. Dunnet appears to be the more favourable site (birds are apparently more site faithful both within and between seasons; males, the dominant sex, are more common than at Keiss, and all movements between the sites were from Keiss to Dunnet, not the other way), but quite what features are so desirable is unclear. Both sites are centred on sand dunes dominated by marram ammophila arenaria, the most significant differences being in the adjoining land. Dunnet beach, for instance, collected much rotting seaweed and had an abundant invertebrate fauna; Snow Buntings regularly fed along the strand line there. The beach at Keiss, by contrast, collected virtually no seaweed and was very rarely visited by Snow Buntings. Inland from Dunnet is a large tract of botanically-rich machair-like grassland known as the Moss of Greenland which was visited sporadically by the Dunnet flock. At Keiss the equivalent area is farmland (pasture plus some arable land) together with an area of botanically-poor grassland. Away from the dunes the Keiss flock resorted mainly to an area of stubble. Predator pressures as judged by the number of sightings of birds of prey (principally Merlins *Falco columbarius*) appeared to be about the same at the two sites.

Population size

The estimated mean wintering population of the Snow Bunting in Caithness during the 14 years for which data are available was 1100 birds, a figure which we suspect may be an underestimate. This represents 7-11% of the British wintering population, which is given in the Winter Atlas (Lack 1986) as 10,000-15,000 individuals, and emphasises the importance of Caithness as a wintering area for the species. The variability of the winter population has been commented on by a number of earlier workers (*e.g.* Nethersole-Thompson 1966, Lack 1986) but ours appears to be the first attempt to estimate this variability. Even though our data extend over only a comparatively short run of years we find the highest total to be approximately 25 times the lowest. We cannot be sure that our figures are typical of Britain as a whole but suspect that they reflect trends at least in the north of Scotland. Most of the birds wintering in this area originate from Iceland (Banks *et al* 1991) and it is probably to here that one must turn to account for the variability. Most Snow Buntings breeding in Iceland remain there for the winter, showing only seasonal movements from the high altitudes of the breeding range to lower ground in the winter (Breuil 1989). The factors that determine how many migrate to the British Isles are unknown but population size, food availability, weather and perhaps the number of migrants from Greenland are the most likely. We suggest that the variable numbers in Caithness reflect the varying percentage of birds which migrate. That individual birds migrate in some years but not in others is illustrated by a bird ringed as a first-year male at our Keiss site in January 1986 and retrapped at Keiss in December 1986 and in Iceland in January 1990. The wintering population in Britain shows a marked bias towards females (Rae & Marquiss 1989, Banks *et al* 1991) in some years but there is an insufficiently long run of data to test whether the sex ratio and the population size are correlated. It should be emphasised, however, that the sex ratio can vary between sites within a particular season and is, by implication, at least partly determined by local factors.

Acknowledgements

We owe particular thanks to the many farmers who have so generously supplied us with grain free of charge, and the landowners on whose land Snow Buntings were caught, especially Mr A. Dunnet of Lyth. We are indebted also to Eric

Maughan for supplying data on Snow Bunting flocks in Caithness and to the many members of the Thurso Branch of the SOC who helped collect this information.

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The breeding distribution and habitat requirements of the Lesser Whitethroat in Strathclyde

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Since 1983, our continuing research has shown that the Lesser Whitethroat is making tentative inroads into Strathclyde. Breeding however is extremely localised, with only three sites having regular breeding success. We therefore attempted to establish why the species has such a restricted breeding distribution in Strathclyde.

Introduction

The Lesser Whitethroat *Sylvia curruca* is a relatively common breeding bird in England, and in ideal downland habitat the breeding density can be as high as 3-6 pairs per km^2 (Sharrock 1978). In Scotland, however, the Lesser Whitethroat is still a relatively scarce breeding species, with a breeding distribution confined mainly to the south east corner, the Lothians in particular, where da Prato (1980) estimated there to be 50-100 pairs. By the mid 1980s the species had expanded its range into other parts of Scotland, as indicated by first county breeding records for Aberdeenshire in 1977, Angus in 1981 and then Caithness and Orkney in 1988 (Scottish Bird Reports 1977-90). Occupied territories were first discovered in Strathclyde during 1983 and the first confirmed breeding record for Renfrewshire was at Paisley in 1986 (pers. obs.).

From a European perspective, the breeding range of the Lesser Whitethroat has also been expanding northwards and westwards. In Norway, there has been a definite westward expansion of the breeding range (S. Eldøy pers. comm.). Northern Ireland could be on the verge of having its first breeding record, for a singing male was located in suitable breeding habitat during May 1985 (Irish Bird Report 1985). These records suggest that the species is undergoing a marked range expansion into northwest Europe.

Study areas and methods

Previously known breeding sites were visited every May during the eight year study period to ensure that occupied territories were used each year. In an attempt to locate new breeding territories, we surveyed sixteen random 5 km squares spread through Ayrshire and Renfrewshire, searching for singing males and suitable breeding habitat. The presence of a pair, or of a singing male, noted on at least two occasions a week or more apart, and occupying the same territory on two or more consecutive years, was taken as evidence of regular breeding. All potential breeding records obtained from county bird reports were also investigated during the study period.

Although Lanarkshire was not well recorded, during the eight year study period one regular breeding territory was located (R. Nisbet pers. comm.). Only Ayrshire and Renfrewshire in the Strathclyde region were found to hold a regular number of Lesser Whitethroat territories. Seven of these regular breeding territories were examined to determine their habitat structure and plant species composition.

To investigate why certain areas of superficially similar habitat did not contain

Lesser Whitethroat territories, seven additional sites were chosen as controls. These sites were not used by Lesser Whitethroats during the study period. This allowed us to ask why there were none and to seek out any vegetational differences between occupied territories and control sites.

Breeding habitat

Lesser Whitethroat territories were recorded in areas where mature hawthorn *Crataegus monogyna* scrub was interspersed with a dense mosaic of bramble *Rubus* sp., dog rose *Rosa canina*, gorse *Ulex europaeus* and in some cases willow *Salix* sp. These five plant species were particularly prevalent in all occupied territories and the control sites. Such scrub areas usually formed habitat islands surrounded by pastoral farmland. The seven territories studied were uniform in several respects. They were either found on disused railway embankments or on regenerating hillside scrub. All areas were practically impenetrable, making vegetation analysis extremely difficult and painful! Perhaps it also explains why so little is known about the breeding biology of this species.

Searching methods

When suitable breeding habitat was discovered in a surveyed area, thirty minutes were allocated to detect any singing males. If no song was heard within that time, a ten-minute long tape lure was played twice with a five minute interval in order to elicit a response. Whenever an occupied site was located, another two visits a week apart were made to establish site fidelity. Observations continued throughout May to determine territory size and habitat utilisation.

Habitat analysis methods

At the end of July, when the breeding season was over, ten randomly spaced transect lines were placed in each territory. Four one metre square quadrats were placed at five metre intervals along these lines. In each quadrat, the percentage cover of the five predominant plant species, hawthorn, bramble, dog rose, gorse and willow, were estimated from ground to canopy level in four one metre height bands. The data recorded from these vegetational surveys were then used in multivariate analyses to describe the habitats in terms of all the plant species combined, rather than just one species at a time.

Results

Singing birds

The best time to search for breeding Lesser Whitethroats was found to be during early May when the males were extremely vociferous and highly conspicuous throughout the day. Males sang almost constantly from exposed sprays of the hawthorn canopy or during feeding forays along the edge of the scrub. On two occasions, a male was observed singing in a short gliding flight across the territory, descending on slow shivering wing beats. Females were much harder to locate, as they tended to skulk in the thickest cover, only appearing briefly when the tape lure had been played.

At times, the Lesser Whitethroat was found to be the loudest songbird in the vicinity and the distinctive penetrating rattle could be heard up to 200 metres away. Our observations over the study period have shown that singing is quite intense during the first fortnight of May, but the amount of song gradually diminishes towards the latter half, until no song is heard from territories known to be occupied during June and July. Since breeding Lesser Whitethroats have such a short song period, a fortnight in most cases, the time in which one can locate and observe singing males is extremely limited.

Territorial behaviour

Our observations indicated that males singing in June and July are unmated, and

we call these transient males. These birds have a characteristic tendency to sing from widely-separated song posts around the periphery of established breeding territories, or singing in habitat totally unsuitable for breeding. Territorial males were sometimes highly aggressive to one another especially when on adjacent territories. Fighting was observed with fierce skirmishes down onto the ground. Tape luring occasionally induced a similar response, with males flying directly to confront the tape recorder and a startled observer!

The Study Sites

Occupied territories

The seven occupied sites are listed, along with some descriptive data, in Table 1. Only 2-3 breeding territories were recorded in Renfrewshire during the study period, and all were within a 1km^2 area. These sites were two disused railway tracks near Dykebar and a disused limestone quarry at Brownside Braes. Ayrshire was the major stronghold of the species in Strathclyde, with 6-8 breeding territories annually since 1985. Sampled sites were located at Heads of Ayr, Burton Farm and Bracken Bay. In Lanarkshire, only one regular breeding territory was located, at Baron's Haugh.

The habitats present at these sites were as follows:

Site 1, Dykebar railway track: One small regular breeding territory, located in the overgrown hawthorn scrub (4m+). With an extensive mosaic of bramble, dog rose, gorse and willow understorey on the embankments, both north and south facing.
Site 2, Dykebar railway track: Another small territory, again located on a nearby railway track which runs alongside site 1. The habitat is similar too, with mature hawthorn (4m+) and a dense understorey of bramble, dog rose, gorse and willow; both north and south facing embankments.
Site 3, Disused limestone quarry: A large territory, of which the boundaries cover the entire quarry area. The habitat is mainly mature hawthorn scrub (4m+) with a dense shrub layer of bramble, dog rose and gorse. The site is situated on a north facing slope.
Site 4, Heads of Ayr: This site could almost be regarded as a colony because up to three pairs vied for territory each year in a confined area of suitable habitat. The site contains both mature hawthorn (3-4m+) and dense patches of blackthorn (2-3m+), the latter in good quantities. Although the understorey contains bramble, dog rose and gorse, it is patchy throughout the site. The site is situated on a NNE facing slope.

TABLE 1. Features of the study sites with occupied territories.

Site no.	District/Site description	Altitude (m)	Territory size/area (ha)	Year of survey	Grid reference
	RENFREWSHIRE				
1	Dykebar railway track	45	0.58	May-July 1986	NS 492 610
2	Dykebar railway track	50	0.62	May-July 1986	NS 492 609
3	Disused limestone quarry	75	1.32	May-July 1986	NS 486 607
	AYRSHIRE				
4	Heads of Ayr (2 territories)	15	0.86	May-July 1986	NS 294 185
5	Burton farm	85	1.06	May-July 1989	NS 315 174
6	Bracken bay	61	2.38	May-July 1987	NS 266 180
	LANARKSHIRE				
7	Baron's Haugh	30	0.81	May-July 1988	NS 746 552

PLATE 1. Heads of Ayr, Ayrshire, up to 2-3 pairs regularly breed here.

PLATE 2. Disused railway tracks at Dykebar, Renfrewshire, where the first county breeding record occurred.
T. Byars

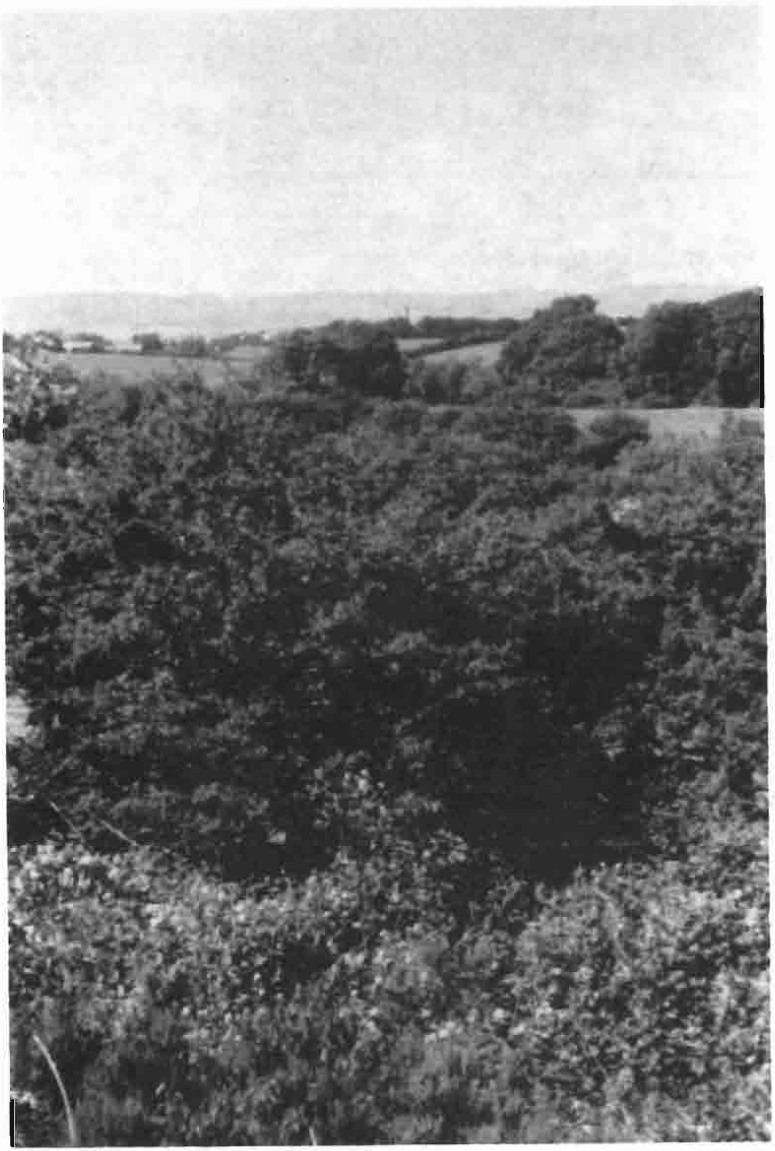


PLATE 3. Breeding habitat at Dykebar, note the dense mosaic-like structure of the scrub vegetation.
T. Byars

Site 5, Burton farm: A large territory, situated in regenerating hillside scrub on a north facing slope. The habitat comprises mature hawthorn scrub (3m+) with an extensive and dense understorey of bramble.
Site 6, Bracken bay: A regenerated section of the disused railway embankments provides an extensive territory for just one regular breeding pair. The site contains mature hawthorn (4m+) and a mature stretch of blackthorn (2m+). The understorey is mainly gorse with small bramble patches on the north and south facing embankments.
Site 7, Baron's Haugh: One small territory located on raised embankments, facing east and west. The territory was in mature hawthorn scrub (3-4m+) with an impenetrable shrub layer mainly of bramble, dog rose and gorse.

Control sites

The seven sites lacking Lesser Whitethroats, which were taken as control sites, were surveyed to provide comparable data. These sites are listed in Table 2, and their habitat characteristics were as follows:

Site 8, Dykebar disused railway: A large area of open hawthorn scrub (3-4m+) with extensive gorse and bramble understorey, situated on a north facing slope.
Site 9, West Brownside Braes: A smaller area of open hawthorn scrub (3-4m+) with a dense gorse understorey, again situated on a north facing slope.
Site 10, East Brownside Braes: Raised embankments covered with mature hawthorn scrub (3-4m+) with sparse bramble, dog rose and gorse understorey. The embankments face north and south.
Site 11, Dalry coal bing: Overgrown hawthorn scrub (2-3m+) with mixed bramble, dog rose and gorse understorey on a SE facing slope.
Site 12, River Caaf: Mature hawthorn scrub (2-3m+) with sparse bramble, dog rose and gorse understorey on a steep south facing slope.
Site 13, Kilwinning disused quarry: Extensive hawthorn scrub (3-4m+) with poor bramble and gorse shrub layer.
Site 14, Rowanside burn: Open hawthorn scrub (3-4m+) with extensive gorse, bramble and dog rose understorey on a steep south facing slope.

*Differences in vegetation between sites**

We carried out statistical analyses to test for differences between the occupied territories

* The Appendices have been lodged with the SOC in the Waterston Library and may be consulted on request.

TABLE 2. Features of the study sites without occupied territories, i.e. used as controls.

Site no.	District/Site description	Altitude (m)	Territory size/area (ha)	Year of survey	Grid reference
	RENFREWSHIRE				
8	Dykebar disused railway	45	0.72	May-July 1990	NS 492 611
9	West Brownside Braes	75	1.92	May-July 1990	NS 484 607
10	East Brownside Braes	100	1.49	May-July 1990	NS 485 605
	AYRSHIRE				
11	Dalry coal bing	50	0.84	May-July 1990	NS 295 513
12	River Caaf	70	0.51	May-July 1990	NS 281 482
13	Kilwinning disused quarry	50	1.32	May-July 1990	NS 317 447
14	Rowanside burn	90	1.75	May-July 1990	NS 237 457

and control sites. No significant differences were found for individual plant species at each of the height bands. However, when we used multivariate methods, which analyse the differences between samples in terms of **all** the species taken together, we did obtain significant results. One such method was classification using the TWINSPAN programme (Hill 1979), splitting up the samples successively into groups which can be regarded as classes or types of vegetation. This successfully classified all the samples, generating eight vegetation classes (see Appendix A*) which may be summarised thus: –

Class A, Mixed: hawthorn rather sparse, but with large amounts of miscellaneous species at all height bands up to 4m.

Class B, Dog rose: again hawthorn is sparse and main plants are dog roses up to 3m high.

Class C, Hawthorn: dominated by dense hawthorn up to 4m high, with little of other species.

Class D, Hawthorn/Bramble: much hawthorn up to 3m high and dense bramble in 0-1m height band.

Class E, Bramble/Gorse: fairly dense bramble up to 1m high and dense gorse up to 2m high, with very little hawthorn.

Class F, Bramble: no hawthorn at all, but very dense bramble up to 1m high and fairly dense up to 2m, together with miscellaneous species.

Class G, Willow: characterised by dense willow, especially in 3-4m height band, but also with some miscellaneous species at ground level.

Class H, Willow/Dog rose/Mixed: dog rose up to 1m and willow between 2m and 4m, but with dense miscellaneous herbs below 1m.

The occurrence of these classified samples in the occupied territories versus the unoccupied control sites is shown in Table 3 and we found there to be a significant difference in plant community structure between occupied and unoccupied sites (χ^2 = 23.24, 7 d.f., P<001). So there were differences between the two groups in terms of the combination of plant species. Of particular interest is the more frequent presence of bramble-containing classes in the occupied territories (especially Class F).

TABLE 3. Comparison of the occurrence of samples in the different vegetation classes between occupied and unoccupied sites. Values in the table are the numbers of samples in each category (e.g. 12 samples in vegetation class A were in occupied territories) and the relationship between vegetation types and occupied/empty sites is statistically significant ($\chi^2 = 23.24$, d.f. = 7, $p < 0.001$).

Vegetation Class	Occupied	Unoccupied
A, Mixed	12	4
B, Dog rose	19	16
C, Hawthorn	75	95
D, Hawthorn/ Bramble	33	30
E, Bramble/Gorse	55	48
F, Bramble	44	27
G, Willow	11	0
H, Willow/ Dog rose/Mixed	3	0

We also used another technique (linear discriminant analysis; see Appendix B*) which indicated significant differences between occupied and unoccupied sites in the 0-1m, 1-2m and 2-3m height bands. While these differences depended much on hawthorn, it is the combination of all five plant species which differentiates the territories from the control sites. In particular, in the 0-1m height band, it is the mosaic structure of hawthorn, bramble, dog rose, gorse and willow which influence the suitability of habitat for the Lesser Whitethroat.

Discussion

The Lesser Whitethroats is a rare breeding warbler in Strathclyde, where a small population of only 9-12 pairs manage to

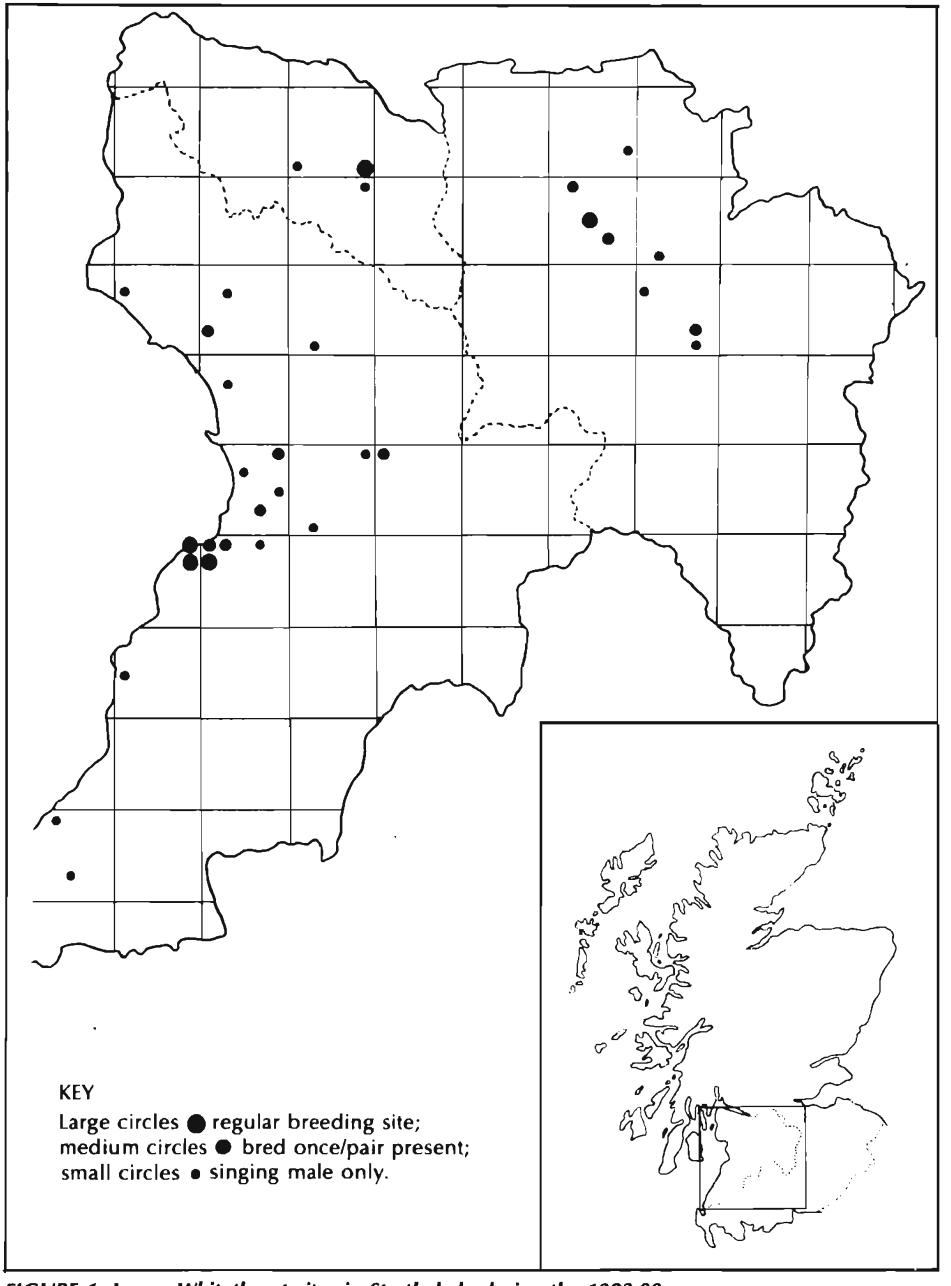


FIGURE 1. Lesser Whitethroat sites in Strathclyde during the 1983-90 survey.

hold territory on a regular basis. The majority are confined to just three main sites in the entire region. Ever since the initial colonisation of 1983, this small breeding population has not increased significantly. By contrast, in the Lothians the species has consolidated and expanded in terms both of breeding distribution and of the number of regular breeding pairs. A 1735 ha study site in East/Mid Lothian, held around twenty territories in 1984 (da Prato 1985). In 1989 there were 47-53 territories in the Lothian region, according to the Lothian Bird Report (McGarry 1989). The earlier figure of 50-100 pairs (da Prato 1980) was only an **estimate**, and is thus not strictly comparable with the later **actual** counts.

The reasons why the Lesser Whitethroat has not had the same success in Strathclyde, could be linked to three major factors.

1: The Lesser Whitethroat is on the northwesterly extremity of its European breeding distribution, therefore adult birds arriving back to breed in Strathclyde must be in such low numbers that they cannot sustain new colonisations elsewhere. This happened in 1990, when breeding Lesser Whitethroats failed to arrive back in Renfrewshire for the first time in eight years. This left three vacant territories in suitable habitat. If there were surplus birds in the vicinity, it is reasonable to assume that the territories would have been filled before the end of May. However, the only bird that did appear was a transient male, singing during late June.

2: It may be the lack of suitable hawthorn habitat which accounts for the limited breeding distribution of the Lesser Whitethroat in Strathclyde. It is this specific type of hawthorn scrub which was found in our study to be different in structural composition when compared to superficially similar control sites.

3: The climate, e.g. cold wet summers, could be slightly unsuitable for the Lesser Whitethroats' breeding requirements. This may restrict the breeding population in the west through the climatic effects on prey availability. Mason (1976) suggested that range limitation of this species in Britain may be related to diet. It is interesting to note that the distribution of Lesser Whitethroats in the Lothian region shows a clear affiliation with the occurrence of the climatic zone known as EE. This zone represents a warm dry lowland region below 200 metres (Birse 1971); and in Strathclyde the only other similar climatic region is located on a narrow coastal strip which includes the Heads of Ayr.

Our studies suggest six important aspects found in all of the seven recorded territories.

1: It is the integrated effect of all five major plant species in forming the dense mosaic structure, especially at the 0-1 metre height band, which appears to be a breeding requirement for the species. This preference for mosaic habitats reflects similar findings in Finland, where Haila *et al.* (1987) found that the Lesser Whitethroat is adapted to habitats with a mosaic-like structure.

2. All seven recorded territories were below the 100 metre contour line. Although there may be exceptions, we found that there is a general lack of suitable breeding habitat above 100 metres. This may be because poor soil quality or exposed ground is unsuitable for the optimum growth of hawthorn scrub. This factor could be important in terms of national distribution, as colonisation in general may be confined as a result to areas below 100 metres.

3. All seven recorded territories were situated on a sloping surface, either on steep hillsides or disused railway embankments. This may be an indication that ideal hawthorn habitat requires a well drained soil for optimum growth and plant species diversity. da Prato (1980) suggested that Lesser Whitethroat territories were specifically located on warm south facing banks. However, we found no correlation between south facing slopes and territory

location; in fact the three territories at the Heads of Ayr were situated on a NNE facing slope.

4. Grazing farm animals were denied access into the recorded territories by means of wire fencing or by the sheer density of the scrub itself. Many times during our survey we would spot from a distance what appeared to be extensive hawthorn canopy only to discover that once beneath the "pristine" canopy, there lay a completely denuded zone from ground level up to one metre. Such areas had evidently been grazed by sheltering cattle and so rendered useless in terms of breeding habitat.

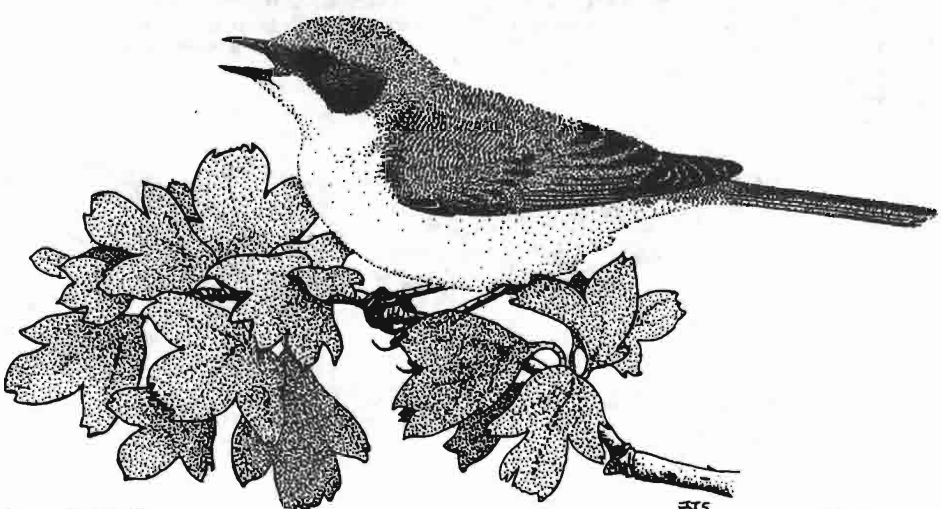
5. The mature hawthorn canopy was found to be 3-4 metres in height and open in structure. This feature of hawthorn canopy may be important for the warblers' spatial feeding requirements (cf. da Prato 1980).

6. Dense bramble patches were present in all seven territories with good coverage in the 0-1 metre height level. We believe that bramble is an essential component of Lesser Whitethroat breeding habitat in Strathclyde (see Table 3). According to the information from BTO nest record cards (Mason 1976), the average nest was in the 0-1 metre height band. This may explain why that particular height band differed in vegetation comparison between occupied territories and control sites. The nest record cards indicate that, of the eight plant species recorded, the highest proportion of nests (47%) were located in bramble. According to Barlein *et al.* (1980), there are great regional differences in the plants in which *Sylvia* warblers nest across Europe. They stated that bramble has a unique significance as a nest bearing plant for four British *Sylvia* warblers, including the Lesser Whitethroat.

If the Lesser Whitethroat is to increase from the known population of 9-12 pairs in Strathclyde, the species might have to expand into inferior habitats. Suitable breeding sites are few and far between in Strathclyde and, if the species has saturated all of the available habitat, this could be the reason why the population has remained constant for eight years.

Conservation

During our research we discovered that two of the major sites are currently under threat by development, Dykebar in Renfrewshire



Lesser Whitethroat *J.J. Sweeney*

and the Heads of Ayr in Ayrshire. Hopefully the habitat and the Lesser Whitethroats can be saved by conservation measures brought about by the new Nature Conservancy Council for Scotland and the respective district councils. Recent negotiations between the farmer and the NCCS over the Heads of Ayr site have resulted in amicable agreements for both parties, thereby saving the entire site from scrub clearance. Management plans have now been drafted in order to maintain and expand the unique habitat specifically for the Lesser Whitethroat.

If such measures are not taken, then this enigmatic warbler may soon disappear as a breeding species in Strathclyde.

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Changes in the breeding status of Black-throated Divers in Scotland

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Extensive surveys in the 1980s confirmed breeding by Black-throated Divers in one year or another at 153 distinct sites. The Scottish population in 1985-89 comprised about 156 territorial/breeding pairs. At least 22 sites once occupied by Black-throated Divers have apparently been abandoned. This is interpreted as evidence of a recent population decline. Most recorded losses were in the 1970s and early 1980s, largely at the edges of the Scottish breeding range.

Introduction

This paper reviews short and long term population trends in Black-throated Divers *Gavia arctica* (BTD) and re-assesses the current size of the Scottish breeding population on the basis of confirmed breeding records in 1985-89.

In Britain BTDs breed only in Scotland. No attempt to count the Scottish population had been made before 1985, although the distribution was mapped in 1968-72 for the *BTO Atlas of Breeding Birds in Britain and Ireland* (Sharrock 1976). The first comprehensive survey was carried out in 1985. It estimated that there were 151 summering territories, with breeding confirmed in 66 of them (Campbell & Talbot 1987).

Concern has been widely expressed about the current status of Scottish BTDs resulting from the relatively low breeding success noted in the 1970s and 1980s (Bundy 1979, Dennis 1973 *et seq.*, Thom 1986), the perceived threats from increased human activities on some of the divers' breeding lochs (Cramp & Simmons 1977, Parslow 1973, Thom 1986) and the influences of general environmental changes such as hydro-electric developments, conifer afforestation (in the catchment areas of lochs) and habitat degradation due to overgrazing and burning. Campbell & Talbot (1987) obtained insufficient data to make a reliable assessment of recent changes in population. Since then, all known previous breeding records have been systematically collated. In addition, further field surveys were carried out in 1986, 1987, 1988 and 1989.

Sources of information

Published site records are few due to the need for confidentiality with this protected species. As a result most data are from the following sources:

1. Egg collections; 20 museums provided information on 148 clutches.
2. Records submitted to Scottish bird recorders.
3. British Trust for Ornithology nest record cards (137).
4. Appeals for past records in ornithological, wildlife and angling publications and all local Scottish newspapers.
5. Information from apprehended egg collectors, via the RSPB Investigation Section.

6. Records from Nature Conservancy Council upland bird surveys in 1980-87.
7. RSPB monitoring through site visits and correspondence from 1971-1989, including specific surveys in 1976, 1977, 1981 and 1983-89. In 1985, each possible breeding loch was visited 1-3 times in May-June (details in Campbell & Talbot 1987). In 1986-89, repeat visits were made to virtually all lochs on the mainland and Inner Hebrides which had past records of BTDs. Additional possible sites were also sought. The presence of adults and evidence for breeding were recorded on standard cards.

With the exception of specific surveys under item 7 above, it is only very rarely that reports were received of visits to lochs when no BTDs were seen. This is a shortcoming which complicates evaluation of status changes. All records were stored on a database held by the RSPB which is to be updated.

Definitions and assumptions

A 'site' is defined as a loch, or a part of a loch, or a group of adjacent lochs, occupied by a single territorial/breeding pair. A site is assumed to be 'currently confirmed' if eggs or unfledged chicks are known to have been present in any year between 1985 and 1989.

Breeding is assumed to have been 'confirmed' in the 'past' if, before 1985, eggs are known to have been taken or if breeding was reported by a reliable observer.

A past breeding record is assumed to be 'unconfirmed' if it relates to a report of breeding by an observer whose reliability was not known to the authors. In all but one of these cases there was just one such record per site.

A site with confirmed breeding in the past is assumed to be 'currently deserted' if birds were either absent on three or more visits in 1985-89, or if only a single bird was seen on 25% or less of four or more visits made to the site. A visit comprised a thorough search in May or June in any or all years 1985-89. In six cases, a site was placed in this category following one or two negative visits by RSPB staff supported by reliable local information.

The likelihood of wrongly classifying a site as deserted using these criteria is very low (Table 1). This was assessed by examining attendance records (average of 11 visits per year in 1986 and 1987) at sites in detailed study areas where breeding was known to occur. For example, one or more adult BTDs were seen on 88% of May/June visits to known breeding lochs, giving a probability of 0.1 of recording no adults at

TABLE 1. The probabilities of wrongly classifying a known breeding site as deserted using the defined criteria (see text). Probabilities were calculated from the proportion of May/June visits when no BTDs, or just one, were seen.

	Number of breeding lochs	Total visits May/June	Probability of recording no adult birds in May/June		Probability of seeing only a single bird on 1 in 4 visits
			single visit	3 visits	
Sutherland					
1986	25	346	0.101	0.0010	0.0003
1987	26	319	0.113	0.0014	0.0004
Ross-shire					
1986	19	163	0.123	0.0019	0.0005
1987	21	181	0.171	0.0050	0.0013
Overall	91	1009	0.121	0.0018	0.0005

a single visit. For sites where breeding regularly occurs year after year, the probability of seeing birds is the same whether visits all occur in a single year or are spread across several years. However, at the small number of sites where breeding is not regular, the schedule of visits could affect the chances of detecting birds.

The current status at a site is classed as 'uncertain' if less than three visits were made to it in May or June 1985-89, or if adults were present on 26-50% of three or more visits but there was no evidence of breeding. If one or two adults were present on > 50% of such visits then this site was designated as holding a 'territorial pair'. The latter case applied to nine sites in total. These cut-off percentages were based on experiences at sites studied in detail.

Results

The 1980s population

We now know of 153 'sites' where breeding was confirmed at least once in the 1980s; 142 of these sites were occupied in 1985-89 (Table 2). In a small number of sites, the same pair may have bred at different lochs in different years, thus inflating the above figures. In areas in West Sutherland and Ross-shire where BTDs were studied in detail in 1983-1988, we knew of six such examples among 66 pairs. Where known, these were recorded as single sites. If this situation was proportionally the same throughout Scotland, the number of distinct confirmed sites (equivalent to territorial pairs) would be reduced from 142 to 135.

Due to the extensive and largely remote potential breeding range of BTDs in Scotland, there are inevitably a number of sites of which we are still unaware. On the basis of a clear picture of coverage over the years, we believe that this number is unlikely to exceed 10 sites. Also there are 35 sites where breeding has been confirmed in the past but where the birds' current status is not certainly known (Table 2). Birds have been seen on 50% or more visits in 1985-89

TABLE 2. Number of Black-throated Diver breeding sites by Region/District.

Region/ District	Confirmed breeding 1985-89	Confirmed breeding before 1985 currently deserted	Confirmed breeding before 1985 current status uncertain	Single unconfirmed report of past breeding currently deserted	Single unconfirmed report of past breeding current status uncertain
Caithness	9	1	0	0	2
Sutherland	47	6	6	2	6
Ross-shire	38	0	6	3	2
Inverness	6	1	0	2	0
Skye & Lochalsh	3	3	0	0	4
Badenoch & Strathspey	2	3	1	0	0
Lochaber	8	1	6	1	1
Tayside & Central	9	0	3	0	2
Strathclyde & SW Scotland	9	7	3	4	5
Outer Hebrides	11	0	10	0	3
Totals	142	22	35	12	25

at nine of these sites, although at eight others we have no record of a recent May/June visit by an observer. Additionally, we know of two sites that currently hold regular territorial pairs but where breeding has never been confirmed.

Our best estimate of the size of the Scottish breeding population in 1985-89 is built up as follows:

Number of distinct territories with confirmed breeding	135
Sites with confirmed breeding in the past and territorial pair now present	9
Sites with current territorial pair but no confirmed breeding past or present	2
Allowance for undetected sites	10
Total territorial/breeding pairs	156

This is very close to the single-year survey result for 1985 of 151 summering territories obtained by Campbell & Talbot (1987).

Deserted sites

The main evidence for changes in numbers is based on the current status of sites where breeding has been known in the past. At least 22 such sites are now occupied (Table 2). This is a relatively large figure compared with the 142 currently confirmed breeding sites. There are few sites for which annual reports are available, particularly before 1970, and as a result it is usually difficult to establish the regularity of past breeding and also the distinctiveness of pairs at adjacent sites. However, at most of these sites breeding was recorded in two or more earlier years (77%) and no other occupied sites are known within a 5km radius (82%, Table 3). Six sites were well established, with breeding confirmed in five or more years (14 years at one site). 64% of known losses involve sites where breeding last occurred in the period 1971-84, although this is when the bulk of available information was collected.

The scale of change is better appreciated by looking at the current status of those sites where breeding was first reported in the more distant past (Table 4). Of the 47 sites where breeding was confirmed before 1940, 26% are no longer occupied. We are uncertain of the current status of a further 19%. Of those, where the current status is known, 32% no longer support breeding BTDs. At two of the 12 unoccupied sites, there is another currently-occupied territory within a 5km radius.

TABLE 3. Circumstances at past sites where Black-throated Divers no longer breed or where their current status is uncertain.

	Breeding last reported:			
	before 1940	1941-1970	1971-1984	Total
Total number of deserted sites	7	1	14	22
Deserted sites with no current site within 5km	6	2	10	18
Deserted site where breeding had been recorded in 2 or more years	5	1	11	17
Deserted sites where breeding had been recorded in 5 or more years	1	0	5	6
Sites where current status is uncertain	6	7	22	35

TABLE 4. The current breeding status of Black-throated Divers at sites where confirmed breeding was first reported prior to 1940.

First confirmed breeding:	Status in 1985-89			
	Site occupied	Site unoccupied	Uncertain	Total
prior to 1900	16	8	3	27
1900-1940	10	4	6	20
Total	26	12	9	47

Sites now deserted are present throughout the breeding range (Table 2), but losses are proportionally larger, in relation to the number of currently used sites, away from the core areas of Sutherland and Ross-shire. Indeed, they occur mainly in peripheral areas at the northern, eastern and south-western edges of the range. 86% occur outside a line connecting the outermost of all the currently known sites on the mainland and inner isles. Status changes in the Outer Hebrides are unclear due to the particularly high density of freshwater lochs and, except for 1985, a lack of comprehensive surveillance.

Due to extensive searching and documentation in recent years, we know of many more sites now than at any time in the past. Breeding has been confirmed at 153 sites in the 1980s compared with 92 sites in the 1970s and just 48 sites in the 1950/60s. However, at none of the 53 sites documented for the first time in the 1980s can we confidently state that breeding had not occurred previously. At 26 of these sites BTDs had been noted during previous decades but breeding had not been proved, and 20 of the remaining 26 sites are at least 1km from the nearest vehicular access and are not regularly visited by observers.

In addition to the documented losses, there are three categories of sites where available information is less clear-cut (Table 2). An unknown proportion of these 72 will constitute additional deserted sites.

Comparisons with 'The Atlas of Breeding Birds'

The nature of coverage differed considerably between the *British Trust for Ornithology Breeding Atlas* (1968-72, Sharrock 1976) and recent BTD surveys (1985-89), making direct comparisons difficult. A broad comparison (Table 5) suggests that there has been a reduction of up to 27% in the number of 10km squares with breeding or territorial pairs present (or 20% if it is assumed that all sites of uncertain current status hold pairs). The real magnitude of this change depends upon the degree to which the criteria for proof of breeding were adhered to during the Atlas survey. A small number of Breeding Atlas records are now regarded to be of doubtful validity and in 3-4 cases a single pair may have been scored in more than one 10km square. However, the results do support the earlier trends noted from examination of historical records.

Short-term changes in West Sutherland

A study area in West Sutherland of about 3000 km^2 has been surveyed in detail in 8 years over the period 1977-88 (Table 6). The frequency of site visits and knowledge of territories and nest sites have all increased over the years and a total of 34 breeding territories were identified.

The evidence suggests that the number of pairs occupying territories remained

TABLE 5. Number of 10km squares holding breeding or territorial Black-throated Divers in 1968-72 (BTO Atlas) and 1985-89. Atlas totals include squares with breeding classed as confirmed or probable. 1985-89 totals include all 142 confirmed breeding sites and 11 regular territorial pairs.

Area	Atlas	1985-89	Difference (%)	Present 1968-72 but not recorded 1985-89	Not recorded 1968-72 but present 1985-89
Caithness	4	3	−25	1	0
Sutherland	36	35	−3	11	9
Ross-shire	34	23	−32	15	4
Inverness	5	6	+20	2	3
Skye & Lochalsh	8	2	−75	6	0
Badenoch & Strathspey	1	2	+50	0	1
Lochaber	15	6	−60	10	1
Tayside & Central	6	10	+67	1	5
Strathclyde & SW Scotland	22	10	−55	13	3
Outer Hebrides	14	9	−36	8	3
Total	145	106	−27	67	29

stable between 1984 and 1988. The apparent increase in total pairs is a result of more widespread surveillance. There is no evidence to suggest that sites given insufficient or no coverage in earlier years were not then occupied. Only one breeding territory has become and remained unoccupied. Three others have been apparently unoccupied for one year, and five for two or more years.

Discussion

Past documentation of the numbers and locations of BTD territories has been very poor. In just a few cases are there clues to the total numbers within geographical units. Harvie-Brown & MacPherson (1904) refer to at least four pairs in the Arisaig district (Lochaber), an area where we currently know of none. In North Uist, Harvie-Brown & Buckley (1888) knew of three or more breeding pairs and Gray (in Baxter & Rintoul 1953) knew of five pairs. We have just one recent record of confirmed breeding, but coverage here has been poor. In south-western parts of the breeding range, we know of no current breeding pairs on Skye, Mull, Coll, Islay, Jura, Arran or the Kintyre peninsula, all areas with past records of one or two breeding pairs (although some are classed here as unconfirmed). Harvie-Brown (1895, in Sharrock 1976) gives these areas as outside the breeding range, but this was apparently incorrect because we now have details of some confirmed 19th and early 20th century records from here (McWilliam 1931). There are also old records of breeding in Orkney (Baxter & Rintoul 1953) and museum-held clutches reputedly taken in Orkney (1877) and in Shetland (1898 and 1919), but we know of no recent breeding records from the Northern Isles.

There is clearly no means of assessing the full size of the Scottish population at any time in the past, and it is therefore difficult

TABLE 6. Annual occupancy of 34 breeding territories in West Sutherland, 1977-88.

Year	Confirmed breeding	Territorial pair	Total pairs	Territories with insufficient surveillance	Territories apparently unoccupied
1977	12	10	22	11	1
1981	10	9	19	11	4
1983	13	14	27	4	3
1984	19	11	30	3	1
1985	25	5	30	1	3
1986	26	4	30	0	4
1987	26	5	31	0	3
1988	20	10	30	0	4

to be sure of the direction and scale of any change in numbers. We currently know of many more sites than have been documented in past decades, but this is undoubtedly due to the great deal of concerted effort put in during the 1970s and 1980s. The best available evidence for status changes rests on the history of occupancy of individual sites. We know from detailed studies in West Sutherland that BTDs there show a high degree of site fidelity from year to year (Table 6; Mudge & Talbot, unpubl. obs.). Deserted sites are, therefore, assumed in most cases to represent lost pairs and the balance of evidence thus points to a population decline. In a small proportion of cases (see Table 3), the apparent loss may be due to movement of the pair to a nearby loch. In the absence of marked birds there is no evidence of whether or not movements over longer distances can occur between years.

The fact that most deserted sites occur around the edges of the breeding range is consistent with an overall decline. In such a situation, changes are likely to be more pronounced in peripheral areas. Similar circumstances could arise with a stable population if there was simply a faster turnover of pairs and sites at the periphery. The available evidence in 1991 does not lend support to this latter scenario.

In general texts, where comment is made, most authors have considered BTDs to be declining in numbers. The decline appears to have been substantial in the early part of the 20th century (MacKenzie 1918; Gilroy 1923; Alexander & Lack 1944; W. Marshall in Baxter & Rintoul 1953; Parslow 1973; Sharrock 1976). Human persecution through egg collecting, shooting of adult birds and breaking of eggs to protect fishing interests, is widely held to have been the cause (Harvie-Brown 1906; Alexander & Lack 1944; Rankin 1947; Baxter & Rintoul 1953). These pressures are generally less strong at present but breeding success is still very poor (Mudge & Talbot, in prep.). Angling-related persecution apparently continued until quite recently. At one loch in East Sutherland, for instance, it is reported that around the 1950s adults were shot and/or eggs broken each year to 'save the trout', and at an Inverness-shire loch, eggs were shaken in most years in the 1950s to destroy the embryos. There are no recent breeding records for BTDs at these sites.

A relaxation of human persecution may have allowed an increase in numbers in the 1940s, 1950s and 1960s. There is no useful information on possible changes in the core mainland areas, but a south-westward extension of the breeding range (re-colonisation ?) was noted between 1951

and 1974 with breeding pairs appearing on Arran and in Ayrshire, Galloway and Central. Such an extension would be unlikely to occur if the overall population was in decline at that time. This is because recruitment would be expected to be concentrated even more heavily on natal areas at a time when gaps are appearing in the existing breeding range. The evidence presented in this paper then points to another phase of decline in the 1970s and 1980s, perhaps as a consequence of the consistently low breeding success observed in these years (Mudge & Talbot in prep.).

We now have good baseline knowledge of the current number and distribution of breeding pairs and are well placed to detect and document future changes. It is important that monitoring is continued in view of the current low level of chick production, and the potential threats to breeding lochs from increased human encroachment, acidification of the loch waters, and land use changes in catchment areas.

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The spring passage of Long-tailed Skuas off North Uist in 1991

D.L. DAVENPORT

Introduction

The spring skua passage at Balranald, North Uist has been studied since 1976 (Davenport 1984, 1987). In 1991 there was an unprecedented passage of Long-tailed Skuas *Stercorarius longicaudus*, with 1,340 counted between 12-21 May, plus a total of 622 Pomarine Skuas *S. pomarinus* between 11-22 May.

Methods

Balranald was manned between 11-22 May. Coverage was fairly .continuous (except during frontal rain) because westerly winds prevailed throughout this period, but special effort was made to watch after the passage of fronts because such conditions often produce the largest movements.

Results

Skua passage was recorded daily between 11-22 May and the largest movements (but not necessarily the day totals) during this period are shown in the accompanying table. The fact that nearly all these movements began in the middle of the day was dictated by the weather conditions, and was not due to any lack of available coverage in the mornings.

Passage and associated weather conditions

Most skua passage at Balranald starts when the wind veers from S or SW to W, NW or N, often following a trough or a front, and the separate movements on May 11, 12 and 13 all come into this category. Early on the 12th there was a warm front and eight hours

TABLE. Skua passage at Balranald, North Uist in May 1991.

Date	Wind	Time	Pomarine	Long-tailed	
				total	largest flocks
11/5	NW4	1100-1500	59	—	
12/5	W5	1100-1900	120	424	18,18,21,27,40,70,110,112
13/5	NW4	1330-1830	70	15	6,8
14/5	NW4	0530-1100	20	14	6
14/5	NW4	1800-1930	15	25	25
18/5	SW5	1115	—	51	51
19/5	SW5	1030-1630	53	536	6,13,15,15,16,20,25,40, 40,50,60,70,80,85
19/5	W4	1815-2015	50	4	
20/5	W4	1200-1800	74	67	4,4,13,20,20
21/5	W5	1345-1945	72	180	180

rain, followed by a cold front in late morning, and although the subsequent clearance was permanent, it was followed by low overcast for the rest of the day with some patchy drizzle. This produced a typical movement of 120 Pomarine and 30 Arctic Skuas in 8 hours, in the middle of which there was an exceptional total of 424 Long-tailed Skuas in 4 hours in only 8 flocks, including two large flocks of 110 and 112 birds.

A trough on 13 May produced a calm morning with drizzle, and in the afternoon there was a movement of 70 Pomarine and 15 Long-tailed Skuas in 5 hours. The wind and weather conditions then remained steady over the next three days, resulting in a typical pattern of skua passage in the mornings and evenings, although the numbers were smaller than expected, with 35 Pomarine and 39 Long-tailed Skuas in 7 hours on the 14th, and very few on 15-16 May.

On 18 May another cold front, preceded by four hours rain, was quickly followed by a flock of 51 Long-tailed Skuas. However, soon afterwards the cloud cleared and the wind dropped very rapidly, and skua passage was negligible for the rest of the day.

On 19 May there was another four hours rain in the morning followed by a clearance. However, because this was a warm front the conditions were rather worse than on the 12th, with the overcast lower and heavier, poorer visibility, and a greater risk of drizzle. This produced another exceptional total of 536 Long-tailed Skuas in 6 hours in only 14 flocks, accompanied by 53 Pomarines which were apparently labouring in the poor conditions. This movement was halted by a weak cold front with two hours rain in the afternoon, after which there were 50 Pomarines in the next 2 hours in slightly improved conditions, but only four Long-tailed Skuas. There was also a total of 29 Arctic Skuas in 8 hours during the day.

On 20 May the weather was dominated by sea fog, but this cleared before midday, producing a movement of 74 Pomarine and 67 Long-tailed Skuas in the next 6 hours, after which the fog closed in again. A cold front, preceded by two hours rain, finally reached Balranald on the morning of the 21st, followed by a permanent clearance, although it remained overcast for four hours. However, no flocks of skuas appeared until five hours later, after which there was a movement of 72 Pomarines in 6 hours, with just one large flock of 180 Long-tailed Skuas.

Behaviour of Long-tailed Skuas on passage

Long-tailed Skuas at Balranald tend either to go by at close ranges, including crossing the headland or the RSPB reserve (Pomarines never cross the land at Balranald), or at long ranges of up to two miles. Distant groups of up to 10 birds typically keep very low in single file, with regular spacing between each bird, and with less periods of banking and gliding than in Pomarines, making them more difficult to see. Both species fly high in level flight in calm weather, but in normal conditions of moderate or fresh winds the low-flying flocks (usually the largest flocks) will climb up high intermittently, which the Pomarines at Balranald never do. This is presumably in order to sight their route past the headland and through the offshore islands. For instance, the flock of 112 on 12 May was first seen about five miles away and over 10 minutes before they were seen again as they reached Balranald.

Most of the large flocks of Long-tailed Skuas in 1991 were distant and travelling in long straggling lines, rather like flocks of Arctic Terns. Typically about two-thirds of the flock formed a nucleus at the front, with the remainder in a thin line trailing behind. Many flocks were seen only because they were already flying high, and many of the others were impossible to count accurately until they did likewise. Rather more surprising was the discovery that climbing flocks were prepared to continue upwards

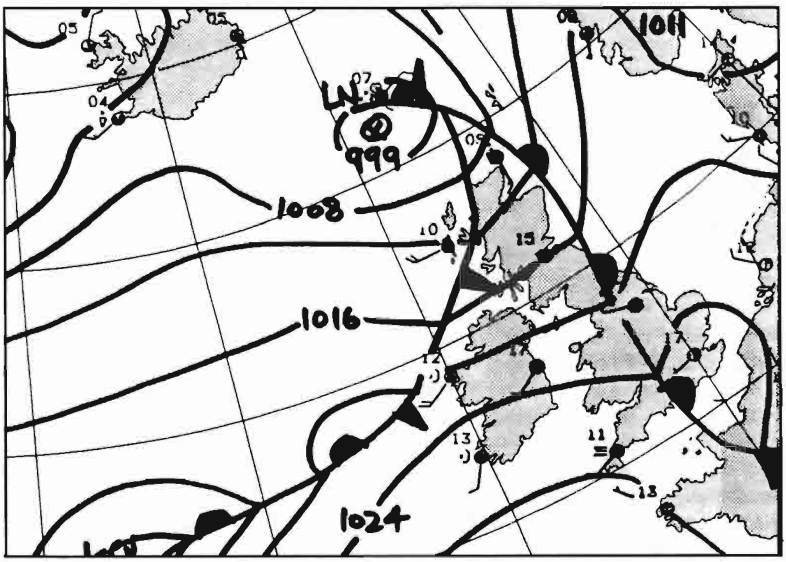

FIGURE 1. Atlantic weather map at 1200 hrs on 12 May 1991. On this date there was continuous rain between the warm and cold fronts, and the Long-tailed Skuas passed Balranald after the cold front.

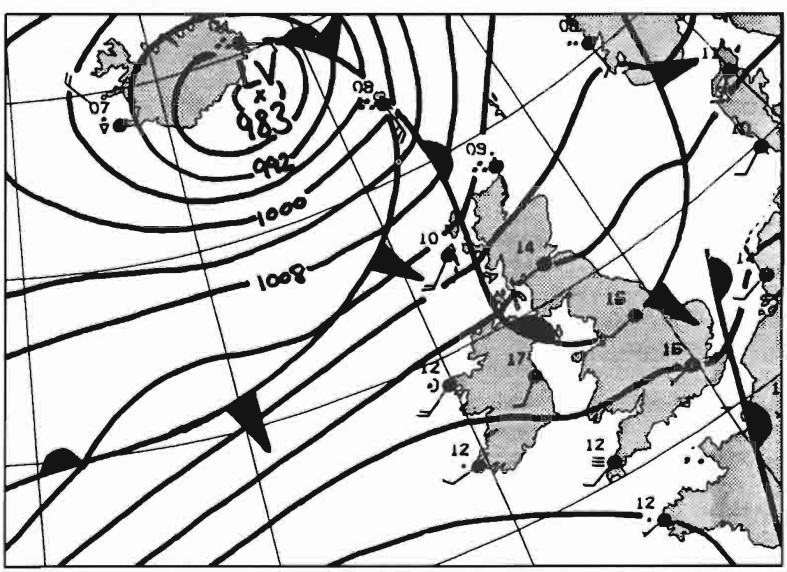

FIGURE 2. Atlantic weather map at 1200 hrs on 19 May 1991. On this date the Long-tailed Skuas passed Balranald in a break in the rain between the warm and cold fronts.

through low overcast in very poor weather conditions, as demonstrated by the flock of 51 on the 18th (descending again about a mile later) and flocks of 25 and 40 on the 19th. A group of 5 Pomarines, which were attempting to remain attached to the flock of 25 Long-tailed Skuas and had started climbing, were left stranded when the flock disappeared into the cloud, and immediately returned to sea level. I saw comparable behaviour on 21 May 1983 when two Pomarines, already attached to a group of seven Long-tailed, failed to follow them across the reserve. In 1991 only a few ones and twos crossed the headland, and the only birds seen to fly over the RSPB reserve were the flock of 27 on the 12th.

Also in 1991 several observations were made by Tim Dix at Ardivachar Point (South Uist), about 15 miles SSE of Balranald. A total of 45 Long-tailed Skuas was seen on 14, 18, 20 and 21 May, and although there was simultaneous coverage at both sites on all these dates, only four of these birds were seen to pass Balranald, which suggests that the remainder went high over North Uist. In addition a group of three was seen to head inland at Paible (North Uist), about 4 miles SE of Balranald, on the 16th. The change in direction of the coastline suggests that Paible would be the best site to see flocks of Long-tailed Skuas intending to bypass Balranald by heading overland.

Discussion

As already stated, most skua passage at Balranald follows frontal rain (and thereby usually occurs in relatively clear weather) when a typical movement of up to 100 Pomarines in 4-7 hours might be accompanied by one or two flocks of Long-tailed Skuas, and often by none at all. The table shows that the movements on May 11, 13, 14 and 21 all fit into this category.

The exceptional numbers of Long-tailed Skuas on 12 May and 19 May were apparently the result of the poor weather conditions, involving winds of force 5 and fronts with several hours rain, followed by low overcast and intermittent drizzle. Such conditions apparently not only bring them close inshore, but also prevent them from passing the Outer Hebrides as quickly as they would like. It seems that they are far more adaptable at coping with adverse weather conditions than Pomarines, and a high proportion prefer to fly high and/or go overland when confronted with an unfamiliar coastline.

If this suggestion is correct, it follows that Long-tailed Skuas probably occur in greater numbers than was previously thought, but they can be seen from Balranald only under very particular weather conditions. For instance, it now seems likely that several large flocks would have been seen on the 18th if the weather had not improved so rapidly, and again on the 21st if the cold front had not reached Balranald until over five hours later.

Previous observations at Balranald and other sites

The largest skua movements at Balranald in previous years are listed here in order to put the 1991 observations into context, and all counts of more than 180 Pomarine and 70 Long-tailed Skuas are included. In May 1982 there were 185 Pomarines in 3½ hours on the 2nd and 345 Pomarines in 4 hours on the 4th. There were no Long-tailed Skuas in this movement, because it was too early in the month. In May 1983 there were 786 Pomarine, 152 Arctic and 387 Long-tailed Skuas between the 19th-22nd, including day totals of 436 Pomarines on the 19th, 182 Pomarines and 271 Long-tailed on the 21st. This movement of Long-tailed Skuas was unusual because it consisted entirely of very small groups, averaging three or four birds, and a total of 81 flew across the headland or the RSPB reserve on the 21st-22nd. In retrospect the fact that it was overcast all day on the 21st, with two hours heavy drizzle in mid-morning, was significant.

In May 1986 there were several large counts of Pomarines including 254 on the 11th, 241 on the 18th and 284 on the 26th, a total of 779 in only 9 hours. In addition there was an exceptionally concentrated movement involving 766 Pomarines in 5 hours on the 21st, accompanied by 168 Long-tailed Skuas in only four flocks. In May 1987 there was just one large movement involving a day total of 703 Pomarine and 77 Long-tailed Skuas on the 17th.

Elsewhere spring movements of Long-tailed Skuas have only been seen at two other sites: at Slyne Head (Co. Galway) there were counts of 22 on 23 May 1979 and 15 on 13 May 1981, while at Wats Ness (Shetland) there were flocks of 18 and 33 on 21 May 1987, and 119 (including a flock of 105) on 22 May 1991. Other sites where observations might be attempted are Neist Point (Skye) and the coast between Aird Brenish and Gallan Head (Lewis). Observers wishing to see Long-tailed Skuas should bear in mind that flocks have so far only occurred at Balranald during 9 – 24 May, and that none are seen if offshore winds occur throughout this period, as happened in 1989 and 1990.

Acknowledgements

The main observations in 1991 were made by Trevor Bowley, John Metcalf and myself throughout the 12th-22nd May, with Alan Dawe and friends during the 12th-16th May, Ken Dummigan during the 13th-16th May, Jeff Stenning during the 18th – 20th May, and Rupert Perkins on the 19th May.

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Shore-bird populations on the Orkney coastline in winter

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A survey of the numbers and distribution of shore-birds on the coast of the Orkney Islands was carried out during the winters 1982-3 and 1983-4. Most of the coastline (many sections of cliff were omitted from the survey) was walked at low tide and totals of 51,000 waders, 15,000 gulls and 8,500 dabbling ducks counted. The most numerous waders were Curlews (17,700), Redshanks (6,900), Turnstones (6,000) and Purple Sandpipers (5,700). Densities of waders on sandy beaches and rocky shores exceeded the average density for British estuaries. There were 9,000 Common Gulls and 5,000 Wigeon.

Variations between the two winters were checked by carrying out a repeat survey on Sanday. The numbers of Purple Sandpipers, Turnstones, Curlews and Ringed Plovers were similar for the two winters. Variation between observers in counting and day to day variations in numbers made it difficult to obtain precise estimates. The most precise counts were for Turnstones and Purple Sandpipers.

For eleven species of shore-birds the Orkney coastline supports nationally or internationally important populations.

Introduction

In 1969 the British Trust for Ornithology initiated a monthly survey of birds inhabiting estuaries (the Birds of Estuaries Enquiry (BOEE)) in order to quantify the numbers and distribution of shore-birds (waders, gulls and wildfowl) present there (Prater 1981). Other coastal habitats, which also support many shore-birds were not surveyed, so the national populations of many species remained uncertain and the relative importance of estuarine versus non-estuarine shore to various species could not be determined. Attempts were made to estimate the national population of some species, eg. the Sanderling *Calidris alba*, mainly a sandy beach species (Prater & Davies 1978) and the Purple Sandpiper *C. maritima*, a rocky shore species (Atkinson *et al.* 1978), based on casual records published in local bird reports. These estimations highlighted the limitation of our knowledge on the numbers and distribution of these species.

In order to measure the size of the populations of open-shore (i.e. non-estuarine) waders and thus complement the BOEE, the Tay Ringing Group undertook a survey of waders on 330km of rocky coast from Berwickshire to Morayshire between 1971 and 1974 (Summers *et al.* 1975). This survey was extended to include Caithness, east Sutherland and east Ross-shire (115 km)

in 1982, when it included all shore-birds on sandy as well as rocky shores (Summers & Buxton 1983). Buxton (1982) carried out a similar survey of the Outer Hebrides between 1978 and 1982. The survey of the Orkney Islands reported here was a continuation of these surveys and a summary of a preliminary report (Tay & Orkney Ringing Groups 1984) has already been incorporated into a subsequent national survey of non-estuarine waders (Moser & Summers 1987). In this paper, details of the numbers and distribution of shore-birds on the coastline of the Orkney Islands in winter is described, and compared with the neighbouring archipelago of Shetland where a survey was conducted in winter 1984-85 (Summers *et al.* 1988).

Study areas

The Orkney Islands are composed almost entirely of Old Red Sandstone which is a sedimentary rock laid down in a huge, shallow freshwater lake during the Devonian period, 350 million years ago (Bailey 1971). The coastline of Orkney has been described by Mather *et al.* (1975). In total, it has about 800km of coastline, as measured on a 1:50,000 scale. Most of this (71%) is composed of low rocky shore, 18% are high cliffs over 15 metres, whilst the remaining 11% is of sand (Fig. 1).

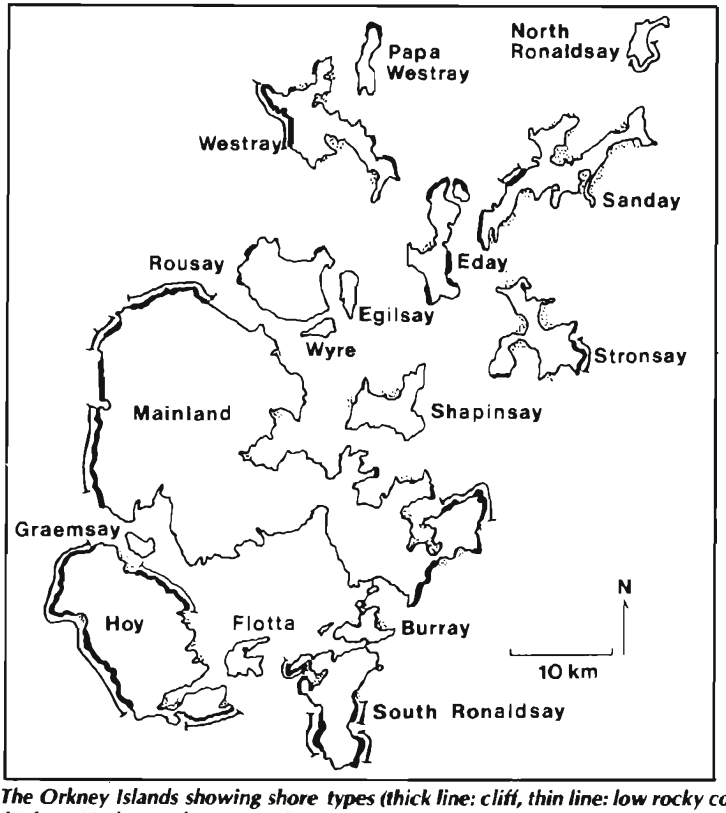

FIGURE 1. The Orkney Islands showing shore types (thick line: cliff, thin line: low rocky coast, stipple: sand or shingle) from Mather et al. 1975) and sections of coast that were not surveyed (|——|).

The islands with the highest proportion of sandy beach are Shapinsay, Sanday and Stronsay. These are mainly in the north-eastern sector of the archipelago. In contrast, cliffs dominate the coastal scenery of South Ronaldsay, Westray, Hoy and west Mainland, mainly round the southern and western edges of the archipelago (Fig. 1).

Although the kelp *Laminaria* spp. forests are usually out of reach of inter-tidal animals, kelp plays an important role in the ecology of rocky shores and sandy beaches, because it can provide a massive input of detritus onto these shores. Although kelps provide most of this, several other brown and red sea-weeds also contribute. The strandings of kelp are uneven along the coast, being concentrated by the configuration of the coast and the action of the offshore currents. Such banks of stranded kelp can reach a depth of a metre or more and provide a rich food supply for scavenging amphipods. Banks, which have been left high and dry by a series of spring tides, eventually begin to rot and decay and in this warm mulch kelp flies *Coelopa frigida* lay their eggs and the resulting maggots feed. Both amphipods and insects are food for waders (Summers *et al.* 1990).

Methods

All the inhabited islands were surveyed: Mainland, Hoy, South Ronaldsay, Burray, Sanday, Westray, Shapinsay, Stronsay, Papa Westray, North Ronaldsay, Rousay, Egilsay, Graemsay, Flotta, Wyre, Auskerry and Eday. Some of the smaller islands were also visited: Glims Holm, Lamb Holm and Hunda. Most of the coastline on these islands was visited but sections of high cliff which, from previous experience, were known to have few or no waders were excluded. About a third of suitable habitat on North Ronaldsay and many tiny islands were not surveyed. Fig. 1 shows the unsurveyed sections and Table 1 shows the length and area of each habitat surveyed on each island.

The islands were surveyed during 22-30 January 1983 and 17 December 1983 to 29 January 1984, when a winter maximum of birds was present.

The counting method was designed to give the best estimate of the wader population present in the inter-tidal zone at low tide. It became apparent during the survey that many waders, ducks and gulls used inland fields to some extent for feeding and for roosting. As a result, the shore counts underestimated the total Orkney population for many species, though for several the underestimation was small.

Counts were carried out whilst walking along the shore between half ebb and half flood, when one would expect birds that feed on the inter-tidal zone to be present. Waders tend to concentrate at the water's edge, following the tide out and in. Because some waders are cryptic, we walked close to the water's edge so as not to miss these birds. Only those birds which were passed by the observer, flew behind, inland or out to sea were counted. Ducks and gulls resting offshore, or over-flying the coast, and birds in fields adjacent to the shore were also counted and noted as being in these habitats.

The shore was further classified according to substrate type; rock (pebble beach, boulder shore and bedrock), sand or mud. Changes in the shore habitat were noted on a map so that the lengths and areas of each section could be calculated later. Lengths were measured from 1:50,000 maps and area determined by cutting out each section from either 1:25,000 or 1:10,560 (6 inch to the mile) and weighing the pieces of paper. These weights were then converted to area using a standard area of paper whose weight was known.

Generally about 10km of shore was walked by each observer each day and sections were demarcated by natural breaks in shore type, e.g. where a sandy beach and rocky shore met, to lessen the chance of local movements by birds affecting the count. The team worked in a given area each

TABLE 1. The lengths and areas of each habitat surveyed on each island in Orkney during winters 1982-83 and 1983-84.

	Length (km)				Area (hectares)			
	Rock	Mud	Sand	Total	Rock	Mud	Sand	Total
S. Ronaldsay	38.2	1.1	3.1	42.4	262.2	7.9	55.1	325.2
Burray	15.2	—	1.8	17.0	116.2	—	11.4	127.6
Hunda	4.8	—	—	4.8	19.5	—	—	19.5
Lamb & Glims Holm	5.3	—	0.4	5.7	28.9	—	10.1	39.0
Hoy	45.1	—	2.8	47.9	323.7	—	34.8	358.5
Flotta	20.7	—	—	20.7	140.2	—	—	140.2
Graemsay	8.0	—	0.7	8.7	54.9	—	3.3	58.2
Mainland	180.2	3.3	15.3	198.8	1464.4	17.9	202.0	1684.3
Shapinsay	30.4	—	4.5	34.9	143.4	—	33.3	176.7
Rousay	33.2	—	—	33.2	130.4	—	—	130.4
Wyre	8.9	—	—	8.9	44.8	—	—	44.8
Egilsay	10.3	—	1.8	12.1	62.5	—	9.9	72.4
Eday	32.9	—	3.4	36.3	166.4	—	47.9	214.3
Stronsay	46.4	—	5.8	52.2	492.3	—	97.6	589.9
Westray	52.2	—	8.8	61.0	447.8	—	153.0	600.8
Papa Westray	16.1	—	1.5	17.6	127.9	—	13.9	141.8
Sanday	66.5	—	33.1	99.6	1089.5	—	610.8	1700.3
N. Ronaldsay	11.2	—	1.5	12.7	178.4	—	11.3	189.7
Auskerry	3.9	-	—	3.9	23.5	—	—	23.5
TOTAL	629.5	4.4	84.5	718.4	5316.9	25.8	1294.4	6637.1

day so that a long continuous length of coastline was surveyed. Again, this was done to minimise the effects on the counts of local movements by birds (Summers *et al.* 1984).

Because the survey was conducted over two winters, there might have been major differences between the two years, making it unrealistic to treat the data as being representative of the winter situation in Orkney. Therefore, in order to make a comparison between the two winters, the island of Sanday was revisited during the second part of the survey, and we selected those sections which contained large numbers of waders for re-surveying (Fig. 2). Only the waders were re-counted because it was not possible to get precise counts of gulls and ducks.

The raw data and preliminary report have been deposited in the libraries of the Scottish Ornithologists' Club, British Trust for Ornithology, Nature Conservancy Council and the Royal Society for the Protection of Birds (Tay & Orkney Ringing Group 1984, Summers & Underhill 1985).

Results

Differences between the two winters

The data for the waders in the two winters on Sanday are shown in Table 2. Counts for the two main habitats have been separated. The sandy coast refers mainly to the open

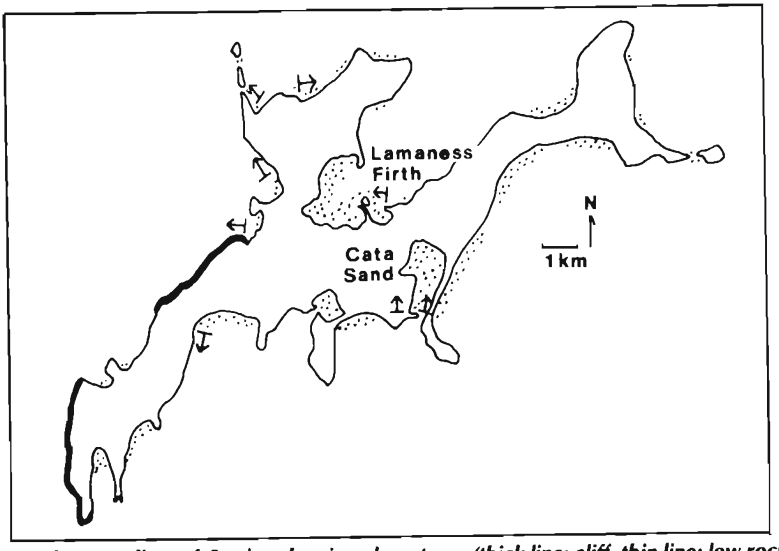

FIGURE 2. The coastline of Sanday showing shore types (thick line: cliff, thin line: low rocky coast, stipple: sand or shingle) and sections that were not surveyed in both winters (↦ ↤).

sandy shore as the two large bays, Cata Sand and Lambaness Firth, were not included (Fig. 2). For some species (Turnstone *Arenaria interpres*, Ringed Plover *Charadrius hiaticula*, Curlew *Numenius arquata* and Purple Sandpiper), the counts in the two winters were similar. Bar-tailed Godwits *Limosa lapponica* and Sanderlings were more numerous on the second count but, as the two large bays which held the greatest concentrations of these species were not surveyed, it is difficult to be sure of the differences between the two years. Numbers of Oystercatchers *Haematopus ostralegus*, Golden Plovers *Pluvialis apricaria*, Lapwings *Vanellus vanellus* and Redshanks *Tringa totanus* were smaller in the second winter (Table 2). Overall, the truly rocky-shore species showed small differences between the two winters and the differences in those species which also use fields were not greater than one might expect on successive days (Summers *et al.* 1984). We therefore combined the data for the two years.

The numbers counted during the winter survey

The total numbers of waders counted on each island are shown in Table 3, and these totals have been split for the two main shore types, rocky shores and sandy beach, in Tables 4 and 5 respectively. The numbers for muddy shore are not shown separately. Mainland had the largest number of waders, almost half of which were Curlews. Sanday had the second highest total but had a greater variety of species compared with Mainland. This was due to its long sections of sandy coast resulting in populations of waders normally associated with soft shores. Thereafter, South Ronaldsay and Westray had the largest numbers.

The total numbers of dabbling ducks and gulls recorded for each island are shown in Table 6. Again, most ducks were seen on the Mainland, and Sanday had the second highest total. The largest numbers of Herring Gulls *Larus argentatus* and Great Black-back Gulls *L. marinus* were on Sanday. The most abundant gull was the

Common Gull *L. canus*, which was also very abundant on fields.

The total number of Oystercatchers counted during the survey was 2777, and they also occurred inland (27 on Papa Westray, 13 on Stronsay and 80 on Eday). Their distribution on the coast was relatively even throughout the islands, but with higher densities on rocky shores than on sandy beaches (Fig. 3, Tables 4 & 5).

Ringed Plovers were found all round Orkney during the survey, associating particularly with sandy beaches (Fig. 4, Table 5). The coastal total probably represents most of the winter population for Orkney, since they were seen inland only occasionally (30 on Stronsay). Grassland is the main winter habitat of the Golden Plover so the coastal count (Table 3) will represent only a small proportion of the Orkney population. Totals of 1100 were seen on fields in Westray, 860 on Stronsay and 125 on Egilsay. The Lapwing is similar to the Golden Plover in that they winter mainly on grassland (60 were counted on Rousay, 90 on Eday and 100 on Stronsay).

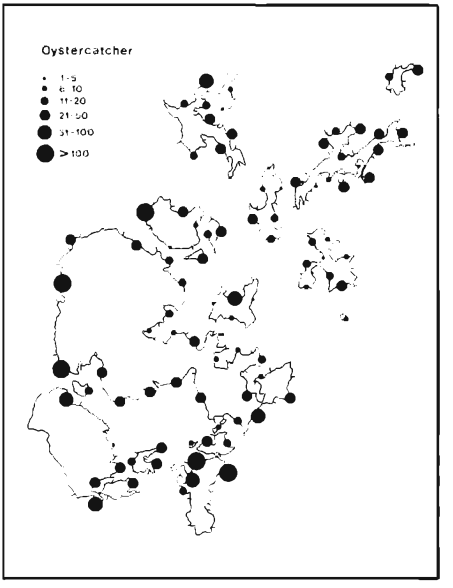

FIGURE 3. The distribution of Oystercatchers on the coast of Orkney in winters 1982-83 and 1983-84.

TABLE 2. Wader totals on selected portions of Sanday in each winter's survey.

	Rock (33.3km)		Sand (17.1km)		Total	
	1982-3	1983-4	1982-3	1983-4	1982-3	1983-4
Oystercatcher	185	121	29	26	214	147
Ringed Plover	133	99	103	143	236	242
Golden Plover	297	114	0	0	297	114
Grey Plover	2	9	4	3	6	12
Lapwing	99	22	0	35	99	57
Turnstone	793	744	45	64	838	808
Purple Sandpiper	928	901	1	50	929	951
Dunlin	225	226	91	168	316	394
Knot	0	1	0	0	0	1
Sanderling	50	154	161	146	211	300
Redshank	489	298	107	16	596	314
Bar-tailed Godwit	1	88	28	32	29	120
Curlew	390	401	73	12	463	413
Snipe	26	30	2	2	28	32

	Oystercatcher	Ringed Plover	Grey Plover	Golden Plover	Lapwing	Turnstone	Purple Sandpiper	Dunlin	Knot	Sanderling	Redshank	Bar-tailed Godwit	Curlew	Snipe	Jack Snipe	Woodcock	Total
S. Ronaldsay	366	40	10	54	480	255	106	100			610	22	2779	41			4863
Burray	67	38		300	150	33					24		374	1			987
Hunda	7	9				24	1				22		1	2			66
Lamb & Glims Holm	6				2	7	1				20		86				122
Hoy	282	94		18	370	188	118				458		881	8			2,417
Flotta	64				31	218	48				153		33	8			555
Graemsay	18	34	2	11	5	43	73	2			63		27	23			301
Mainland	846	485	4	1223	2004	1774	952	433	18		2555	54	10282	77			20747
Shapinsay	70	40		47	238	220	18				225		1,421	18			2297
Rousay	204	35		24	46	192	270	52			141		80	60			1,104
Wyre	23	2		1	1	58	41				57		3	14			200
Egilsay	53	72		16	20	318	242	2			143		55	39	1	1	962
Eday	62	39			97	413	252	5			418		92	23			1,401
Stronsay	115	168		46	15	377	712	39		167	300	47	277	144			2407
Westray	219	136		147	79	579	1079	100		177	815	1	561	61			3954
Papa Westray	10	93			4	38	167				3	12	1	330			358
Sanday	307	279	14	477	121	1149	1247	1288		474	899	616	762	54			7687
N. Ronaldsay*	51	51		177		75	276	34		40	32	17	6	4			763
Auskerry	7					40	70				8		8	25			158
TOTAL	2777	1615	30	2541	3703	6001	5673	2055	18	858	6946	769	17729	632	1	1	51349

* Count incomplete

TABLE 3. The number of waders counted on the coast of Orkney in winters 1982-83 and 1983-84.

	Oystercatcher	Ringed Plover	Grey Plover	Golden Plover	Lapwing	Turnstone	Purple Sandpiper	Dunlin	Knot	Sanderling	Redshank	Bar-tailed Godwit	Curlew	Snipe	Jack Snipe	Woodcock	Total
S. Ronaldsay	323	28			480	238	99	70			508		1967	41			3754
Burray	66	36		300	150	31					24		172	1			780
Hunda	7	9				24	1				22		1	2			66
Lamb & Glims Holm	6				2	7	1				20		86				122
Hoy	252	19		18	330	164	113				439		812	8			2155
Flotta	64				31	218	48				153		33	8			555
Graemsay	15	12	2	11	5	41	61				62		27	23			259
Mainland	693	280	3	923	1704	1736	945	298	12		2365	8	9548	72			18587
Shapinsay	70	40		18	108	62	16				210		221	18			763
Rousay	204	35		24	46	192	270	52			141		80	60			1104
Wyre	23	2		1	1	58	41				57		3	14			200
Egilsay	39			16	17	241	178	2			106		54	37	1	1	692
Eday	61	22			84	411	252	5			414		86	23			1358
Stronsay	111	109		46	15	365	712	37		82	293	47	277	134			2228
Westray	205	59		105	49	437	1,079	2		2	613	1	396	54			3002
Papa Westray	7	52			4	31	71				3		1	30			199
Sanday	270	151	2	297	112	1040	1156	265		220	735	143	611	45			5047
N. Ronaldsay	44	9		177		73	266	25		1	26	12	6	1			640
Auskerry	7					40	70				8		8	25			158
TOTAL	2467	863	7	1936	3138	5409	5379	756	12	305	6199	211	14389	596	1	1	41669
Density	46	16		36	59	102	101	14		6	117	4	271	11			784

TABLE 4. The number and density (numbers/km²) of waders on the rocky shores of Orkney in winters 1982-83 and 1983-84.

	Oystercatcher	Ringed Plover	Grey Plover	Golden Plover	Lapwing	Turnstone	Purple Sandpiper	Dunlin	Knot	Sanderling	Redshank	Bar-tailed Godwit	Curlew	Snipe	Total
S. Ronaldsay	43	12		54		17	7	30			93	22	812		1090
Burray	1	2				2							202		207
Hunda															
Lamb & Glims Holm															
Hoy	30	75			40	24	5				19		69		262
Flotta															
Graemsay	3	22				2	12	2			1				42
Mainland	141	197	1	300	325	29	7	110	6		117	46	452	1	1732
Shapinsay				29	130	158	2				15		1200		1534
Rousay															
Wyre															
Egilsay	14	72			3	77	64				36		1	2	269
Eday	1	17			13	2					4		6		43
Stronsay	4	59				12		2		85	7			10	179
Westray	14	77		42	30	142		98		175	202		165	7	952
Papa Westray	3	41				7	96					12			159
Sanday	37	128	12	180	9	109	91	1023		254	164	473	151	9	2640
N. Ronaldsay	7	42				2	10	9		39	6	5		3	123
Auskerry															
TOTAL	298	744	13	605	550	583	294	1274	6	553	664	558	3058	32	9232
Density	23	57	1	47	42	45	23	98		43	51	43	236	2	713

TABLE 5. The number and density (numbers/km²) of waders on the sandy beaches of Orkney in winters 1982-83 and 1983-84.

	Mallard	Wigeon	Teal	Black-headed Gull	Herring Gull	Great Black-back Gull	Common Gull
S. Ronaldsay	120	190	37	65	167	104	416
Burray	80	84	6	1	9	5	59
Hunda	58	38	208			5	2
Lamb & Glims Holm					1	2	1
Hoy	37		41	28	39	99	560
Flotta	17		7	5	35	44	18
Graemsay	7	60		1	16	8	53
Mainland	961	1,755	604	498	555	301	3,403
Shapinsay	113			11	1	32	2,228
Rousay	42	77	8	5	137	71	265
Wyre	36	57	25		2	8	
Egilsay	77	176	145	1	31	5	101
Eday	41	66	59		106	83	26
Stronsay	140	498	12	40	482	163	205
Westray	55	456	144	57	184	370	180
Papa Westray	45	3	36		6	14	
Sanday	229	1,386	262	11	939	1,046	1,281
N. Ronaldsay*					64	87	140
Auskerry	7	42	3		200	200	5
TOTAL	2,065	4,888	1,597	723	2,974	2,647	8,943

* Partial count, and ducks not counted

TABLE 6. The numbers of dabbling ducks and gulls counted on the coast of Orkney in winters 1982-83 and 1983-84.

Numbers of these species on the shore (Table 3) are dependent on the weather conditions (Baillie *et al.* 1986). They become more numerous on the shore when cold weather makes grassland invertebrates less available.

The Turnstone is one of the few waders that is typically seen on rocky shores in winter (Lack 1986). Thus, the count of 6001 (Table 3) is probably close to the total Orkney population, though some were seen foraging on the grass fields (160 on Papa Westray, 115 on Eday and 110 on Stronsay) and birds will have been missed on the small islands that were not visited. They were fairly evenly distributed throughout Orkney (Fig. 5) and occurred commonly on sandy beaches (Table 5) as well as rocky shores (Table 4).

The total number of Purple Sandpipers counted during the survey was 5673 (Table 3), and their distribution was biased towards the north east of the archipelago (Fig. 6). They were seen on fields only at high tide at night when roosting around pools on flooded fields on Sanday. Therefore, the

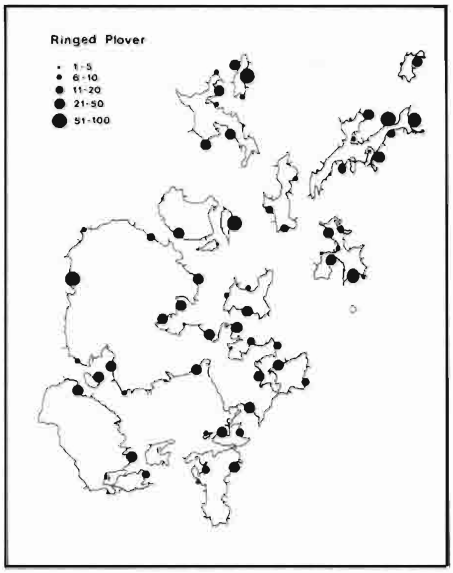

FIGURE 4. The distribution of Ringed Plovers on the coast of Orkney in winters 1982-83 and 1983-84.

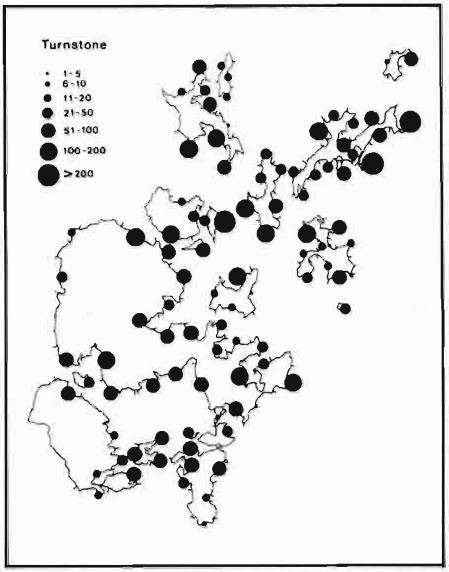

FIGURE 5. The distribution of Turnstones on the coast of Orkney in winters 1982-83 and 1983-84.

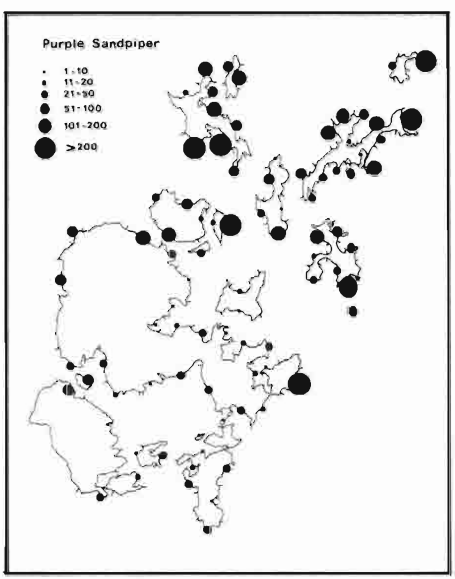

FIGURE 6. The distribution of Purple Sandpipers on the coast of Orkney in winters 1982-83 and 1983-84.

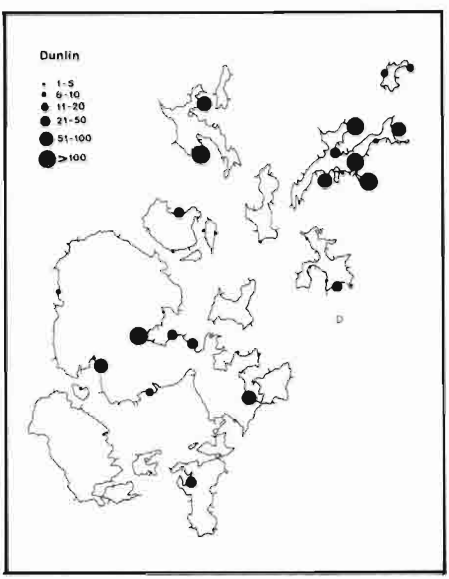

FIGURE 7. The distribution of Dunlins on the coast of Orkney in winters 1982-83 and 1983-84.

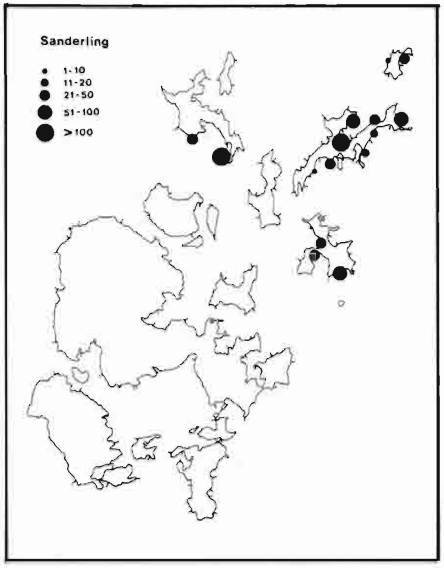

FIGURE 8. The distribution of Sanderlings on the coast of Orkney in winters 1982-83 and 1983-84.

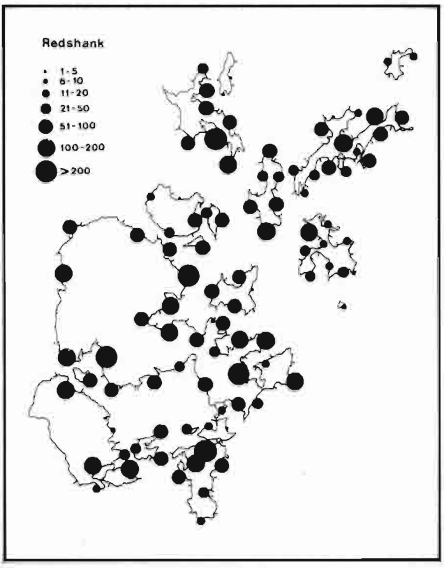

FIGURE 9. The distribution of Redshanks on the coast of Orkney in winters 1982-83 and 1983-84.

total counted probably represents most of the Orkney population, although there will have been uncounted birds on the smaller islands that were not visited.

Most of the 2055 Dunlins counted (Table 3) were on the few bays of fine sand on Sanday and at Sandi Sand, Deerness (Fig. 7). A few were seen inland (150 on Westray and 70 on Stronsay). Only 18 Knots *Calidris canutus* were seen, all at Sandi Sand, Deerness. The 858 Sanderlings counted (Table 3) probably represent the bulk of the Orkney population as they were seen inland only at high tide. Sanderlings were restricted to the northern isles, particularly Sanday (Fig. 8).

Redshanks were common throughout Orkney; almost 7000 were counted in the present survey, particularly on the rocky shores throughout the islands (Table 4, Fig. 9). They were also common on the grass fields (100 on Eday and 217 on Stronsay). The total of 769 Bar-tailed Godwits (Table 3) was found on sandy shores (Table 5), particularly in the bays of fine sand on Sanday (Fig. 9). Although generally found on shores, some did feed inland, even at low tide (50 on Stronsay).

Curlews were the most abundant wader (Table 3) and occurred mainly on Mainland and South Ronaldsay (Fig. 11). Almost 18,000 were counted on the coasts and there were many inland (1143 on Mainland, 35 on Rousay, 750 on Eday, 970 on Stronsay, 185 on Westray and 85 on Papa Westray). Given that the field counts were incomplete it is likely that the total Orkney population exceeds 25,000.

Despite the fact that Snipe *Gallinago gallinago* are normally associated with marshes and fresh water, quite large numbers, 632 (Table 3), were found on the shores, particularly the rocky shores (Table 4).

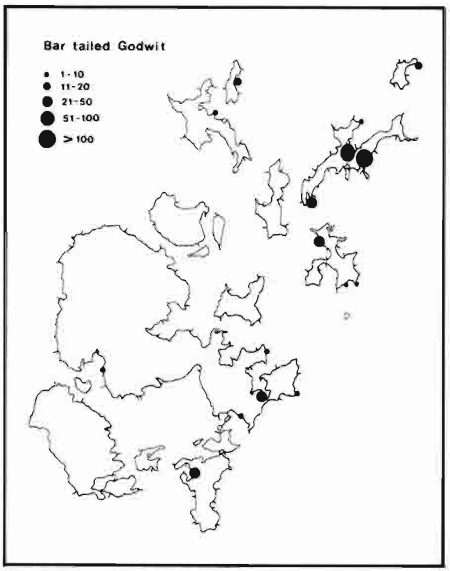

FIGURE 10. The distribution of Bar-tailed Godwits on the coast of Orkney in winters 1982-83 and 1983-84.

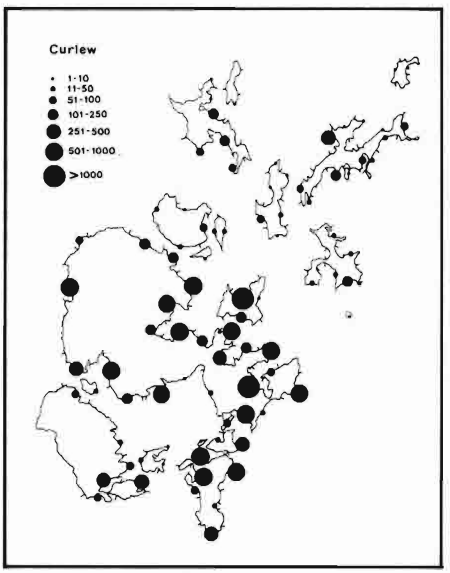

FIGURE 11. The distribution of Curlews on the coast of Orkney in winters 1982-83 and 1983-84.

Discussion

Repeat counts of waders along sections of rocky shore have shown that there are differences between observers: in particular, less exprienced observers tend to underestimate numbers (Summers *et al.* 1984). There are also species differences because cryptic species are more difficult to count than conspicuous ones (Spearpoint *et al.* 1988). Further, there are day-to-day variations in the numbers of waders using a particular section of coast, especially for those species which also use inland habitats for feeding, such as Oystercatcher, Lapwing, Golden Plover, Curlew and Redshank (Summers *et al.* 1984). Only for those species which are virtually restricted to the inter-tidal zone and are site faithful, such as the Turnstone and Purple Sandpiper (Atkinson *et al.* 1981, Metcalfe & Furness 1985), can one achieve reasonably precise counts, ie variation of less than 20% between repeat counts (Summers *et al.* 1984). By designing our counting to survey long sections of coast each day, we largely overcame the counting problems associated with short distance movements by waders along the coast.

The present survey spanned two winters and repeat counts on Sanday showed that only the numbers of Ringed Plovers, Turnstones, Purple Sandpipers and Curlews were similar in the two winters, ie differences of less than 11%. Numbers of Oystercatchers, Golden Plovers, Lapwings and Redshanks were smaller in the second year and numbers of Sanderlings and Dunlins increased. Given the variations in numbers associated with differences between observers, together with day-to-day variations in numbers and between-year differences, it is felt that precise information was obtained only for the Turnstone and Purple Sandpiper. However, the information on the other species does give

an indication of populations occurring on the Orkney coastline.

The recorded density of waders on the rocky shores of Orkney (784/km^2) falls within the values obtained on the mainland of Scotland from Fife to Caithness (202-1258/km^2) (Summers & Buxton 1983). In comparison, densities on estuaries can be as high as 4940/km^2, but the average for all estuaries in Britain is only 486/km^2 (Prater 1981), lower than that found on either the rocky shores or sandy beaches (713/km^2) of Orkney. Densities on the sandy shores were as high as on the rocky shores. Part of the biological richness of the sandy shores stems from the stranded kelp which originates from sublittoral rocky shores. The rotting kelp provides a food source for crustaceans and insects on which waders feed (Summers *et al.* 1990).

Although the neighbouring archipelago of Shetland has a longer coastline (1,500 km compared with Orkney's 800 km), far fewer waders winter in Shetland (12,000 compared with Orkney's 51,000) (Summers *et al.* 1988). Shetland has few sandy shores so Grey Plovers, Bar-tailed Godwits, Knots and Sanderlings are rare. However, even the rocky shore species are less abundant and it is thought that this is related to the nature of these shores. Only 18% of the Orkney coast is cliff whereas Shetland has 29%, and cliffs tend to be avoided by waders (Summers *et al.* 1988). Also, the low rocky shores of Orkney have broad intertidal areas whereas the hard metamorphic and igneous rocks of Shetland result in a narrow intertidal zone. Therefore, the area of shore available to waders in Shetland is less.

Several species used fields as well as the shore for feeding so that our survey did not give a total for the Orkney population. The inland habitats of Orkney have been and are being greatly modified, as marshes and moors are turned into farmland, particularly to grass fields for grazing, hay or silage. This has had an impact on the wintering birds because so many species of waders and other birds (Starlings *Sturnus vulgaris* and Common Gulls) forage on these fields (Lea & Bourne 1975). It is possible that the creation of pasture has led to an increase in the number of waders wintering in Orkney. Heppleston (1982) found that fields were important to Lapwings, Curlews, Redshanks and Golden Plovers, but less so to Oystercatchers, Turnstones and Dunlins. There were 2-3 times more waders in the fields at high tide than at low tide, showing that many waders move from the shore to fields in response to the tides. It would be useful to extend our survey to find out more about the numbers and distribution of waders on fields.

The Ramsar Convention on Wetlands of International Importance came into effect in December 1975. Britain became a contracting party to the convention, thereby promising to safeguard wetlands of international importance. The convention drew up criteria on which to identify wetlands of international importance and two of these were that the wetland should regularly support at least 20,000 waterfowl, or support at least one percent of a biogeographical population of one species of waterfowl. For each species, Salmon *et al.* (1989) listed the number which would represent one percent of the Western European population (Table 7). On a similar basis, if a wetland contains at least one percent of the national total, then that wetland may be regarded as nationally important for that species (Table 7). For several species, the Orkney population exceeds these one percent values showing that Orkney is nationally and internationally important for these species (Table 7). As a result of our findings, the Nature Conservancy Council have recommended the designation of the following sites as Special Protection Areas and Ramsar sites: North Ronaldsay, south Westray, south-east Stronsay, east Sanday and north Mainland. It is hoped that these sites will be designated in the near future. Although open coastline is not as threatened as estuaries by the influences of man it is

TABLE 7. Numbers qualifying for international and national importance (Salmon *et al.* 1989) set beside the totals for the coast of Orkney. Only those species for which Orkney is either nationally or internationally important are shown.

	International qualifying level	National qualifying level	Population on the Orkney coast
Wigeon	7,500	2,500	4,800
Teal	4,000	1,000	1,600
Oystercatcher	9,000	2,800	2,800
Ringed Plover	500	230	1,600
Golden Plover	10,000	2,000	2,500
Turnstone	700	450	6,000
Purple Sandpiper	500	160	5,600
Sanderling	1,000	140	860
Redshank	1,500	750	6,900
Bar-tailed Godwit	1,000	610	770
Curlew	3,500	910	18,000

certainly not immune to them. For example, there are proposals to harvest the kelp forests off Sanday and Switha which, if they went ahead, would reduce the food base in the form of stranded kelp upon which the waders rely.

Acknowledgements

The survey could not have been carried out without the generous financial contributions by several people and organisations: Sir Herbert Bonar, the Nature Conservancy Council, the Royal Society for the Protection of Birds, the Scottish Ornithologists' Club and Shell UK. The following people took part in the survey: S. Brogan, N. Buxton, C. Corse, P. Davey, M. Davey, M. Gray, J. Hogarth, J. Johnston, B. McCutcheon, M. Martin, E. Meek, P. Moore, M. Nicoll, R. Rae, A. Rendall, P. Reynolds, K. Slater, R. Smith, R. Summers, J. Williams, S. Williams and K. Woodbridge. The draft was commented on by Dr R.P. Prŷs Jones and Professor L.G. Underhill.

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A census of the large inland Common Gull colonies of Grampian

M.L. TASKER, A. WEBB AND J.M. MATTHEWS

A census of two large Common Gull colonies on hills in Grampian found that they contained a total of between 25,000 and 40,000 pairs. This remarkable figure represents just under half of the British and Irish population and 6% of the world population of this species.

Introduction

In Scotland, Common Gulls *Larus canus* nest typically in relatively small groups, frequently on small marshy areas or beside the coast. In Grampian there are two very large Common Gull colonies nesting on the tops of moorland hills overlooking agricultural land. The first is in the Correen Hills, north of Alford and the other in the Mortlach Hills to the south-east of Dufftown (Fig. 1). Common Gulls were recorded in the Correen Hills by Sim (1903), who noted a few pairs on the Hill of Drumbarton in 1890. This particular hill no longer holds Common Gulls as it is overgrown with a maturing conifer plantation.

Bourne *et al.* (1978) noted the presence of these colonies and estimated that 4000-5000 pairs of Common Gulls were breeding on the Correen Hills, along with small numbers of Lesser Black-backed Gulls *L. fuscus* and Herring Gulls *L. argentatus*. These authors noted two sub-colonies in the Mortlach Hills, both of around 1000 pairs, also with other species of gull present. Preliminary inspection in 1986 indicated that these colonies were probably considerably bigger than the estimates made in the 1970s, so a formal survey of numbers was made in 1988-1989. A search of the literature and an appeal for records was undertaken to put these colonies in context. Sites on suitable nearby hills were checked.

Methods

The colony in the Correen Hills comprised five sub-colonies (Fig. 2), while that in the Mortlach Hills was divided into six (Fig. 3). Two visits to each colony were made in late May and early June, either in 1988 or 1989. Warm dry days were chosen in order to minimise the effects of disturbance caused by the survey, both on the gulls and on other species nesting on these hills. The boundaries of the sub-colonies were mapped approximately during the first visit. On the second, one person laid out a grid of bamboo poles, each 100m apart, throughout each sub-colony. This person also plotted the boundary of the sub-colonies as

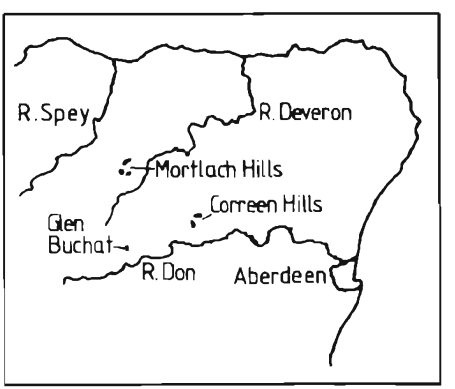

FIGURE 1. The location of large Common Gull colonies in northeast Scotland.

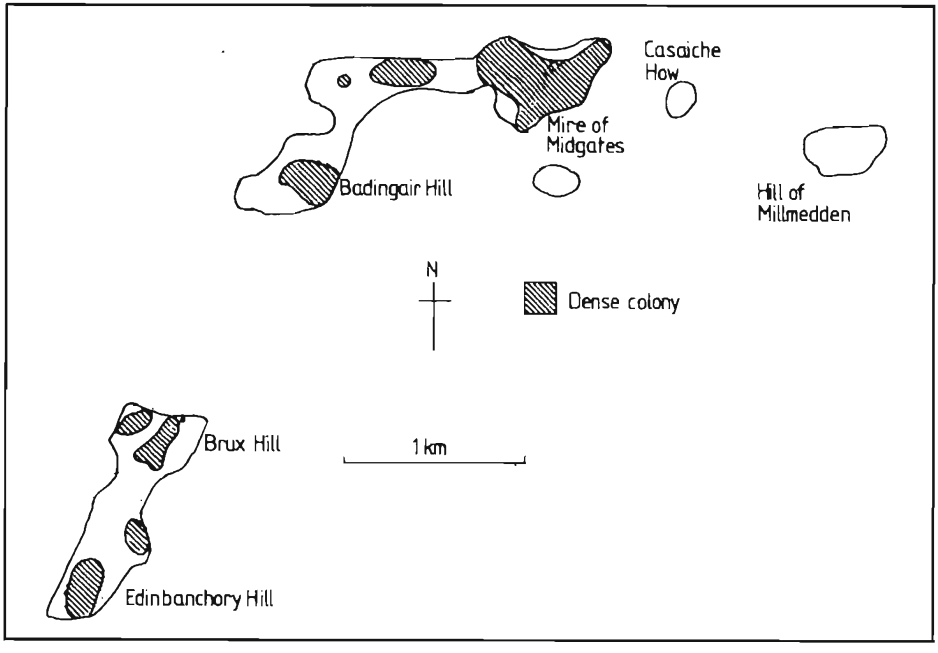

FIGURE 2. The location of sub-colonies of Common Gulls, indicating dense parts of the colony, in the Correen Hills.

accurately as possible, based on the location of the grid. One or two other counters, using a piece of rope 9.77m long, recorded the number of nests within a 300m^2 circle centred on these poles. Numbers of eggs were recorded for each nest. For those nests with no eggs, an assessment was made as to whether the nest was active: fresh soil or nest material implied an "active nest".

The colony boundaries and densities of nests (two categories: active and all) at each sampling point were then plotted onto large-scale maps. In some sub-colonies there were obvious areas that were at much higher densities than others. The distribution of densities within sampling circles in these sub-colonies was bimodal. Sampling circles holding either seven or more active nests or a total of more than ten nests were categorised as being in dense parts of the colony and were delineated on the maps. The colony area and the area of each of the dense and less dense parts were then calculated using a planimeter. Numbers of nests (both active and all) in each part of each sub-colony were then calculated by multiplying colony area by the mean density of nests in that part. Standard errors and 95% confidence limits were calculated. Numbers of apparently occupied territories in the two smallest sub-colonies in both the Correen and Mortlach Hills were estimated by eye. The vegetation was also described within each sample circle, but these results are not analysed in detail here.

Results

A total of 13,950 active nests was estimated to be present in the Correen Hills, out of an estimated total of 24,450 nests (Table 1). Equivalent figures for the Mortlach Hills were 10,750 and 16,200. The largest sub-

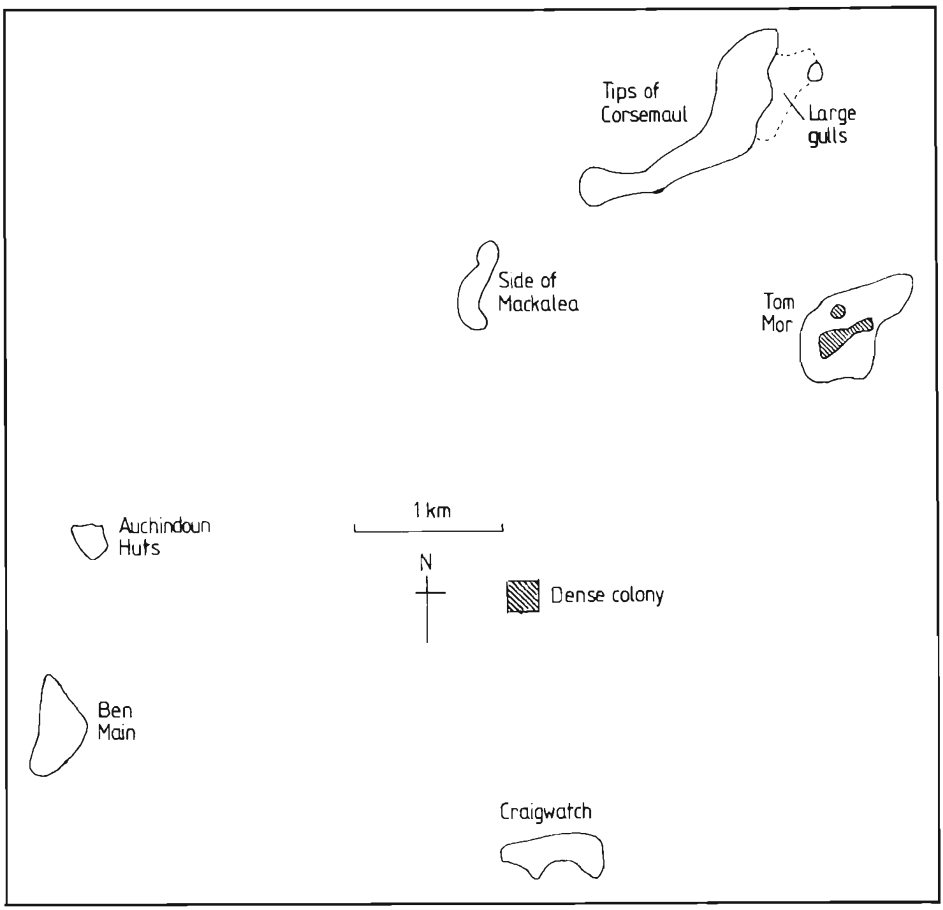

FIGURE 3. The location of sub-colonies of Common Gulls, indicating dense parts of the colony, in the Mortlach Hills.

colony was that on the northern Correen Hills of Badingair and Mire of Midgates, which held 9200 active nests among a total of 17,000.

Counts of other gull species found 50 pairs of Black-headed Gulls *L. ridibundus* in both the Craigwatch and Auchindoun Huts sub-colonies of the Mortlach Hills, and 4 pairs of Great Black-backed Gull *L. marinus*, 37 pairs of Herring Gull and 110 pairs of Lesser Black-backed Gull to the immediate east of the Tips of Corsemaul sub-colony. One pair of Lesser Black-backed Gulls nested in the Hill of Millmedden colony on the Correen Hills with 40 pairs of Lesser Black-backed Gulls and two pairs of Herring Gulls on low ground to the south of the Mire of Midgates. 40 pairs of Lesser Black-backed Gulls, with 10 pairs of Herring Gulls were present on the east side of Edinbanchory Hill.

The search for further large Common Gull colonies found only one other with

more than 100 pairs. This was in Glen Buchat (Fig. 1), where two sub-colonies held 793 (+/− 290) active nests of a total of 993 (+/− 329) nests, based on 15 sampling circles of 300m^2, distributed at 50m intervals. About 100 pairs were found at two other sites in the early 1980s during recording for the *North-East Scotland Bird Atlas* (Buckland *et al.* 1990). These were at Corrennie to the south of Alford and Presendye to the north of Tarland. Visits to these sites in 1989 found about 50 pairs at the former, and none at the latter. At least 8 other sites held 50 or less pairs of Common Gull in north-east Scotland.

Discussion

The total number of pairs breeding in each colony probably exceeds the number of active nests at any one time, but by how much is difficult to tell on the basis of these surveys. Within a colony, laying of eggs occurs over a protracted period; under ideal circumstances, a study on the phenology of the laying season should be undertaken in order to determine the proportion of nests that are active at the time of an individual count compared with the total number active during the breeding season. The count of active nests provides a minimum number

TABLE 1. Numbers of Common Gull nests present in sub-colonies on the Correen and Mortlach Hills. (i) Active nests, (ii) All nests (including active nests).

(i) Active nests	No. of plots	Mean Density (nests/100m^2)	Area (ha)	Numbers (95% confidence)
(a) Correen Hills				
Badingair/Midgates (higher density)	29	2.57	27.89	7181 (+/− 1532)
Badingair/Midgates (lower density)	31	0.67	29.90	2058 (+/− 560)
Brux/Edinbanchory (higher density)	13	2.72	11.00	2990 (+/− 528)
Brux/Edinbanchory (lower density)	26	0.57	24.79	1271 (+/− 424)
Hill of Millmedden[1]				350
Casaiche How[1]				100
Total				13950 (+/− 3044)
(b) Mortlach Hills				
Tips of Corsemaul	56	0.66	51.24	3385 (+/− 745)
Tom Mor (higher density)	7	2.72	5.05	1374 (+/− 101)
Tom Mor (lower density)	26	1.00	28.00	2800 (+/− 608)
Ben Main	18	1.00	18.19	1785 (+/− 725)
Craigwatch	16	0.77	16.31	1217 (+/− 554)
Auchindoun Huts[1]			3.36	100
Side of Mackalea[1]				80
Total				10731 (+/− 2733)

(ii) All nests	Mean Density (nests/100m²)	Numbers (95% confidence)
(a) Correen Hills		
Badingair/Midgates (higher density)	4.42	12342 (+/- 1414)
Badingair/Midgates (lower density)	1.54	4597 (+/- 966)
Brux/Edinbanchory (higher density)	4.20	4626 (+/- 355)
Brux/Edinbanchory (lower density)	0.97	2415 (+/- 740)
Hill of Millmedden[1]		350
Casaiche How[1]		100
Total		24430 (+/- 3475)
(b) Mortlach Hills		
Tips of Corsemaul	0.96	4910 (+/- 922)
Tom Mor (higher density)	3.39	1711 (+/- 216)
Tom Mor (lower density)	1.59	4458 (+/- 921)
Ben Main	1.70	3133 (+/- 1466)
Craigwatch	1.10	1819 (+/- 627)
Auchindoun Huts[1]		100
Side of Mackalea[1]		80
Total		16211 (+/- 4152)

Notes
1: Estimate made by eye

of pairs breeding. Pairs of Common Gulls may build or start more than one nest within their territories; this has been recorded for Lesser and Great Black-backed and Herring Gulls elsewhere (Cramp & Simmons 1983), but not for Common Gulls; however this may be due to lack of study. In the present survey, it was assumed that each pair had either one active nest, or none at all. The non-active nests could have either been alternative sites, established earlier in the breeding season, or sites of pairs that discontinued the breeding attempt after making a nest scrape.

The use of a regular, as opposed to a random, pattern of quadrats is not ideal; it does not allow for the possibility of regularity in the distribution of nests within the colony. There was however no evidence of this, with the distribution of numbers in each quadrat being approximately normal (after the separation of some sub-colonies into higher and lower density areas). One advantage of a regular sampling pattern is that the colony boundaries can be checked rapidly and accurately, thus giving a higher precision to the estimate of colony area. In addition, quadrat locations can be found rapidly; an important feature when limited numbers of counters are available or time within a colony is limited, either by landowner request, or the need to keep disturbance to a minimum.

The colonies on Correen and Mortlach

Hills are the largest in Britain and may be the largest in the world. There has been no full survey of breeding Common Gulls in Britain. Cramp *et al.* (1974) found a total of 12,400 pairs nesting on the coast in 1969/70, a figure revised to 13,000 pairs by Lloyd *et al.* (1991). These latter authors found 15,700 pairs in coastal colonies in 1985/87. Sharrock (1976) estimated a British and Irish total of 50,000 pairs, based on an average of 50 nesting pairs within just over 1000 occupied 10km squares found during 1968-72. Lloyd *et al.* (1991) updated this total to 71,400 for the mid-1980s.

The sum of totals given for the western Palearctic by Cramp & Simmons (1983) exceeds 560,000 pairs, while Lloyd *et al.* (1991) estimated the world population at about 580,000 pairs. The largest colony recorded in the literature is one of between 10,000 and 11,000 on Langwerder in Germany (Nehls 1973). This count followed a period of prolonged growth that started in the early years of this century (Kumari 1976), so it is possible that numbers nesting there are even larger now. The largest colony in Denmark in 1974 was of 7000 at Amager and there were a further 5 colonies holding over 1000 pairs (Moller 1978). There have been substantial declines in Scandinavian countries, where the largest numbers breed (Evans 1984).

The reasons for the presence of these two large colonies can be speculated upon. As mentioned above, a small colony was present in the Correen Hills in 1890, but the next recorded visit to the site was not until 1972-73, when Swann (1974) estimated 2000-3000 pairs were present; a count in 1974 showed 3000-4000 pairs were present. Numbers had increased to 4000-5000 pairs in 1976 (Bourne *et al.* 1978) and 5250 in 1977 (W.R.P. Bourne in Knox & Bell 1978). A drop to 2500-3000 pairs in 1978 was recorded by A.F.G. Douse in Knox & Bell (1979), and 3000 birds were seen there in 1984 (W.J. & E.H. Foubister in Bell *et al.* 1985).

Bourne *et al.* (1978) recorded 1000 pairs at both the Tips of Corsemaul and Craigwatch in 1977, while 1000 and 300 pairs were found at these sites respectively in 1978 (A.F.G. Douse in Knox & Bell 1979). 1550 pairs were recorded for the Mortlach Hills in 1985 (Hogg 1986). None of the counts at either colony was conducted in any formal manner, so it is difficult to determine trends in numbers, or when any major increases may have occurred.

Local opinion is that numbers nesting on lowland mires in north-east Scotland have declined, both through drainage and planting with conifers (e.g. Bourne *et al.* 1978). At present, both the Correen and Mortlach Hills offer undisturbed sites overlooking agricultural land that has good food supplies (Douse 1981). Both hills are used primarily as grouse moors, and it is likely that the activity of the gamekeepers keeps these hills relatively free of predators, both of Grouse *Lagopus lagopus* and Common Gulls.

The location of some of the sub-colonies is likely to change due to forestry. The sub-colonies at Craigwatch in the Mortlach Hills, the Hill of Millmedden and the eastern part of the Mire of Midgates in the Correen Hills and the colony in Glen Buchat are all in areas planted with young conifers. It is likely that these sub-colonies will move as the trees grow and the canopies close.

Acknowledgements

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A re-examination of the Operation Seafarer estimates of Arctic Tern populations for Orkney and Shetland

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An examination of the raw data for the national seabird census carried out in 1967-70, 'Operation Seafarer', shows that many of the counts of Arctic Terns on Shetland were made too late in the breeding season and probably did not cover all of Shetland; they are therefore likely to be underestimates of the true figures. The counts for Orkney appear to lack these problems although there has been some confusion in past published accounts of what the totals actually were. This re-analysis has implications for the assessment of the importance of recent seabird failures on Shetland.

Introduction

Recent seabird breeding failures have drawn attention to the trends in seabird numbers on Orkney and Shetland. Bourne (1989 abcde) has suggested that the recent breeding failures of Arctic Terns *Sterna paradisaea* on Shetland should be seen in the light of an apparent increase in the Shetland breeding population between 1969 and 1980. On the basis of the following analysis it is here suggested that there is no firm evidence of any such increase.

Methods

Data sources

There are two published complete surveys of Arctic Tern numbers on Orkney and Shetland. Copies of the summaries of the 'Operation Seafarer' (OS) data (Cramp *et al.* 1974) are lodged with the RSPB at Sandy. The tabulated data consist of: the colony name, grid reference, date of visit, an estimation of the accuracy of the counts and the numbers of pairs of nesting Arctic Terns at the site. Data for 1980 are from Bullock and Gomersall (1980, 1981).

Counting methods

For OS, nest counts may have been the commonest methods used for estimating numbers but this is not explicitly made clear. Bullock & Gomersall estimated nesting numbers by counting birds flushed from colonies and relating the numbers of birds in the air to the number of nests in the colony. Here the possibility that both these methods may give unreliable estimates of nesting numbers has been disregarded and the counts are simply taken at face value.

Results

Population size

The Orkney totals given by OS and Bullock & Gomersall are very similar in the two surveys (Table 1) even though the totals for different islands differ between the two surveys, but those for Shetland are very different.

The Orkney total has been the subject of different estimates over the years. The published OS figure of 12,300 pairs (Cramp *et al.* 1974) chose to disregard the estimate of 17,500 pairs from the North Hill, Papa

TABLE 1. Counts of Arctic Terns breeding in Orkney and Shetland in 1967-70 (Operation Seafarer) and 1980 (Bullock & Gomersall 1980, 1981). All figures refer to pairs.

SHETLAND	1967-70	1980
Unst	2002	1393
Yell	447	5354
Fetlar	750	2372
Whalsay	1164	3468
Mainland	2090	10611
Papa Stour	375	4394
Foula	262	4200
	7090	31792

ORKNEY	1967-70	1980
Westray	9927	2282
Papa Westray	17865	7563
Sanday	1180	3179
Stronsay	0	2430
Eday	190	669
Rousay	643	4951
Shapinsay	41	169
North Ronaldsay	950	1537
Mainland	657	1682
Hoy/Graemsay	68	1699
Walls/Flotta	207	2317
South Ronaldsay	449	4501
	32177	32979

Westray colony because it was considered unreliable. Lloyd *et al.* (1975), when reviewing tern population trends, reinstated the figure of 17,500 pairs and stated that the colony might have been even larger than this (based on nest densities in 1974 and the extent of the colony in 1969). Lloyd *et al.* (their Table 4) give Orkney totals for 1969, based on OS, as 27,795 pairs on the Westray group and 384 pairs on other Orkney islands. Bullock & Gomersall (1980, 1981) pointed out that Lloyd *et al.* inadvertently omitted 4,000 pairs from their Orkney total. Thus the actual OS estimate of Orkney Arctic Tern numbers was 32,179 pairs. This figure is very similar to that arrived at in 1980, although the distribution of birds throughout Orkney was quite different.

One remaining puzzle for anyone wishing fully to understand what OS found on Orkney is to explain how the use of an (undisclosed) lower estimate for a colony estimated at 17,500 pairs could lead to a total Orkney population of 12,300 pairs (Cramp *et al.* 1974); more than 17,500 pairs lower than the now accepted total of 32,179 pairs.

OS estimated the Shetland Arctic Tern population as 7,660 pairs. The present author's analysis of the OS data gives a different, but broadly similar, figure of 7,090 pairs (some of the data are presented as ranges which probably leads to the discrepancy). The OS estimates for all Shetland island groups, except Unst, are lower than the Bullock & Gomersall estimates (Table 1).

Coverage

Bullock & Gomersall claimed to have achieved complete coverage of the coast of Orkney and Shetland and of most inland areas. It is difficult to assess what coverage OS achieved but it is striking that there are large parts of Shetland where no colonies were reported in OS (Figure 1). By simply looking at the distribution of colonies, which were recorded, it is clear that those which were near to seabird cliffs probably stood a higher chance of being recorded during OS than those located in areas with few other breeding seabirds. There are numerous examples of Arctic Tern colonies which have had a long history of occupancy in the period following OS and which do not appear in the OS database. The Dalsetter colony, 405164, held an estimated 900 pairs in 1980 and has been continuously occupied ever since. OS reported no Arctic Tern colonies at the southern end of Yell, yet this area has held substantial colonies totalling several hundred pairs since at least 1974 (Bullock & Gomersall 1980). If these gaps

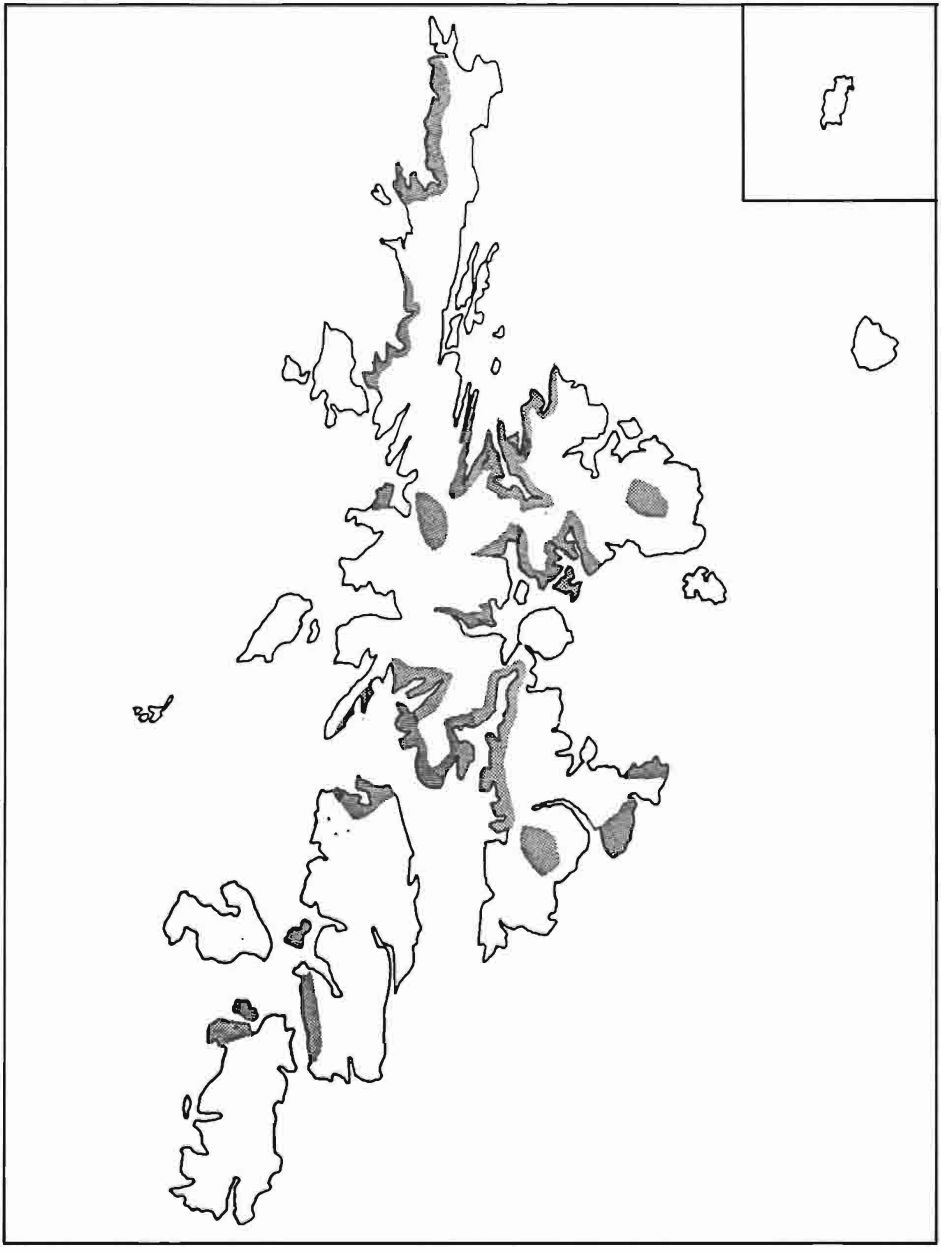

FIGURE 1. Shetland: the shaded areas are ones from which no Operation Seafarer counts are recorded and therefore may be ones in which Arctic Tern colonies were overlooked.

indicate lack of coverage then this could have led to numbers being greatly underestimated. Orkney appears to have been completely covered by OS since the distribution of colony locations is similar to that recorded by Bullock & Gomersall (even though the number of birds at individual colonies differed markedly between surveys).

Timing

The OS counts were made between early June and early August. On Orkney, 89% of the terns recorded during OS were counted in the second half of June (4% in early June, and 2% in early July; for 4% no information on date is given) but the Shetland counts were made much later; 70% of the counted terns (where counting date is given) were recorded from visits made in July (39% of unknown date, 10% in early June, 10% in late June, 27% in early July and 15% in late July). Some counts of currently large Shetland colonies were made after most Arctic Terns would have fledged and left their colonies. For example, counts on Out Skerries were made on 24 July 1970, many of the Yell counts were made on 19 or 23 July 1970, the Scalloway islands were surveyed from 11-16 July 1969, Mousa was visited on 14 July 1969, and many Papa Stour colonies were counted from 15-21 July 1969. The median laying date for Arctic Terns on Shetland in 1987 was 2 June, and in 1988 was 31 May, on Orkney the median laying date in 1988 was 30 May and in 1989 was 28 May (Monaghan *et al.* 1991). This suggests that, with a six week period between laying and fledging (Cramp 1985), half of the successful nests should have fledged by mid-July. And by this time, practically all nests which are going to fail will have failed. Bullock & Gomersall collected data between late May and mid July.

Year

More than 97% of the terns counted during OS on Orkney were counted in 1969. The Shetland counts came from 1967 (3%), 1968 (< 1%), 1969 (54%) and 1970 (42%). Thus if terns changed their distribution between 1969 and 1970 there is scope for either double counting of birds in both years or for birds to have been missed in both years.

Discussion

On Orkney, OS achieved complete coverage in one year (1969) and nearly all counts were made at an appropriate stage of the nesting season. The Arctic Tern population on Orkney in 1969 was very similar to that estimated in 1980: around 32,500 pairs. It seems reasonable to conclude that Arctic Tern numbers on Orkney were broadly similar in the two years, although it is impossible to say how they might have changed in the interval.

The Shetland counts are more difficult to interpret. Doubts have previously been expressed about the completeness and accuracy of the OS totals for Arctic Terns on Orkney and Shetland (Bullock & Gomersall 1980, 1981; Harris 1974). The lack of records from much of Shetland suggests that coverage during OS was incomplete. Some areas of Shetland, including the normally large colonies on Papa Stour and Mousa, were visited too late in the season to provide useful data. It is therefore suggested that the OS estimate of Arctic Tern numbers for Shetland be regarded as an underestimate of unknown size.

Bourne (1989 abcde) has suggested that the current breeding failures of Arctic Terns on Shetland should be seen in the light of an apparent increase in the Shetland breeding population between 1969 and 1980. On the basis of this analysis there seem to be no grounds for believing that such an increase took place on either Orkney or Shetland, and it is here suggested that the low breeding success and decline in numbers of Arctic Terns on Shetland (Walsh *et al.* 1990) should be taken seriously.

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The breeding birds of Hermaness, Shetland

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Forty-eight species of bird are known to have bred on the Hermaness National Nature Reserve, which has one of the largest seabird colonies in Britain. In excess of 100,000 seabirds of thirteen species breed regularly with the numbers of Gannet, Great Skua and Puffin of particular importance. Unfortunately, in common with other Shetland colonies, breeding success of many seabird species has declined in recent years as sandeels, which dominated the diet of many species, have become harder to find.

Introduction

Hermaness National Nature Reserve (NNR), on the island of Unst in Shetland, includes, with the outlying skerries of Muckle Flugga and Out Stack, the northern-most land in the British Isles (Fig. 1). The reserve covers 980 hectares rising to 200m at Hermaness Hill, with base rocks mainly of schist and gneiss. The coastline consists almost entirely of cliffs, rising to 170m at the Neap, most seabirds nesting on the higher west cliffs. The vegetation of the peninsula is mainly blanket bog dominated by heather *Calluna vulgaris*, common cottongrass *Eriophorum angustifolium*, and deergrass *Scirpus caespitosum*, with crowberry *Empetrum nigrum* co-dominant in drier areas. Acidic and maritime grassland is present around the periphery. The reserve is part of the Burrafirth Common Grazings and is grazed by Shetland sheep all year. Some peat-cutting occurs near the Loch of Cliff and there are currently over 3000 visitors each year.

There is a long history of conservation on Hermaness beginning in 1831 when the then laird, Dr.L. Edmondston, began to protect the few breeding Great Skuas *Stercorarius skua*. In 1891 the Edmondston family employed a keeper to increase protection on the site, a role later taken over by the Royal Society for the Protection of Birds (RSPB), which included Hermaness in it's Watcher scheme from 1907-1960. The original NNR was declared in 1955, with an extension added in 1958, and the reserve is managed by the Nature Conservancy Council (NCC) under agreements with the Buness Estate and, for the Muckle Flugga skerries, the Northern Lighthouse Board.

Wardening on-site has been carried out only in 1978 and since 1985, with MGP warden in 1988-90. Additional work on the reserve has been undertaken by visiting researchers, with one group lead by ARM visiting almost annually since 1972. Since 1976 the Shetland Oil Terminal Environmental Advisory Group (SOTEAG) has conducted annual monitoring of selected seabird species, co-ordinated by MH. Most of the information on the NNR is contained in unpublished reports to the NCC and SOTEAG so this paper has been prepared to summarise all information on the breeding birds up to and including the 1991 breeding season.

Methods

As different census methods have been used over the years, details of count units are

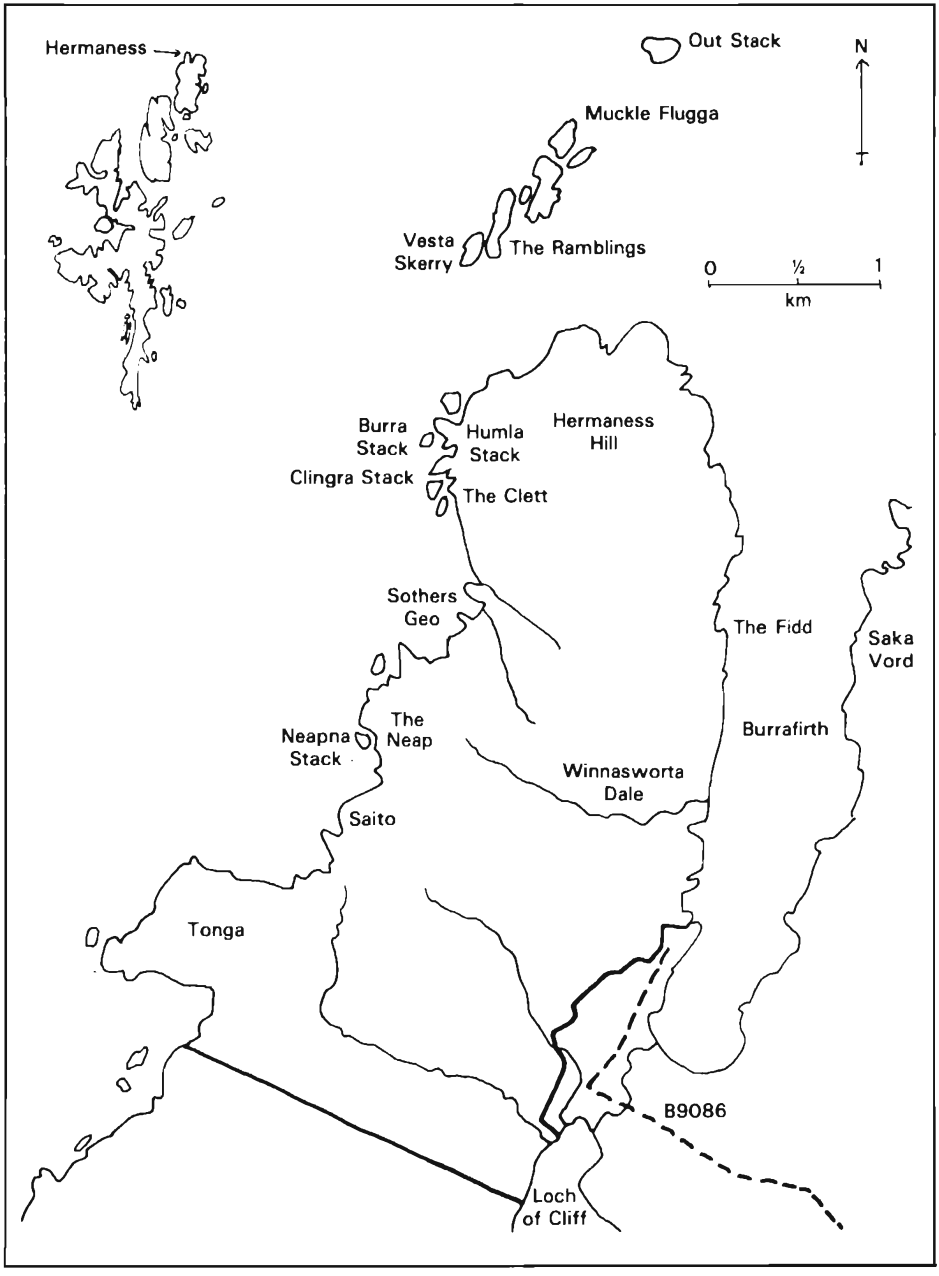

FIGURE 1. Map of Hermaness National Nature Reserve showing locations mentioned in the text.

given in the species accounts, with relevant information on census methods. Counts for 'Operation Seafarer' in 1969 quoted 'pairs' in Cramp *et al.* (1974), but the original count units are used here wherever possible. In many cases reference has been made to original reports so some figures vary from already published sources. Most recent surveys have used either the Apparently Occupied Nest (AON), the Apparently Occupied Site (AOS), or the Apparently Occupied Territory (AOT) as their units, although sometimes the number of individuals was the only unit that could be used.

Nearly all counts have been land-based, although some cliff-faces are visible only from the sea: only Gannet *Sula bassana* and Kittiwake *Rissa tridactyla* have been censused from the sea, and no complete survey of the Muckle Flugga skerries has been attempted.

Breeding success of some seabirds has been monitored in selected study plots since 1988 or 1989. Monitoring of Kittiwake is carried out using photographs so that all nesting attempts are known (Harris 1987), with similar techniques used for Fulmar *Fulmaris glacialis*, and also Gannet from 1991. For other species the number of breeding attempts are estimated by taking a series of June counts followed by counts of the number of large chicks likely to fledge taken later in the season. Breeding productivity was calculated as being the mean number of chicks fledged per pair attempting to breed in the sample areas, except for Fulmar for which the mean number of occupied sites in June was used as an estimate of the number of pairs.

Comments on breeding species

Red-throated Diver *Gavia stellata*. The RSPB watchers recorded just one or two pairs in the 1920s and 1930s. Between 1958 and 1974 there were 5-7 pairs present. Since 1976 monitoring, largely carried out by J.D. Okill for SOTEAG, has revealed 7-12 nesting pairs, with 7 in 1990 and 8 in 1991. 14 sites have been used, two of which are no longer suitable due to silting or disturbance. Breeding productivity has been relatively poor since 1988 (Table 1), compared with figures of 1.00 chicks per pair in 1986 and 1.09 chicks per pair in 1987 from the 11 pairs present in those two years (J.D. Okill pers. comm.).

Fulmar. Prospecting commenced in 1894, with breeding confirmed in 1897 when there were already 57 occupied sites (Fisher 1952). The breeding population was estimated to have reached 1000 pairs by 1939, 1500 by 1944 and 2000 by 1949 (Fisher 1952). Recent counts, all excluding the Muckle Flugga skerries, are of 5880 sites in 1965 (Dott 1967), 8491 in 1969, 9669 in 1974 (Albon *et al.* 1976, Harris 1976) and 14,582 AOS in 1986. Occasional breeding attempts are made even on Out Stack, where there was an AOS in 1989 and 1990. Monitored productivity is fairly low (Table 1), and although comparable with figures elsewhere in Shetland for the past three years, productivity has declined in Shetland recently (Heubeck 1989, Walsh *et al.* 1990, 1991).

Manx Shearwater *Puffinus puffinus*. Large numbers bred on Unst last century, especially around Burrafirth, but breeding ceased sometime in the first half of this century (Saxby 1874, Venables & Venables 1955). A bird was heard calling in flight at Sothers in 1974.

Storm Petrel *Hydrobates pelagicus*. A colony present in the 1950s presumably still exists on Muckle Flugga, although this colony is not listed by Lloyd *et al.* (1991). A stranded bird was found ashore in daylight in 1987 and a dead bird found in 1991. (A. Sinclair pers. comm.). Breeding was also confirmed between the Neap and Tonga in 1938/39 and was suspected for some time afterwards (N. Gordon unpubl.), but extensive searches of the mainland coast have failed to provide any proof of recent

TABLE 1. Productivity (chicks reared per pair) of certain species of seabird in monitored plots on Hermaness, 1988-91. Sample sizes given in brackets; * = all known nesting attempts; + = mean figure calculated from two plots.

	1988		1989		1990		1991	
* Red-throated Diver	0.56	(9)	0.88	(8)	0.71	(7)	0.88	(8)
+ Fulmar	—		0.36	(277)	0.37	(276)	0.32	(311)
Gannet	—		0.81	(357)	0.65	(372)	0.75	(457)
Shag	—		0.29	(42)	0.51	(68)	1.02	(83)
* Arctic Skua	0.03	(33)	0.07	(28)	0.42	(24)	(0.50	(28)
Great Skua	—		1.03	(66)	0.69	(39)	1.14	(44)
+ Kittiwake	—		0.45	(181)	0.48	(179)	1.06	(164)

breeding. However, remains have been found recently in Great Skua pellets and non-breeding birds have been attracted to tape-lures.

Gannet. Recorded ashore on the Muckle Flugga skerries in the 1860s (Saxby 1874), but breeding was not confirmed until 1917 when there were a few pairs on Vesta Skerry (Fisher *et al.* 1939). The colony spread to Burra Stack in 1920, Humla Stack soon afterwards, Neapna Stack in 1928 and the Neap in 1930 (Fisher *et al.* 1939, RSPB watchers' reports). Since then Saito, Clingra Stack and the Rumblings have been colonised. Early counts of the colony include 2045 pairs in 1938 (Fisher *et al.* 1939), 2611 pairs in 1939 and an estimated 3150 pairs in 1949 (Venables & Venables 1955). As parts of the colony can only be viewed from the sea land-based counts of 3450 nests in 1965 (Dott 1967), and 5225 nests in 1974 (Albon *et al.* 1976, Harris 1976) are incomplete. 'Operation Seafarer' included an aerial survey of 5894 pairs in 1969 (Cramp *et al.* 1974). Confusion over count criteria led to a wide range of counts by SOTEAG between 1977-84, but Hermaness has always been a difficult colony to count, partly due to the high proportion of non-breeders, not all of which are segregated into clubs (Murray & Wanless 1986). In 1986 a revised census produced a total of 9904 AON, with any site containing nest material included as an AON (Wanless 1986). Of the non-breeding population of 6820 birds, only about half were in discrete clubs. Full details of a repeat census in 1991 are not available at the time of writing but there was no evidence of any significant change in the breeding population. (S. Murray pers. comm.). Productivity has been good but rather variable in 1989-91 (Table 1), possibly due to variation in technique, which was standardised in 1991.

Cormorant *Phalacrocorax carbo.* Saxby (1874) recorded a colony on Muckle Flugga last century but there are no other records.

Shag *Phalacrocorax aristotelis.* This species nests principally on boulder beaches on Hermaness, making assessment of the breeding population difficult. Only numbers of individual birds can be censused although in a sample in 1974 more nests were counted than birds with a ratio of between 1.5 – 2:1 (Albon *et al.* 1976), while in 1990 68 active nests were found south of Tonga where only 35 birds could be observed. The following counts all exclude the Muckle Flugga skerries – 315 birds in 1965 (Dott 1967), 887 'pairs' in 1969, 937 birds in 1974 (Albon *et al.* 1976), 1170 birds in 1978 (late count), 962 birds in 1986 and 268 in 1989. This recent decline in birds attending the colony

is reflected in late June counts of active nests with eggs or young in the boulder beaches between Humla Stack and the Clett: 199 nests in 1974 declined to 151 in 1986, 93 in 1987, 73 in 1988 and 42 in 1989, but increased to 68 in 1990 and 83 in 1991. It is suspected that in recent years many birds are not attempting to breed, a common response to poor feeding conditions by this species (Lloyd *et al.* 1991). Breeding success in 1988-90 was very poor although no accurate figure is available for 1988 (Table 1). There was a welcome increase in productivity in 1991 to a level more comparable with recent figures from two other Shetland sites (Heubeck 1989, Walsh *et al.* 1990, 1991).

Wigeon *Anas penelope.* Saxby (1874) records a nest last century but this is the only breeding record.

Red-breasted Merganser *Mergus serrator.* The RSPB watcher reported 2 broods in 1918, the only confirmation of breeding.

Eider *Somateria mollissima.* Breeds regularly but 19 nests found in 1974 is the only indication of numbers. The RSPB watchers' reports suggest the species was commoner in the 1920s.

White-tailed Eagle *Haliaeetus albicilla.* Bred formerly but became extinct sometime before 1859 (Saxby 1874), probably because the eyrie on Saito was robbed almost annually in the 1840s (R. Matthewson in *New Shetlander* 137 (1981).

Merlin *Falco columbarius.* Single pairs have bred twice, in 1957 and 1981.

Peregrine *Falco peregrinus.* Single pairs have bred, either at Tonga or the Neap, regularly prior to 1933 and occasionally during 1951-76.

Oystercatcher *Haemotopus ostralegus.* Breeds regularly but the only censuses are of 18 AOTs in 1989 and 16 in 1990.

Ringed Plover *Charadrius hiaticula.* The RSPB watchers recorded breeding fairly regularly in the 1920s and 1930s but the only recent attempts were beside Loch of Cliff in 1981 and 1989.

Golden Plover *Pluvialis apricaria.* Breeds regularly with counts of 5 pairs in 1974, between 5-8 AOTs during 1985-90, and 11 AOTs in 1991.

Dunlin *Calidris alpina.* The RSPB watchers' reports suggest that breeding did not take place in the 1930s but the species now breeds regularly with 23 pairs in 1974 and a maximum of 31 AOTs during 1985-89.

Woodcock *Scolopax rusticola.* Saxby (1874) was shown a nest and saw the incubating bird last century, this being one of only two Shetland breeding records (Berry & Johnston 1980).

Snipe *Gallinago gallinago.* Breeds regularly with 45 AOTs censused in 1989, although this may be an underestimate.

Whimbrel *Numenius phaeopus.* First recorded breeding last century (Evans & Buckley 1899) with sporadic breeding since. Breeding records were most frequent in the 1950s and 1960s (N. Gordon unpubl.) while the most recent but unsuccessful attempts were by 2 pairs in 1987.

Curlew *Numenius arquata.* Bred regularly and in increasing numbers in the 1920s and 1930s according to the RSPB watchers, but only sporadically since the 1950s. Recently there have been single pairs in 1987, 1988 and 1990 and 4 AOTs in 1989, but none bred in 1985, 1986 or in 1991 when the only occupied territory was abandoned early in the season.

Common Sandpiper *Actitis hypoleucos.* The only known breeding attempts were in 1979 and 1982.

Red-necked Phalarope *Phalaropus lobatus.* Breeding was suspected during the 1920s and 1930s and was confirmed by the RSPB watcher in 1935 and 1937. There are no recent breeding records.

Arctic Skua *Stercorarius parasiticus.* Raeburn (1888) recorded 30 pairs in 1885 and 60-100 pairs in 1887, attributing the increase to the easing of persecution from collectors. In 1922 there were 200-300 pairs (Pitt 1922) with the RSPB watchers recording similar numbers in the 1930s. However, by 1958 there were only 50-75 pairs (Eggeling 1958) while in 1970 57 nests were located (L. Johnston unpubl.) and 54 nests were found in 1974 (Albon *et al.* 1976). Breeding last took place on the former stronghold of Hermaness Hill in 1986 and now most territories are on the periphery of the reserve. Recent counts were of 31 AOTs (23 nests) in 1987, 33 AOTs (26 nests) in 1988, 28 AOTs in 1989, 24 AOTs (19 nests) in 1990 and 28 AOTs in 1991. Since 1988 at least productivity has been low (Table 1), with figures much lower than those given by Furness (1987). However, similar figures have been obtained elsewhere in Shetland recently, presumably due to the breeding failure of other seabirds from which Arctic Skuas kleptroparasitise most of their food (Heubeck 1989, Walsh *et al.* 1990, 1991). On Hermaness predation of chicks by Great Skuas is also an important source of mortality (pers. obs.).

Great Skua. In 1774 Low (1879) recorded this species from the adjoining hill of Saxa Vord, but as he did not visit Hermaness Hill the first record for the site was not until 1831 when the 3 pairs were the only ones in Britain outside Foula (Evans & Buckley 1899). Under protection the population rose to 50-60 pairs in 1850, but by 1871 pressure from collectors had reduced the total to less than 5 pairs (Saxby 1874). For the next 20 years never more than 12 pairs nested (Evans & Buckley 1899), until the employment of a keeper on the hill in 1891 (Clarke 1892) lead to an almost immediate change in fortune. There were 16 pairs in 1897 (Evans & Buckley 1899), 42 pairs by 1907 (Cramp *et al.* 1974) and in 1922 "the watcher counted over eighty nests after which he lost count" (Pitt 1922). By 1949, Venables & Venables (1955) estimated the total Unst population at 350-400 pairs. In 1958, 340 pairs on Hermaness were estimated from nest searches (Eggeling 1958) and using similar techniques in 1965 Dott (1967) gave a figure of 286 pairs and 24 'non-breeding pairs' which was presumably used in the 'Operation Seafarer' estimate of 300 pairs (Cramp *et al.* 1974). In 1974 a team of eight walked the entire reserve in 5m transects, then used correction factors to allow for missed nests or broods to derive a figure of 786 pairs from 739 nests located (Albon *et al.* 1976). A similar survey in 1985 using wider transects produced a total of 616 pairs, very probably an undercount, but used by Ewins *et al.* (1988) in calculating the Shetland population. In 1989 a survey using techniques recommended by Furness (1982) located 896 AOTs. In view of this the Shetland population can probably be upgraded by 280 from the 5647 AOTs given by Ewins *et al.* (1988). The non-breeding population in four club sites on the reserve has peaked at between 185-190 birds in 1989-1990. Occasional breeding failures on Foula and Noss (Walsh *et al.* 1990, 1991) were followed by reduced productivity on Hermaness in 1990, although productivity was high in 1989 and 1991 (Table 1). In recent years some dead chicks have been found, presumed predated by other Great Skuas while left unattended by their parents.

Common Gull *Larus canus.* The RSPB watchers recorded a declining population in the 1920s which was extinct by 1936. The only recent breeding records were of single pairs in 1987 and 1988 and 2 pairs in 1990.

Lesser Black-backed Gull *Larus fuscus.* Recorded as common by the RSPB watchers and N. Gordon (unpubl.) up until the 1950s but none were recorded in 1965, 1969 or 1974 (Dott 1967, Harris 1976). The only recent breeding record is of one AOT in 1986.

Herring Gull *Larus argentatus.* The only complete counts are of 45 pairs in 1969, 52

pairs in 1974 (Harris 1976) and 42 AOTs in 1989, the latter count including one AOT on the Muckle Flugga skerries.

Great Black-backed Gull *Larus marinus.* The only complete counts are of 6 pairs in 1969, 15 pairs in 1974 (Harris 1976) and 20 AOTs in 1989, including 5 on the Muckle Flugga skerries, one of which was on Out Stack where a nest has been recorded in the past (Rankin 1947). 2 pairs were present on Out Stack in 1991 (J.D. Okill pers. comm.).

Kittiwake. From the accounts of the flocks flying to the Loch of Cliff to bathe (Saxby 1874) the Hermaness colony must have been very large in the past. However, recent counts indicate a continuing decline. Land-based counts, excluding the Muckle Flugga skerries, produced totals of 3303 nests in 1965 (Dott 1967), 4831 nests in 1969, 3888 nests in 1974 (Harris 1976), 2105 AONs in 1985, 1243 AONs in 1989 and 1135 AONs in 1990. Counts from the sea, including the Flugga and other colonies not visible from the land are of 3872 AONs in 1981 (Richardson 1985), 3497 AONs in 1987 and 2280 AONs in 1991. The population therefore declined by over 40% between 1981 and 1991, with the decline being particularly marked around Saito and the Neap where many colonies have been abandoned. There is evidence that some birds have moved to colonies elsewhere on Unst. A good breeding season in 1991 followed much poorer breeding success in 1989 and 1990 (Table 1), though still higher than productivity recorded at most other Shetland colonies in those years (Heubeck 1989, Walsh *et al.* 1990, 1991). However, the decline in the breeding population at Hermaness began before recent declines noted elsewhere in Shetland (Heubeck *et al.* 1986, Heubeck 1989). The reason for this decline on Hermaness is unclear, but predation by Great Skuas at the colony has been noticeably high for at least 40 years (Lockie 1952, Andersson 1976, Heubeck *et al.* 1987, pers. obs.).

Common Tern *Sterna hirundo.* A sporadic breeder amongst Arctic Terns *Sterna paradisea* at the Fidd, first recorded in 1974 with the highest count of 54 pairs in 1980 (Bullock & Gomersall 1981). No Arctic Terns were recorded in 1980 although it is very likely that some were present. The most recent breeding records are of 4 pairs possibly rearing one chick in 1988, and at least 7 pairs rearing 6 chicks in 1991, including 4 pairs at a new colony at Fiska Wick.

Arctic Tern. The RSPB watchers recorded breeding in the 1920s and 1930s. A few pairs have bred in most recent years at the Fidd, the highest count (apart from the count in 1980 noted above) being 18 pairs in 1974 (Harris 1976). Birds had not bred successfully for many years until 1991 when 12 pairs reared 9 chicks in two colonies. The record of a large colony between the Neap and Tonga in 'Operation Seafarer' data in 1969 would appear to be erroneous.

Guillemot *Uria aalge.* All counts have been land-based although an estimated 30% of birds are not visible from land, including those on the Muckle Flugga skerries. The earliest available counts indicate an increase in the population from 8730 individuals in 1965 (Dott 1967) to 15,983 in 1969, 18,228 in 1974 (Albon *et al.* 1976, Harris 1976) and 22,760 in 1978 (a late census which was probably an underestimate). Recent counts have been of 14,374 individuals in 1987, 15,074 in 1988, 15,948 in 1989, 12,779 in 1990 and 17,158 in 1991. Annual monitoring of six sample plots since 1976 has revealed a similar pattern (Fig. 2). The 1990 count was just 43% of the maximum in 1977, but it is likely that the very low counts in 1989 and 1990 were due to lower colony attendance rather than being due to a decrease in the breeding population. In 1991 colony attendance increased, but there still appears to be an underlying trend for a decrease in the breeding population. Population changes on Hermaness mirror those at other Shetland colonies, with an

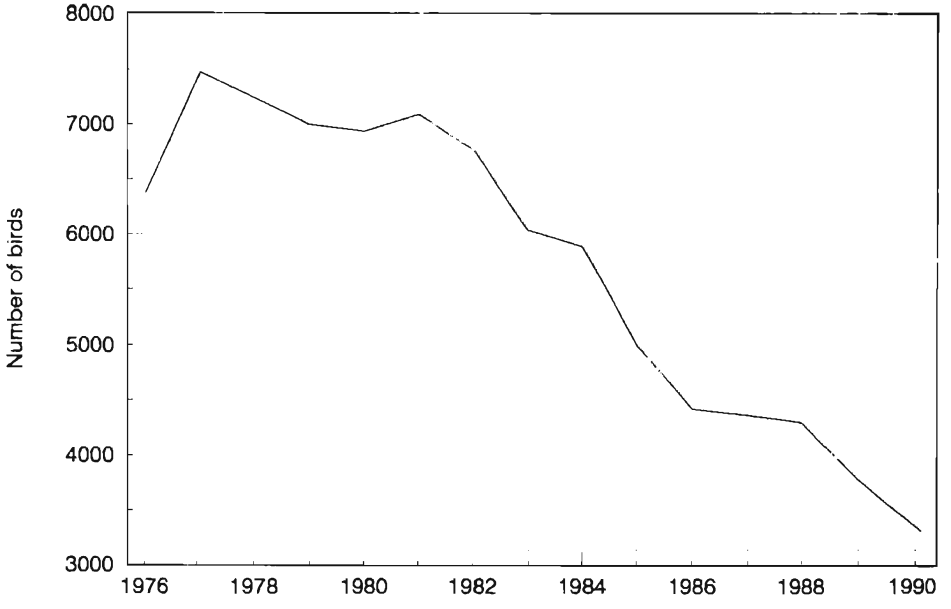

FIGURE 2. Mean annual counts of Guillemots at monitored plots on Hermaness.

increase followed by a decline since the early 1980s, believed to be caused largely by increased winter mortality (Heubeck *et al.* 1991). Productivity on Hermaness has not been assessed accurately. It was believed to be lower than normal in 1989 and 1990 but improved in 1991.

Razorbill *Alca torda.* Most nest in boulder beaches making an accurate assessment of the breeding population difficult. Comparison between the following June counts is probably not very reliable, but a recent decline is suggested by totals of 780 individuals in 1965 (Dott 1967), 2060 in 1969, 1100 in 1974 (Harris 1976), a late count of 1844 in 1978, 942 in 1986, 787 in 1989, 471 in 1990 and 622 in 1991. Two recent pre-breeding counts of most of the coastline in May revealed 1488 individuals in 1989 and 1127 in 1990. Accurate breeding productivity figures are not available but near complete breeding failure was suspected in 1989 and 1990 (Pennington *et al.* 1990, pers. obs.). In 1991, however, biometrics of chicks indicated a greatly improved breeding season.

Black Guillemot *Cepphus grylle.* Only small numbers breed, mostly along the Burrafirth shore, with June or July counts of 15 birds in 1965 (Dott 1967), 20 in 1969, 14 in 1974 (Harris 1976), 35 in 1978 and 26 in 1986. A pre-breeding census in 1983 gave a total of 22 birds (Ewins & Tasker 1985).

Puffin *Fratercula arctica.* Most burrows are on steep slopes or in scree where the usual quadrat sampling method is impossible so no accurate population estimate of the colony exists. In 1987 counts of birds present in the evening were made and a correction factor derived from the ratio of adults to burrows in a control area. However, abnormal behaviour due to breeding failure affected the results so that the figure of *c.*25,000 pairs probably reflects the number of breeding attempts surviving

to the census date. The actual breeding population is estimated to be up to 50,000 pairs, with Harris (1976) regarding the population of Hermaness and Saxa Vord combined as being of a similar order to that of St Kilda. There are no indications of any recent change in the size of the population through monitoring of burrows in a permanent transect at Sothers Geo since 1974 (Harris 1984, Lloyd *et al.* 1991). However, the account of Saxby (1874) suggests that the colony was much smaller last century. Reduced breeding success has been suspected since 1986 with few adults seen carrying food in July, mean food load weight *c.*30% of the 1974 level (Martin 1989) and large numbers of dead chicks seen in 1988 and 1989. In 1989 productivity was estimated to be 0.04 chicks per occupied burrow from a sample of 158 nests (J. McKee pers. comm.). However, 1990 was the best breeding season since at least 1985, with over 50% of a small sample of chicks fledging, although losses of eggs and small chicks were not assessed, and 1991 was considered an even better breeding season (P.M. Ellis pers. comm.).

Rock Dove *Columba livia.* Breeds regularly in small numbers, but there are no census figures.

Skylark *Alauda arvensis.* An abundant breeding species but never censused.

Pied Wagtail *Motacilla alba.* A pair bred beside Loch of Cliff in 1986.

Grey Wagtail *Motacilla cinerea.* A pair bred in Winnasworta Dale in 1990: there are no breeding records for Shetland outside Fair Isle prior to 1990 (Shetland Bird Report 1990).

Meadow Pipit *Anthus pratensis.* Breeds regularly but the only census is of 28 AOTs in 1989.

Rock Pipit *Anthus petrosus.* Breeds regularly but the only census is of 36 AOTs in 1989, including one pair on Muckle Flugga.

Wren *Troglodytes troglodytes.* Breeds regularly with 29 AOTs in 1989, excluding any on Muckle Flugga where there was a pair in 1988.

Wheatear *Oenanthe oenanthe.* Breeds regularly but the only census is of 49 AOTs in 1989.

Blackbird *Turdus merula.* First recorded breeding by the RSPB watcher in 1934. Has bred sporadically since, most recently 2 pairs on the cliff at Saito in 1980, and a probable breeding record on the north side of Tonga in 1991.

Raven *Corvus corax.* Breeds regularly with 2 pairs recorded in 1938 by the RSPB watcher, 3 AOTs in 1983 (Ewins *et al.* 1986), 4 AOTs in 1987-89 and 5 in 1990. These territories are all on the mainland but a pair bred on Muckle Flugga in 1957 (W. Eggeling unpubl.).

Hooded Crow *Corvus corone.* An irregular breeder with recent records of single pairs in 1986 and 1989-91, 3 pairs in 1987, but none in 1988.

Starling *Sturnus vulgaris.* Breeds regularly on the cliffs with a census of 23 AOS in 1989, although this is probably an underestimate.

Twite *Carduelis flavirostris.* Breeds regularly in small numbers but never censused as most pairs nest on sea-cliffs.

Two other species deserve mentioning. In 1970, 1972 and 1974-87 a Black-browed Albatross *Diomedea melanophris* summered with the Gannets on Saito, building a nest from 1975 onwards (Sutherland & Brooks 1979). After an almost three year absence, the bird reappeared in the springs of 1990 and 1991. In 1974 Redwing *Turdus iliacus* was erroneously listed as breeding on Hermaness (Shetland Bird Report 1974).

Discussion

The greatest ornithological significance of Hermaness lies in its seabird populations. Hermaness holds significant proportions of

TABLE 2. Populations of seabirds on Hermaness and their percentage of the Shetland and British Isles populations.

	Count & unit	Year	% of Shetland population	& of British % Irish pop.
Fulmar	14582 AOS	1986	6.2	2.6
Gannet	9904 AOT	1986	57.6	5.2
Shag	962 ind.	1986[1]	13.8[2]	2.0[2]
Arctic Skua	28 AOT	1991	1.2	0.7
Great Skua	896 AOT	1989	15.1[3]	11.0[3]
Herring Gull	42 AOT	1989	0.8	>0.1
GBB Gull	20 AOT	1989	0.6	>0.1
Kittiwake	2280 AON	1991	4.5	0.4
Arctic Tern	11 prs.	1991	>0.1	>0.1
Guillemot	17158 ind.	1991	10.6	1.5
Razorbill	787 ind.	1989[1]	5.6	0.4
Black Guillemot	22 ind.	1983[1]	0.2	>0.1
Puffin	50000 prs.	est.	*c*.40.0[4]	*c*.10.0[4]

Notes. Percentages calculated from figures in Lloyd *et al.* (1991). [1] most recent Hermaness census not used as counts since date given believed to be underestimates. [2] assuming each individual on Hermaness equivalent to one pair. [3] including revised Hermaness population. [4]assuming Hermaness population is as given.

the Shetland and of the British and Irish populations for a number of species (Table 2). However, despite the colony's obvious importance, relatively few accurate censuses have been carried out. On the mainland most species have only been censused from land although parts of the colony are invisible except from the sea. Offshore, the Muckle Flugga skerries have never been accurately censused except for Gannet and Kittiwake, although a significant number of Guillemots in particular are known to breed there.

Additional problems with censusing apply to particular species. Gannets on Hermaness are censused according to slightly different criteria compared to other British and Irish colonies because of the high proportion of immatures (Wanless 1986, Lloyd *et al.* 1991). Shags are poorly censused as counts of individuals on Hermaness consistently underestimate the number of nests, although for comparison with other areas the 1986 Hermaness census of individuals was divided by two by Lloyd *et al.* (1991) to estimate the number of pairs present. Nest searches of all boulder beaches carried out from the sea would be the only way of accurately censusing Shags on Hermaness. Razorbills also nest on boulder beaches on Hermaness and are therefore difficult to census, especially as colony attendance in this species is known to be very variable (Harris 1989). Few accurate censuses of Great Skuas have been carried out and the 1985 census, used in British population estimates by Batten *et al.* (1990) and Lloyd *et al.* (1991) is believed to be an underestimate. Using the 1989 Hermaness census the British population would be *c*.8200 pairs rather than the figure of 7900 usually quoted. Puffins are the least accurately censused of all the seabirds breeding on Hermaness, with the only

attempt at a census in 1987 believed to be an underestimate.

However, three species of seabird breeding on Hermaness are of particular importance (Table 2). The Gannet colony is the sixth largest in the British Isles and contains approximately 4% of the world population (Lloyd *et al.* 1991). The revised Great Skua population represents over 6% of the North Atlantic population and, because the Great Skua is geographically isolated from the South Atlantic populations of skuas, sometimes considered to be conspecific, this figure effectively represents the proportion of the world population (Furness 1987, Lloyd *et al.* 1991). The Puffin population, while it's exact size remains uncertain, is undoubtedly of significant size in British terms, although representing only a small proportion of the world population (Harris 1984, Lloyd *et al.* 1991).

Last century, however, Hermaness would have appeared a very different place, with apparently fewer Puffins, very few Great Skuas and no breeding Gannets or Fulmars. The colonisation by Fulmars was an early part of the species' spectacular spread (Fisher 1952); Gannets have increased over the same period with the ending of harvesting by remote human communities (Nelson 1978) while Great Skuas have increased largely due to protection (Furnesss 1987). The causes of any long-term changes in the Puffin population are unknown.

Many seabird populations have increased this century but in recent years many of Shetland's seabirds, including those on Hermaness, have suffered reduced breeding success, and in some cases decreases in breeding population or colony attendance (Heubeck 1989, Walsh *et al.* 1990, 1991, Lloyd *et al.* 1991). Although a number of factors are involved, including increased winter mortality of Guillemots and Razorbills (Underwood & Stowe 1984, Mead 1989, Heubeck *et al.* 1991), and predation by Great Skuas on Kittiwakes and Arctic Skuas, the most important factor would appear to be a reduced availability of food, especially sandeels *Ammodytes marinus* during the breeding season (Heubeck & Ellis 1986, Heubeck 1988 & 1989, Walsh *et al.* 1990). Dietary studies have shown that most seabirds on Hermaness were feeding their chicks largely on sandeels until at least the mid 1980s, but by 1990 most species have shown sometimes dramatic changes in diet (Martin 1989, pers. obs.). For those species monitored on Hermaness in 1989-91, only the productivity of Gannet could be considered high in all years. Productivity of Fulmar, Great Skua and Kittiwake was low, and that of Shag, Arctic Skua and Puffin very poor in at least one year of monitoring (Table 1). Productivity of Guillemot and Razorbill was not accurately assessed, but was obviously poor in 1989 and 1990.

The 1991 breeding season saw a welcome increase in breeding productivity for seabirds not only at Hermaness but throughout Shetland. This was undoubtedly due to a greater availability of sandeels, although the reasons for the increase in the sandeel stock are unclear. It is highly unlikely that the increase was due to the closure of the commercial sandeel fishery in Shetland in 1991, although the closure must still be regarded as the correct decision. A slight increase in the Shetland sandeel stock in 1991 was predicted by Scottish Office Agriculture and Fisheries Department scientists in December 1990, but it was also expected that this improvement would be short-lived as the incoming 1990 year class appeared poor. Although the increase in the 1991 sandeel stock exceeded expectations, this should only serve as a further indication of how little is known about the sandeel population. Until there are signs of both a sustained improvement in the sandeel stock and an increase in seabird productivity over a number of seasons it would be wise to remain cautious about the future for seabirds on Hermaness and elsewhere in Shetland.

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The breeding Gulls of Coll, Inner Hebrides 1969-70 to 1989-90

J.G. BLATCHFORD & J.R. WRIGHT

Different workers have estimated breeding gull populations for the island of Coll on several occasions over the past 20 years, and estimates often include Gunna, Soy Gunna, Soa, and sometimes the Eilean Mor group. While these populations are important their inclusion makes comparisons between different years difficult. By adopting a colony by colony approach and concentrating entirely on the mainland of Coll (including only minor islets which can be clearly observed from the shore) we feel we have been able to make valid comments on recent changes in the breeding populations of gulls. In particular we have been able to clarify the previously confusing records for the Lesser Black-backed Gull and Herring Gull populations. We find that Lesser Black-backed Gulls have increased by at least 300% over 20 years, while the Herring Gull population has increased much less. We go on to suggest a method which might allow the more accurate monitoring of future population trends for these two species in the Inner Hebrides.

Introduction

During May 26 – June 3 1989, and May 25-June 2 1990 a party of 4 staff and 8 students from St. Mary's Sixth Form College surveyed the mainland of the island of Coll. Unless it has been specifically indicated otherwise in the text the techniques of counting, numbers of observations, routes walked and overall effort were kept as similar as possible to those made by one of us during June 13-19 1969 and June 5-12 1970 (Blatchford, J.G. 1971). This enabled us to compare the figures from each survey directly. Counting methods were those recommended for Operation Seafarer 1969-70. Observation of incubating birds from a distance was followed by walking through colonies counting individual nests. Where large numbers or mixed colonies were involved, the number of adults flying overhead was also counted. (For instructions for Operation Seafarer 1969-70 see Lloyd, Tasker & Partridge: *The Status of Seabirds in Britain and Ireland*, Appendix IV: 307-316). During the course of this work, Broad & Cadbury published *Breeding seabirds of Coll and Tiree* (1989). Subsequently we have been able to obtain the records for Coll from the Seabird Colony Register (SCR) for the period 1969-1987 from the Nature Conservancy Council (NCC Seabird Colony Register data for 1969-87). This SCR data has allowed us to consider the gull populations colony by colony.

TABLE 1.

Gull population of Coll (in pairs)

Species	1969-70	1986-88	1989-90
Black headed Gull	—	28	12
Common Gull	12	19	29-31
Great Black-backed Gull	11 (19)	47 (186)	28-30
Lesser Black-backed Gull & Herring Gull together	286 (686)	908 (1234)	951

Notes:
(1) 1969-70 figures are from Blatchford (1971), adjusted for mainland only using SCR data. 1986-88 figures are from Broad & Cadbury (1989). 1989-90 figures are based on our own survey results – now lodged with the SCR.

(2) Figures are for mainland of Coll including only minor islets which can be clearly observed from the shore. Figures in brackets are estimates for Coll including Gunna, Soy Gunna, Soa and the Eilean Mor group (called "whole island" estimates in text.)

Comment on species

Black-headed Gull *Larus ridibundus.* Black Headed Gulls appear to be very mobile on the island. The colony of 20 pairs recorded at 'North Friesland – NM 186541' in 1987 (NCC 1969-87) was not there by 1990. It was reliably reported that it had moved by 1989 to 'Hyne – NM 204545'. In 1990 it had moved to 'West of Loch Ronard – NM 198556' and comprised 10 pairs. The 1989 site at Hyne had been taken over by a colony of 18 pairs of Common Gulls. In 1990 we found another two pairs on a small islet at NM 220625.

Common Gull *Larus canus.* Common Gulls would appear to move in a similar fashion. There has been no record of a Common Gull colony at 'Cnoc na h-Osnaiche – NM 195589' since 1969 (NCC 1969-87), although 7 pairs of Herring Gulls were reported to be there in 1989. As mentioned above, 18 pairs of Common Gulls seem to have taken over a colony of Black headed Gulls at Hyne.

Great Black-backed Gull *Larus marinus.* In our experience, Great Black-backed Gulls seem to be solitary nesters, preferring raised areas or isolated rocky hillocks. When we approached, they usually left the site early to reappear later from a different direction. Our figures, for nests actually found, are minimum numbers and we therefore consider that the 47 pairs estimated for 1987 (NCC 1969-87) is a more realistic figure than our 19-23.

Lesser Black-backed Gull ***Larus fuscus* & Herring Gull** ***Larus argentatus.***
Lesser Black-backed Gulls and Herring Gulls seem to have increased dramatically over the twenty years since 1969/70. There seems to be a remarkable agreement over the locations of most of their important breeding colonies (see Fig. 1a), and over the size of their joint breeding population of approaching 1000 in recent years. What is less well-known is the proportion of the two species within this population. We first became aware of this after our 1989 survey when we read in *Breeding Seabirds of Coll and Tiree* (Broad & Cadbury 1989) that the estimate for the mixed colony at 'Moorland at NM 252596' was 143 pairs of Herring Gulls and 23 pairs of Lesser Black-backed Gulls. Our own estimate had been almost exactly the reverse – 25 pairs of Herring Gulls and 150 pairs of Lesser Black-backed Gulls. On our return to the island in 1990 this colony was re-counted with great care. We diverged from our policy of maintaining counting effort at 1969-70 levels and our estimated went up to 25 pairs of Herring Gulls and 200-500 pairs of Lesser Black-backed Gulls. The increase probably reflects the extended period of observation in some part, but we also felt that the colony had actually expanded since the previous year. Alerted to the problems of counting in this remote and relatively difficult part of Coll

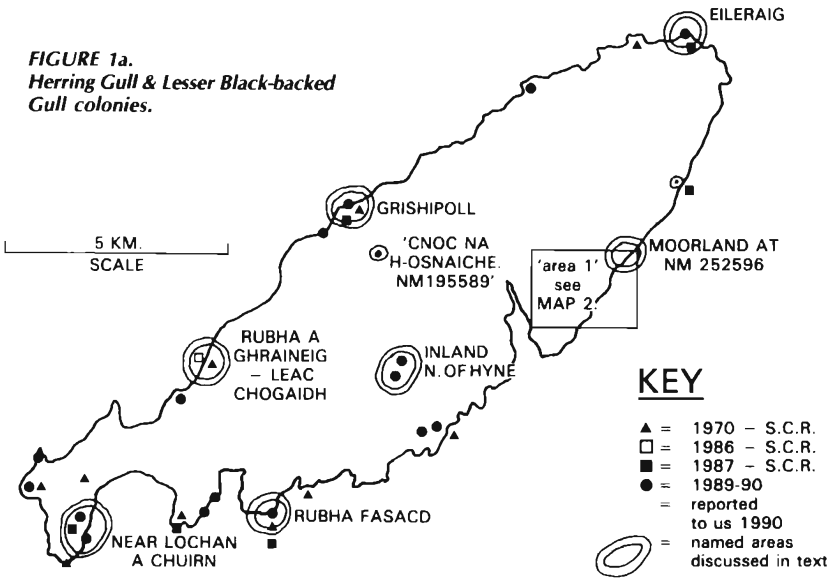

FIGURE 1a.
Herring Gull & Lesser Black-backed Gull colonies.

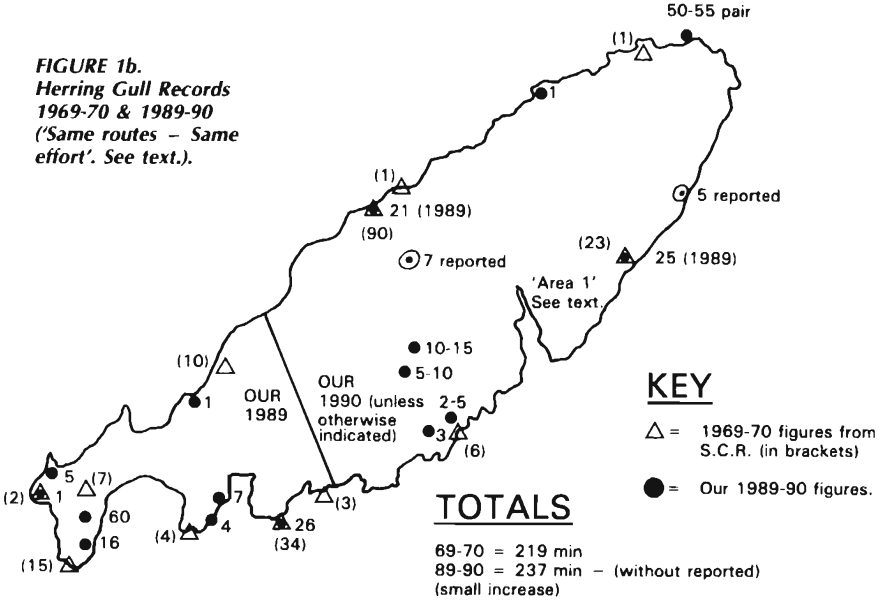

FIGURE 1b.
Herring Gull Records 1969-70 & 1989-90 ('Same routes – Same effort'. See text.).

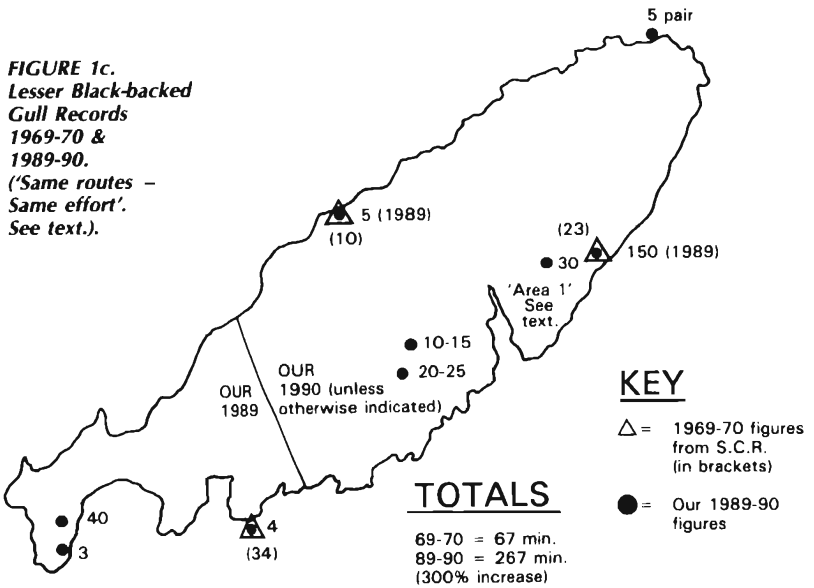

FIGURE 1c. Lesser Black-backed Gull Records 1969-70 & 1989-90. ('Same routes – Same effort'. See text.).

we searched the whole area extremely carefully and believe we have discovered new (or previously missed) colonies. It became increasingly difficult to match our colonies with those previously reported, and therefore to compare individual colony records with our own. In order to demonstrate the confusion that has arisen in this area our initial analysis considers the recent records for the moorland area north of Arinagour (Area 1 – see Fig. 2).

Our 1990 figures for the whole of area 1 were: 160-180 pairs of Herring Gulls and 357-447 pairs of Lesser Black-backed Gulls, compared with 1987 figures of 210-278 pairs of Herring Gulls and 29-52 pairs of Lesser Black-backed Gulls (NCC 1969-87) and 1986-88 figures of 225 pairs of Herring Gulls and 62 pairs of Lesser Black-backed Gulls (Broad & Cadbury 1989).

Details for colonies 1-5 shown on Fig. 2

COLONY 1

There is general agreement that this colony is longstanding and at NM 252596. It is even possible that this is the 'breeding colony of several hundred pairs – of Lesser Black-backed Gulls – on level moor north of Arinagour in June 1955' referred to by Morton Boyd (1958). As noted above our 1989 and 1990 estimates for this colony do not agree with previous records. We returned to this colony in 1990 specifically to check our identification and recording and remain convinced that Lesser Black-backed Gulls greatly outnumber Herring Gulls. We suggest that an error may have led to an inverstion of the figures quoted by Broad & Cadbury.

COLONY 2.

In 1989 we estimated 30 pairs of Lesser Black-backed Gulls while in 1990 the number had fallen to 15-20 pairs. There were no Herring Gulls present either year. Broad & Cadbury give 33 pairs of Herring Gulls and 4 pairs of Lesser Black-backed Gull for a colony 'East of Loch a'Chrotha' in 1986-88 (Broad & Cadbury 1989), although there is no similar record in the

Seabird Colony Register for 1987. We suggest a similar error occurred for this colony, and that the figures are best interpreted as a small mixed colony which is decreasing.

COLONY 3.

Our 1990 figures for this colony were 5 pairs of Herring Gulls and 35 pairs of Lesser Black-backed Gulls. Broad & Cadbury recorded 25 pairs of Herring Gulls and 5 pairs of Lesser Black-backed Gulls 'East of Loch Urbhaig' (1986-88), and the same figures are given for NM 238579 'Loch Urbhaig – Loch nan Geadh' in 1987 (NCC 1969-87). Once again we suggest that the figures have become inverted and that these figures represent a small mixed colony which has recently increased slightly.

COLONY 4.

This is a large mixed colony with an estimated 30 pairs of Herring Gulls and 100 pairs of Lesser Black-backed Gulls. Broad & Cadbury recorded 49 pairs of Herring Gulls and 10 pairs of Lesser Black-backed Gulls in square NM 2358 'Between Loch a' Chrotha and Loch nan Geadh'. It is not clear whether they refer to our colony 4. The SCR has no record of any colony in this square for 1987.

COLONY 5.

In 1990 we recorded 105-120 pairs of Herring Gulls and 42 pairs of Lesser Black-backed Gulls in this colony. In fact it is probably better considered as a small LBB colony adjacent to a larger HG colony. Neither Broad & Cadbury nor the SCR have

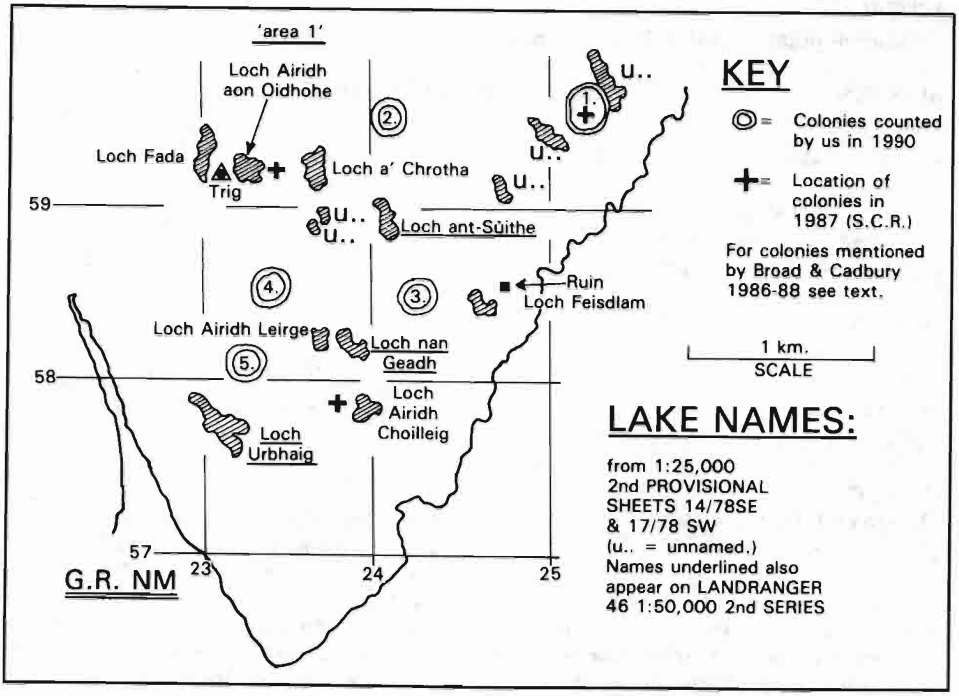

FIGURE. 2 Location of colonies of Herring Gulls and Lesser Black-backed Gulls reported in area 1 in recent years.

any record of a similar sized colony in this area. This is a significant colony that has, it seems, previously been missed.

Colonies previously recorded in this area but not so far discussed

The SCR has a record of 60-103 pairs of Herring Gulls and 2-5 pairs of Lesser Black-backed Gulls at NM 234592 'Loch a' Chrotha' for 1987. We did not find this colony, nor is it mentioned by Broad & Cadbury for 1986-88. The map reference would place this colony in plain view of the trig point and it is unlikely that we would have overlooked it in 1990. The SCR also has a record of 2 pairs of Herring Gulls at NM 243574 'Meal nan Muc'.

Records for other major colonies with several records

'Grishipoll point – NM 183596' (counted by us in 1989 and 1990)

SPECIES	1970 (1)	1987 (1)	1986-88 (2)	1989 (3)	1990 (3)
Herring Gull	90	125	125	21	53
Lesser B B Gull	10	15	15	5	6

(1) NCC 1969-87
(2) Broad & Cadbury 1989
(3) Our own survey results

'Rhubha Fasacd – NM 169523'

SPECIES	1970 (1)	1987 (1)	1986-88 (2)	1989 (3)
Herring Gull	34	26	23	26
Lesser B B Gull	34	5	5	4

(1) NCC 1969-87
(2) Broad & Cadbury 1989
(3) Our own survey results

Here, as with Grishipoll there is evidence for the long term trend of movement away from these 'traditional' sites. This might be due to increasing use of Coll by holidaymakers who visit these scenic areas.

Records for other significant sites

EILERAIG

On a small grassy island overlooked by cliffs, just off the coast near Eileraig, we estimated 50-55 pairs of Herring Gulls and 5 pairs of Lesser Black-backed Gulls. Broad & Cadbury have 40 pairs of Herring Gulls and 10 pairs of Lesser Black-backed Gulls for 1986-88, while the SCR has 42 pairs of Herring Gulls and 10 pairs of Lesser Black-backed Gulls for 1987.

NEAR LOCHAN A CHUIRN

To the east of Lochan a Chuirn there is a large mixed colony. In 1989 we estimated 60 pairs of Herring Gulls and 40 pairs of Lesser Black-backed Gulls at this site. Broad & Cadbury have 250 pairs of Herring Gulls and 30 pairs of Lesser Black-backed Gullts for 1986-88, while the SCR has 300-350 pairs of Herring Gulls and 30 pairs of Lesser Black-backed Gulls. Our estimates might very well be on the low side, but the figures still suggest a significant movement away from this site. Further south, on the coast near Port a Mhurain we recorded 16 pairs

of Herring Gulls and 3 pairs of Lesser Black-backed Gulls in 1989. Broad & Cadbury have 75 pairs of Herring Gulls at this site for 1986-88, while the SCR has no record for 1987. Again these results suggest a rapid decline in the colonies in the southern end of the island, maybe associated with increasing leisure use.

INLAND NORTH OF HYNE

North of the road, between the cairn and Loch Boidheach we found two small mixed colonies which together contained 15-25 pairs of Herring Gulls and 30-40 pairs of Lesser Black-backed Gulls in 1990. There are no other records for colonies in this area. It might well be that these are relatively new colonies. If birds are being displaced from the more accessible and scenic areas this sort of site might well increase in importance. It is interesting to note that these two 'new' colonies are quite close to the area to which the Black-headed Gull colony moved to 1990 (see above).

NM 158513 – 'RUBHA A GHRAINEIG – LEAC CHOGAIDH'

The SCR records 41 pairs of Herring Gulls and 1 pair of Lesser Black-backed Gulls from this site for 1986, and 10 pairs of Herring Gulls for 1970. There is no record for 1987, and the site is not mentioned by Broad & Cadbury for 1986-88. We found no colony at this site, although we walked this stretch of coast in 1989.

MINOR UNSPECIFIED SITES

In 1989-90 we recorded Herring Gulls from 10 other sites (see Fig. 1b). Together these small colonies or individual pairs accounted for an additional 36-39 pairs. In 1986-88 Broad & Cadbury give 42 pairs at sites not already discussed (e.g. Ben Feall) or at minor unspecified sites and the SCR only 3 pairs.

Population trends

Our original intention was to walk the same routes in 1989-90 as one of us (JB) had in 1969-70 during Operation Seafarer. During 1990 we spent considerable time and effort exploring the moorland north of Arinagour and also revisited Grishipoll Point (See above.) In our analysis we deliberately exclude these records since the larger estimates resulted from much greater 'effort'. We also discount two colonies of Herring Gulls reported to us but not visited by us – these colonies account for 12 pairs of Herring Gulls. The figures presented below therefore represent our best attempt at a direct comparison between the 1969-70 and 1989-90 survey results. In 1969-70 minimum figures were used, so our minimum estimates for 1989-90 are presented.

HERRING GULL

In 1969-70 there were 219 pairs and in 1989-90 237 pairs, a possible slight increase.

LESSER BLACK-BACKED GULL

In 1969-70 there were 67 pairs, in 1989-90 267 pairs. This increase of 300% represents a 15% per annum increase – very close to the 14.3% quoted for the Isle of May average between 1930 and 1972. (Thom 1986, p.214).

In 1969-70 Lesser Black-backed Gulls accounted for 23% of the total combined Coll population. It is interesting to note here that the 'Operation Seafarer' figures quoted for the whole of Argyll in 1969-70 give an almost identical ration of 24.7% (Thom 1986 pp. 213 and 215). Our figures show that by 1989-90 Lesser Black-backed Gulls account for 53% of the total combined Coll population.

The combined Herring Gull and Lesser Black-backed Gull population was 505 pairs. Using these figures to extrapolate from table 1 to a 'whole island' population, which includes Gunna, Soa etc. we get 1209 pairs. This is remarkably similar to Broad & Cadbury's 1234 pairs.

If we include our 1990 minimum estimates for the moorland north of

Arinagour, our 1990 estimates for Grishipoll point, and the two Herring Gull colonies reliably reported to us in 1990, our 'mainland only' estimates go up to 439 pairs of Herring Gulls and 512 pairs of Lesser Black-backed Gulls.

Note that these estimates still show Lesser Black-backed Gulls accounting for approximately 53% of the total combined population.

Leaving our 'same routes – same effort' approach and comparing these higher figures directly with 1969-70 estimates we calculate a 100% increase in Herring Gulls and 664% in Lesser Black-backed Gulls.

Future trends

Bearing in mind the problems mentioned above we suggest that for monitoring future trends three of the colonies on the "moorland north of Arinagour" (colonies 3, 4, and 5 on Fig.2) should be used. We suggest this because the relative remoteness and difficulty of the terrain gives it some immunity from human interference, and also because it is a small and discrete area that can reasonably be surveyed in one day by any interested persons who find themselves on Coll. These three colonies together have 140-155 pairs of Herring Gulls and 177 pairs of Lesser Black-backed Gulls – i.e. 53%-56% of the total combined population, a microcosm of the island – giving a total combined population of 317-332 (roughly one third of the total island popultion).

Conclusions

Black Headed Gull – maintain a small presence on the island, but the nesting sites are likely to change from year to year.
(12 pairs)

Common Gull – maintain a similar small presence with some movement.
(30 pairs)

Great Black-backed Gull – significant increase over 20 years.
(30-50 pairs)

Lesser Black-backed Gull – have increased by at least 300% (maybe as much as 700% over 20 years, but this phenomenon has previously been obscured.
(c.500 pairs)

Herring Gull – there has been a significant increase (maybe as much as 100%) over 20 years.
(c.450 pairs)

(Note – figures in brackets are our own estimates for current mainland populations).

Acknowledgements

We would like to thank John, Keith, John Fraser, Andy Knight and Dr. de Mornay for their help; the Nature Conservancy Council for allowing access to the Seabird Colony Register data; and St. Mary's Sixth Form College, the Tees and Hartlepool Port Authority, I.N.C.A., Chevron U.K. Ltd., and Ringtons' Tea for their sponsorship towards expedition expenses.

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(Revised manuscript received 29 June 1991)

Short Notes

Egg retrieval by Slavonian Grebe

During late June and early July 1990 I maintained almost daily observation of a pair of Slavonian Grebe *Podiceps auritus* incubating a clutch of 4 eggs at Loch Ruthven RSPB nature reserve, Inverness-shire. The Slavonian Grebe nest was a substantial structure built largely from leaves and stems of bottle sedge *Carex rostrata* and water horsetail *Equisetum fluviatile*. During heavy rain on 1 July the water level in the loch rose substantially causing at least one of the adults to work for many hours bringing in new nest material to build up the nest. Although grebe nests float, the buoyancy of nest material is insufficient to completely counteract the effects of large increases in water level. Despite the efforts of the birds the nest became less stable, the nest material was less compact and the rim of the nest cup was depressed. Also, the whole structure now tilted considerably as the adults moved on and off.

Despite the instability of the nest, the nest and clutch of eggs survived intact until 5 July when at 1547 hrs one of the eggs rolled down the side of the nest as the incubating adult shuffled around on the nest platform. The egg remained floating alongside the nest and at first the adult grebe did not react, but after a few minutes it stretched its head down to the egg and was able to roll it back into the nest. This was achieved quite easily by rolling the egg up against the side of the nest using the underside of the bill. Shortly afterwards, at 1550 hrs, the egg again rolled out of the nest and was soon retrieved in the same way. At 1625 hrs the off-duty Slavonian Grebe came towards the nest to relieve the incubating bird. However, as its partner moved off the nest, an egg was held within its breast feathers and fell into the water. The changeover was completed without attending to the floating egg and the situation remained unchanged when I left at 1800 hrs.

The following morning at 0900 hrs I discovered that all 4 eggs were back in the nest and remained so when I checked again that evening. I was not able to observe the nest again until the morning of 8 July by which time one of the eggs had hatched and the chick was being brooded. Three eggs remained in the nest. Two changeovers were observed that day without incident but during the third at 1728 hrs the incubating bird rolled an egg out of the nest as it slid off the nest. During subsequent observations neither adult showed any interest in the egg and it remained floating near the nest while the pair hatched a second chick and left the vicinity of the nest.

On 20 July, long after the family had left the nest site I broke the deserted eggs. The floating egg contained a fully developed embryo, while the remaining unhatched egg in the nest had no development.

That the floating egg was so near to hatching explains its high buoyancy. Clearly if such an event happened early during incubation the egg would have sunk and would have been lost. It is likely that in the first instance, egg loss was caused by the change in nest structure and increasing instability of the nest resulting from the rise in water levels. As the nest became less well bound and the nest cup flattened so the possibility of eggs rolling out was increased. The ability to retrieve eggs lost in this way must be a useful ability for a species nesting so close to the water surface whose nest structure is liable to become unstable.

M.J. Pollard, Royal Society for the Protection of Birds, Munlochy, Ross and Cromarty, IV8 8ND.

(Egg retrieval is a well known phenomenon in gulls and geese at least, and has been described eg by G P Baerends & R H Drent 1982. *Behaviour* 82, 1-416 and K Z Lorenz & N Tenberger 1939. *Tierpsychol.* 2: 1-29, but retrieval from water is unusual. Eds.)

Black-throated Diver attacking and killing Red-throated Diver

On 24 August 1990 I made the following observations on Black-throated Diver *Gavia arctica*, and Red-throated Diver *Gavia stellata* nesting on two lochs approx. 1 km apart. The loch on which the Black-throated Divers were nesting was approx. 1.5 × 0.75 km and the Red-throated Diver loch was 0.2 × 01 km. The Black-throated Divers had one fledged juvenile and the Red-throated Divers had two large young.

At approx. 1100 hrs an adult Red-throated Diver flew out from its breeding loch at a height of 30 m over the south west end of the Black-throated Diver loch. However, it circled back and made a near vertical stoop towards the south end of the Black-throated Diver loch. It then flew on without landing on the loch, gained height and circled back over the middle of the loch before again diving down onto the loch. When the diver was on the water surface a juvenile Peregrine *Falco peregrinus* was seen to make a number of dives at the Red-throated Diver, missing it narrowly each time as the Red-throated Diver ducked to avoid being hit. Although I had not seen the Peregrine earlier it is most likely to have brought about the stooping behaviour of the Red-throated Diver in its attempt to avoid capture, forcing it to land on the Black-throated Diver loch. A few minutes after its attack on the Red-throated Diver the Peregrine flew off and landed on the south shore of the loch.

During the Peregrine attack the Black-throated Diver pair were on the loch about 100 metres away – the juvenile was not on the loch at the time. Almost immediately after the Peregrine had flown off an adult Black-throated Diver swam towards the Red-throated Diver and proceeded to attack it. Initially the Black-throated Diver grabbed the Red-throated Diver by the neck and submerged its victim several times as well as beating it with its wings. During the next 20 minutes the Black-throated Diver made repeated stabbing actions with its bill – striking the Red-throated Diver on the head. The Red-throated Diver put up little apparent defence or signs of counter aggression against the attack. During two or three brief pauses in the attack the Red-throated Diver raised its head but the Black-throated Diver immediately resumed its assault.

After about 25 minutes the attacks became less frequent. The Red-throated Diver now showed few signs of movement apart from slight movements of its wings. As soon as the Red-throated Diver was dead and floating on its back the attacking Black-throated Diver swam away, joined the other Black-throated Diver and about two minutes later flew off to the west end of the loch where they were joined by the juvenile Black-throated Diver which flew onto the loch. Some time later the dead adult Red-throated Diver was washed up on the east shore of the loch. The crown of its head was bare of plumage and the exposed flesh red and bleeding from the attack – there were no other obvious signs of injury.

Cramp & Simmons 1979, BWP Vol I, discussed territorial aggression of Black-throated Diver and stated 'Fights are rare and similar to those of Red-throated Diver ie. with stabbing, wing beating, and spearing; occasionally a participant gets killed, whether from spearing or drowning (Sjölander 1968). There is no mention of such interactions between Black-throated Divers and Red-throated Divers. It is possible that encounters/aggressiveness between these species are more frequent than previously known, particularly where breeding pairs are in close proximity to each other.

Allan Mee, RSPB Highland Office, Munloch, Ross and Cromarty, IV8 8ND.

Hen Harrier stalking prey

Hen Harriers *Circus cyaneus* typically quarter low over open ground when hunting. They have also been recorded hunting on the ground, alighting and then waiting for prey to appear before grabbing it (*BWP* Vol. 2). R.C. Dickson once saw a female prowling in heather, apparently stalking young Meadow Pipits *Anthus pratensis* (Watson, D. 1977. *The Hen Harrier*. Poyser, Berkhamsted).

On 24 May 1990 while driving over a moor in Perthshire I saw an adult male Hen Harrier interacting with Red Grouse *Lagopus lagopus*. The Harrier was diving at a pair of grouse which I presumed had a brood of small young. It attacked in typical fashion about twenty times over a ten minute period, but was thwarted every time by the grouse which flew up at it. The female was particularly aggressive and made contact a few times. The Harrier then settled about 30 m from the grouse and, for the next few minutes, the pair of grouse occasionally popped their heads up from the deep heather. The Harrier then flew to a bare piece of ground about 10 m from the grouse and stalked along the edge of the deep heather with head well down so as to appear almost horizontal. When it got to within 2-3 m of the grouse they again flew at it. The Harrier stalked like this three times and then tried stalking at the other side of the deep heather but with the same result. Finally, it flew off out of sight and I left 5 minutes later when it had not returned. At that time the grouse had not moved from the safety of the deep heather.

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Aerial chases by Merlins in autumn and winter

Spectacular aerial chases by Merlins *Falco columbarius* in autumn and winter have not been well documented, apart from those performed at their communal roosts (e.g. see Dickson 1973; Sys 1982). Macintyre (1936) noted that when two adult Merlins meet while hunting they often 'play' together in the air for short periods but he gave no details. I have recorded aerial chases on 11 occasions between 1968-89, so they may be rather more common than previously published accounts suggest.

All these chases were in west Galloway; seven were in October, two in January and two in February. They were by males and 'brown' Merlins together on five occasions, by two brown Merlins on five and by three brown Merlins on one. Calls were heard on only three occasions but they may have occurred more often than this when the birds were out of earshot or were flying away. Most chases occurred near ground level but three of them took place at a height of over 40-50 metres, mainly over low ground such as farmland or low-lying moors and only once over upland stubble. On two occasions the birds touched talons during a chase, once this involved a male and brown bird and once two brown birds. A male was seen dropping his talons twice as he flew ahead of a brown Merlin in one chase. The birds were seen 'fluttering' together on two occasions, once a male and brown bird together and once two brown birds. The chases lasted at least 1-2 minutes and the longest was about one hour long (albeit including some rests on fence posts). On one occasion a male and brown bird broke off their aerial chase to harass a 'ringtail' Hen Harrier *Circus cyaneus* and on another a brown Merlin interrupted its aerial chase to attack a Woodpigeon *Columba palumbus*. During these chases the Merlins frequently landed on fence posts or

trees or bushes often beside or near each other.

The significance of these aerial chases is difficult to interpret but it is also difficult to obtain information on the relationships between birds in winter. At their winter roosts chases were thought to be important in forming, strengthening or maintaining pair bonds (Dickson 1973) but Sys, on the other hand, thought they were only playful in character. Cramp & Simmons (1980) state that display flights (in the breeding season) are rather inconspicuous and rarely observed, but 14 courtship displays have been recognised in the north American subspecies and these include aerial courtship (Johnsgard 1990) although apparently not spectacular aerial chases, but on a few occasions tail chasing by a female chasing her mate has been seen. If aerial chases occur almost entirely in non-breeding periods, there must be some advantage in them taking place then at a time when energy efficiency must be at a premium. While these chases in autumn and winter could be interpreted as exuberant or 'playful', I am inclined to think that they might have a more direct function.

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Correspondence

(The Editor welcomes correspondence on suitable topics in *Scottish Birds*. It is essential, however, that all letters are addressed to the Editor and that personal or libellous comments should be avoided. ***eds)***

The seabirds of Troup Head

The contribution by C.J. Lloyd & S.G. North on the seabirds of Troup Head (*Scottish Birds* 14: 199-204), and another by C.S. Lloyd & M.L. Tasker on those of north-east Scotland (*North-east Scotland Bird Report* 1986: 42-50), both overlook some previous references, the proper acknowledgement of "Operation Seafarer" data (about which I have already complained once in *Scottish Birds* 11: 129), and misinterpret the Guillemot records. Since A.J.M. Smith and I have also overlooked some earlier references to this site and failed to explain past counting methods in a previous review of north-east Scottish seabirds using some of the same data (*North-east Scotland Bird Report* 1977: 36-42), which was not mentioned either, it may be useful to enlarge upon them.

The remarkable seabird colony on Troup Head, which has now become the second British mainland Gannetry, first appears to have been described at length by the Rev. James Smith in 1850 (*Zoologist* 8: 2905-2914). He also subsequently encouraged the local cobbler-naturalist Thomas Edward of Banff to publish his original observations in many branches of natural history, including the birds of Banffshire, observations for northeast Scotland in the first national survey of British breeding birds, early beached bird surveys, and various observations on Troup Head, described in his biography by Samuel Smiles in 1876 (*Life of a Scotch Naturalist – Thomas Edward, Associate of the Linnaean Society*. Popular Edition, 1897, John Murray.).

Copies of the original instructions for the first national census of all British breeding seabirds, "Operation Seafarer" in 1969-70, were deposited with summaries of the results for public consultation, on condition that there is proper acknowledgement to the Seabird Group who organised the survey, with the RSPB, BTO, NCC (Britain), Irish Wildbird Conservancy (Ireland), Edward Grey Institute (Oxford), and Aberdeen University Library. While the unit counted was normally the "apparently occupied nest", since Guillemots construct no nest it was asked that they be counted individually, and the figures were then converted into pairs comparable with those recorded for other species by assuming that each bird represented a pair for reasons set out on p. 176-177 of the book reporting the results (Cramp, S., Bourne, W..P., & Saunders, D. 1974. *The Seabirds of Britain and Ireland.* Collins.).

Unfortunately, while in 1969-70 the Guillemots usually seem to have been recorded individually in the way requested, this is not often noted on the recording cards. In consequence it has apparently often been assumed that the birds were counted as pairs, so that the totals are not comparable with those obtained by subsequent counts of individuals. In fact the totals recorded during "Operation Seafarer" in 1969-70 appear closely comparable with those obtained by the current Seabird Colony Register, which has continued to ask for records of individual birds but has not always obtained them. I

checked the totals reported during Operation Seafarer for Troup Head among other sites from both the air and sea in the early 1970s myself, and there has certainly been an increase of Guillemots there since then.

W.R.P. Bourne, Department of Zoology, Aberdeen University

Inter Island flights by Sanderlings at North Ronaldsay

R W Summers, in his short note on 'Inter island flights by Sanderlings at dusk and dawn in Orkney' (*SB* 16(1): 46) asks 'why do so few (Sanderlings) occur on North Ronaldsay by day' and suggests 'the reason why Sanderlings leave North Ronaldsay by day may be due to lower food availability'. He cites daytime island counts of 11, 17 and 12 on 8, 9 and 10 May 1990 respectively.

Experience in 1986 suggests, however, that very large numbers of Sanderling fed by day on North Ronaldsay, and I was led to conclude that this may be a typical feature of spring migration there. In the second half of May 1986 counts for Sanderling on the island were:

19th	20th	21st	22nd	23rd	24th	25th	26th	27th	28th	29th	30th
43	52	25	575	300	80	7	500	175	325	680	400

My own observations in this period concentrated on 26-30 May, when the birds were certainly feeding on the island all day.

While it may be that there has been a change in behaviour between 1986 and 1990, there was certainly food available in 1986, and the birds did not leave, but exploited it.

Ron Youngman, 20 East Moulin Road, Pitlochry, Perthshire PH16 5HY

Research Index

The following is an index of fieldwork and research presently undertaken with specific Scottish interest. This Index will be updated yearly. The present list has been compiled alphabetically by the institutes where the research is based but several institutes circulated did not reply. If you are doing research in this area but not represented here, please put us right by sending details to the editor.

Aberdeen University:

Cosgrove, P. The importance of conservation zones for bird populations in upland spruce forest, concentration on broadleaf strip, unplanted stream edges, marshes etc, in otherwise unbroken conifer. Based at Kielder, Northumberland (PhD study).

Dunnet, G.M. The Fulmar on Eynhallow in Orkney (since 1950) concerned primarily with population dynamics, longevity and, recently, recruitment.

Dunnet, G.M. & Heubeck, Martin. Monitoring programme (since 1778) in breeding seabird populations in Shetland, as well as changes in seabird and waterfowl wintering populations in two areas – Yell Sound and Sullom Voe and the Bluemull/Colgrave Sounds area of north-east Shetland.

Gorman, Martyn L. & Reynolds, Peter. Feeding ecology of raptors (Short-eared Owl, Hen Harrier and Kestrel) in Orkney, particularly concerned with the effects of changes in land-use.

O'Hanrahan, B. Bird population density and diversity in relation to plant and insect diversity on agricultural set-aside fields, near Newburgh, Grampian (PhD study).

Patterson, I.J. & Fuchs, R.M.E. Management of grassland to provide reserves for wild geese; experiments with different mowing, grazing and fertiliser regimes at the RSPB reserve at the Loch of Strathbeg, Grampian.

Patterson, I.J. & Ollason, J.G. Bird population density and species diversity in upland spruce plantations, in relation to different management regimes especially changes in compartment size; based at Kielder, Northumberland and Cowal, Argyll.

Patterson, I.J. & Laing, R. Monitoring of wildfowl and wader numbers on the Ythan estuary, Grampian. Twice-monthly counts throughout the year, with special emphasis on the Eider Duck in the breeding season.

Rae, S. Habitat use by Ptarmigan, especially in the breeding season, in relation to vegetation type and productivity, cover and other environmental factors (PhD study).

Edinburgh University:

Carter, Adrian. Feeding behaviour and microhabitat distribution of waders on rocky shores, especially in East Lothian (PhD study).

Cresswell, Will. Behaviour and ecology of a predator-prey system: Sparrowhawks and Redshanks, concentrated on Tynninghame, East Lothian (PhD study).

Deag, John. Studies on communication and social organization in tits, with field work mainly at Ormiston, East Lothian.

Hanna, Laurel. Barn Owl population genetics (PhD study).

McAfferty, Dominic. Ecological energetics of Barn Owl (PhD study).

McGrady, Mike. Ecology of urban Sparrowhawks (PhD study, recently completed).

Scott, Graham. Social behaviour and communication in Blue Tits (PhD study).

Taylor, Iain. Long-term study (started 1978) of Barn Owl ecology and conservation. Has been monitoring, since 1980, changes in Lapwing breeding density in relation to agriculture.

Wilson, Jeremy. Population biology of Dippers on the Midlothian South Esk. Social organization and communication in Great Tits (PhD study 1986-1989).

St Andrews University

Adhikerana, A.S. Singing behaviour in Coal Tits (PhD study).

Graves, J.A. & Ortega-Ruano, J. Mating and reproductive success in Shags on the Isle of May.

Halley, D. A study of recruitment in Guillemots on the Isle of May (PhD study).

Mann, N.I. & Cobb, J.L.S. Song and breeding in Willow Warblers.

Slater, P.J.B. Field and laboratory studies on the development and organisation of bird vocalisations.

Williams, J.M. Habitat matching and cultural changes in Chaffinch song (PhD study, now completed).

Stirling University:

Alves, Marie-Alice. Behavioural ecology of Sand Martins (PhD study).

Bell, Mike. Wildfowl counts. Breeding wader surveys. Raptor monitoring.

Bryant, David. Energy requirements of wild birds. Populations and ecology of estuarine birds (especially Forth). Hirundine and Dipper breeding ecology.

Johnstone, Ian. Territorial behaviour in Robins and Dippers (PhD study).

Newton, Anne. Breeding ecology and survival rates of Dippers and Swallows.

Newton, Steve. Wildfowl ecology and populations. Dipper population ecology. Peregrine monitoring.

Ward, Sally. Egg laying and incubation behaviour in Swallows and Dippers (PhD study).

Wernham, Christine. Breeding ecology of Puffins (with ITE Banchory – PhD study).

Items of Scottish Interest

Recently published papers and reports on birds in Scotland. Most are available in the Waterston Library for reference. Those marked with an asterisk are available from the SOC at the prices quoted, but please add 50p for postage and packing regardless of the number of items ordered.

The librarian is glad to receive reprints or copies of papers on any aspect of ornithology or general natural history.

Scientific papers

Baber, I. 1990. Breeding success of seabirds on Handa Island, Sutherland in 1990. *Nature Conservancy Council CSD Report no. 1136.* 10 pp.

Banks, K.W., Clark, H., Mackay, I.A.R., Mackay, S.G. & Sellars, R.M. 1991. Origins, population structure and movements of Snow Buntings wintering in Highland Region, Scotland. *Bird Study* 38: 10-19.

Calladine, J., Dougill, S., Harding, N. & Stroud, D.A. 1990. Moorland birds on the Campsie Fells, Touch Hills and West Ochil Hills, Stirling: Habitats, distribution and numbers. *Forth Nat. & Hist.* 13: 53-69.

Crossley, J. (1991). Monitoring of breeding success of cliff-nesting seabirds in Orkney in 1990. *Nature Conservancy Council CSD Report no. 1163.* 12 pp and maps.

Cunningham, P., Stroud, D.A. & Fox, A.D. 1990. Greenland White-fronted Geese in the Outer Hebrides. *Hebridean Naturalist* 10: 64-68.

Dott, H.E.M. 1991. Unusual concealment behaviour by Coot. *British Birds* 84: 107. An occurrence in Lothian.

Dunn, P.J. & Hirschfeld, E. 1991. Long-tailed Skuas in Britain and Ireland in autumn 1988. *British Birds* 84: 121-136.

Elliott, G.D. & Avery, M.I. 1991. A review of reports of Buzzard persecution 1975-1989. *Bird Study* 38: 52-65.

Evans, I.M., Pienkowski, M.W. & Dennis, R.H. 1991. Experimental re-introduction of Red Kites. *Nature Conservancy Council CSD Report 1224,* 50 pp.

Feltham, M.J. 1990. The diet of Red-breasted Mergansers during the smolt run in north-east Scotland: the importance of salmon smolts and parr. *J. Zool. (Lond.)* 222: 285-292.

Fox, A.D. 1991. History of the Pochard breeding in Britain. *British Birds* 84: 83-98. Includes a useful survey of occurrences in Scotland.

Fox, A.D., Stroud, D.A. & Francis, I.S. 1990. Up-rooted Common Cotton-grass *Eriophorum angustifolium* as evidence of goose feeding in Britain and Ireland. *Bird Study* 37: 210-212.

Furness, R.W. 1990. Foula seabird studies 1990. Unpublished paper Univ. Glasgow. 7pp.

Furness, R.W. 1991. Numbers and population trends of Manx Shearwaters on Rhum. *Nature Conservancy Council CSD Report no. 1168,* 36 pp.

Galbraith, H. & Watson, A. 1991. A flight characteristic of recently fledged Lapwings. *British Birds* 84: 151-152. Based on a study in Scotland.

Giroux, J.-F. 1991. Roost fidelity of Pink-footed Geese in north-east Scotland. *Bird Study* 38: 112-117.

Grant, M.C. 1991. Relationships between egg size, chick size at hatching, and chick survival in the Whimbrel. *Ibis* 133: 127-133.

Greenland White-fronted Goose study (1990). Greenland White-fronted Geese in Britain: 1987/88-1989/90. *Greenland White-fronted Goose Study Res. Rep. 7.* 44 pp.

Hamer, K.C. & Furness, R.W. 1991. Age-specific breeding performance and reproductive effort in Great Skuas. *J. Anim. Ecol.* 60: 693-704. A study on Foula, Shetland.

Hamer, K.C. & Furness, R.W. & Caldow, R.W.G. 1991. The effects of changes in food availability on the breeding ecology of Great Skuas in Shetland. *J. Zool. (Lond.)* 223: 175-188.

Harris, M.P. 1990. Isle of May seabird studies 1990. *Nature Conservancy Council CSD Report no. 1134,* 21 pp.

Harvey, I.V., Proctor, R. & Donald, C. 1990. Fair Isle seabird monitoring scheme 1990. *Nature Conservancy Council CSD Report no. 1164,* 54 pp.

Harvey, I.V. & Riddiford, N. 1990. An uneven sex ratio of migrant Long-eared Owls.

Ringing & Migration 11: 132-135. Trapped on Fair Isle.

Henty, C.J. 1990. The spring return of moorland birds to the Ochil Hills of Central Scotland. *Forth Nat. & Hist.* 13: 71-76.

Hislop, J.R.G., Harris, M.P. & Smith, J.G.M. 1991. Variation in the calorific value and total energy content of the Lesser Sandeel *Ammodytes marinus* and other preyed on by seabirds. *J. Zool. (Lond.)* 224: 501-517. Includes a study of the intact fish brought back by Guillemots and Puffins to breeding colonies on the Isle of May, Canna and St Kilda.

Holloway, J.F. 1990. Richard's Pipits and the 'long grass' fallacy. *British Birds* 83: 506. Behaviour of birds on Fair Isle.

Ingold, P. 1991. Competition for feeding areas and dominance relationships among Shelducks *Tadorna tadorna* with broods. *Orn. Scand.* 22: 27-32. A study in the Ythan estuary, Aberdeenshire.

Klomp, N.I. & Furness, R.W. 1990. The diets and numbers of non-breeding Great Skuas in a comparison among colonies. Appl. Ornith. Unit, Dept. Zool., Univ. Glasgow report to Nature Conservancy Council. 135 pp. Studies made at seven colonies in Shetland in 1989 and 1990.

Klomp, N.I. & Furness, R.W. 1990. Variation in numbers of nonbreeding Great Skuas attending a colony. *Orn. Scand.* 21: 270-276. Based on studies in Foula, Shetland in 1975-76 and 1988-89.

Lansdowne, P., Riddiford, N.J. & Knox, A.G. 1991. Identification of Arctic Redpoll. *British Birds* 84: 41-56.

Macdonald, J.W., Ligoater, R., Atkinson, N.K. & Small, J. 1990. Further causes of death in Scottish Swans *(Cygnus olor & C. cygnus). State Vet. J.* 44(124): 81-93.

Marquiss, M. & Leitch, A.F. 1990. The diet of Grey Herons breeding at Loch Leven, Scotland, and the importance of their predation on ducklings. *Ibis* 132: 535-549.

Monaghan, P., Uttley, J.D. & Burns, M.D. 1991. The role of food supply in the breeding performance of Terns. *Joint Nature Conservation Committee Report no. 2* (Report to JNCC and RSPB). 25pp. A study in Shetland 1987-89.

Moss, R. & Watson, A. 1991. Population cycles and kin selection in Red Grouse. *Ibis* 133 Suppl. 1: 113-120.

Newton, I. & Galbraith, E.A. 1991. Organochlorines and mercury in the eggs of Golden Eagles from Scotland. *Ibis* 133: 115-120.

Newton, I. & Marquiss, M. 1991. Removal experiments and the limitation of breeding density in Sparrowhawks. *J. Anim. Ecol.* 60: 535-544. A study in south Scotland.

Olsthoorn, J.C.M. & Nelson, J.B. 1990. The availability of breeding sites for some British seabirds. *Bird Study* 37: 145-164. A study in Aberdeenshire.

Okill, J.D. & Wanless, S. 1990. Breeding success and chick growth of Red-throated Divers in Shetland 1979-88. *Ringing & Migration* 11: 65-72.

Parr, R. 1990. Moorland birds and their predators in relation to afforestation. *Nature Conservancy Council CSD Report no. 1081*, 48 pp.

Paterson, A.M. & Riddiford, N.J. 1990. Does the Cape Gannet enter European waters? *British Birds* 83: 519-526. Includes description of a possible occurrence at Fair Isle on 20 April 1988.

Paterson, I.W., Boyer, P.R. & Massen, D. 1990. Variations in clutch size and breeding success of Greylag Geese breeding in the Uists, Scotland. *Wildfowl* 41: 18-22.

Riddiford, N. 1990. Tree Pipit with suspended or arrested moult. *Ringing & Migration* 11: 104. The bird was trapped on Fair Isle.

Riddiford, N.J. 1991. A field characteristic for identification of Collared Flycatchers in female and non-breeding plumages. *British Birds* 84: 19-23. A study sparked off by observations on Fair Isle.

Rogers, M.J. and the Rarities Committee. 1990. Report on rare birds in Great Britain in 1989. *British Birds* 83: 439-496.

Sims, J. 1991. The Royal Air Force Ornithological Society's expedition to the Uists in spring 1988. *RAFOS J.* 20: 5-21.

Spencer, R. and the Rare Breeding Birds Panel. 1990. Rare breeding birds in the United Kingdom in 1988. *British Birds* 83: 353-390. Includes a substantial Scottish contribution.

Spencer, R. and the Rare Breeding Birds Panel. 1991. Rare breeding birds in the United Kingdom in 1989. *British Birds* 84: 349-370 and 379-392.

Stowe, T.J. & Hudson, A.V. 1991. Radio telemetry studies of Corncrake in Great Britain. *Vogelwelt* 112: 10-16. A study in the Uists 1984-87.

Swann, R.L. 1991. Canna seabird studies 1990. *Nature Conservancy Council CSD Report no. 1166,* 9 pp.

Summers, R.W., Smith, S., Nicoll, M. & Atkinson, N.K. 1990. Tidal and sexual differences in the diet of Purple Sandpipers in Scotland. *Bird Study* 37: 187-194.

Tasker, M.L., Webb, A., Harrison, N.M. & Pienkowski, M.W. 1990. Vulnerable concentrations of marine birds west of Britain. Nature Conservancy Council. 45 pp.

Taylor, I.R. 1991. Effects of nest inspections and radiotagging on Barn Owl breeding success. *J. Wildlife Management* 55: 312-315.

Thompson, P.S. & Thompson, D.B.A. 1991. Greenshanks and long-term studies of breeding waders. *Ibis* 133 Suppl. 1: 99-112.

Vickery, J. 1991. Breeding density of Dippers, Grey Wagtails and Common Sandpipers in relation to the acidity of streams in southwest Scotland. *Ibis* 133: 178-185.

Walsh, I.M., Avery, M. & Heubeck, M. 1990. Seabird numbers and breeding success in 1989. *Nature Conservancy Council CSD Report no. 1071,* 102 pp.

Walsh, P.M., Sears, J. & Heubeck, M. 1991. Seabird numbers and breeding success in 1990. *Nature Conservancy Council CSD Report no. 1235,* 80 pp.

Wanless, S., Burger, A.E. & Harris, M.P. 1991. Diving depths of Shags breeding on the Isle of May. *Ibis* 133: 37-42.

Wanless, S., Harris, M.P. & Morris, J.A. 1991. Foraging range and feeding locations of Shags during chick rearing, *Ibis* 133: 30-36. Radio-tracking of Shags from the Isle of May.

Ward, R.M. 1990. Cormorants scavenging behind trawler. *British Birds* 83: 424-425. This occurred off Ailsa Craig.

Webb, A., Harrison, N.M., Leaper, G.M., Steele, R.D., Tasker, M.L. & Pienkowski, M.W. 1990. Seabird distribution west of Britain. Aberdeen, Nature Conservancy Council. Phase 3 of the "Seabirds at Sea" project. 282 pp.

Multi-paper reports

RSPB Conservation Review no. 4 1990. Cadbury, C.J. & Everett, M. (Eds) 1990. 96 pp. £5.50 post free from RSPB, The Lodge, Sandy, Bedfordshire SG19 2DL. Includes "Seabirds, fisheries and politics" by M. Avery (pp. 36-39), and "Birds and conservation problems of the high tops" by R. Dennis (pp. 48-51).

Bird Reports

Argyll Bird Report for 1990. S.J. Petty (Ed) 1991. 74 pp. £3.50*. Includes a paper on "Wintering wildfowl in Argyll" by S.F. Newton & A.V. Newton.

Arran Bird Report for 1990. Margaret H. Dunn (Ed) 1991. 20 pp. £1.50*.

Ayrshire Bird Report for 1990. Angus Hogg (Ed) 1991. 56 pp. £2.50*. Includes several short articles including one on "Horse Island RSPB Reserve" by David Fairlamb.

Bavelaw Marsh Bird Report for 1990. Allan Brown (Ed) 1991. 9 pp, in "Bavelaw Marsh Nature Reserve Annual Report 1990.

Borders Bird Report no. 11 for 1989. R.D. Murray (Ed) 1990. 82 pp. £3.75*. Several short papers including "Quail in the Borders 1989" and "First successful breeding of Nuthatch in Scotland" by R.D. Murray, and a "Gazetteer of Borders Place Names".

Caithness Bird Report for 1989. E.W.E. Maughan (Ed) 1990. 41 pp. £2.60*.

Caithness Bird Report for 1990. E.W.E. Maughan (Ed) 1991. 65 pp. £2.20*.

Canna Bird Report no. 14 for 1989 and 1990. R.L. Swann 1990. 16 pp.

Central Region Bird Report for 1989. C.J. Henty (Ed). Pp 31-51 in *Forth Naturalist and Historian* vol. 13, 1990.

Clyde Bird Report for 1989. Iain P. Gibson (Ed) 1991. 76 pp. Includes a report on "Quails in the Clyde Area 1989" by Neil Darroch.

Colonsay and Oronsay Bird Report for 1990. A 7 pp. unpublished report by J. Clarke and P.M. Clarke 1991.

Dunbartonshire and Stirlingshire, Peregrine report for 1990. A 2 pp. unpublished report by John Mitchell, 1990.

Fair Isle Bird Report for 1990. Pp. 15-60 in *Fair Isle Bird Observatory report no. 43.* P. Harvey & V. Thom (Eds) 1991. Includes a short report on "seabirds and sandeels" by Pat Monaghan. £3.50*.

Isle of May Bird Observatory Report for 1989. Ian Darling (Ed) 1990. 48 pp. £2.50*.

Loch Lomond, Heronry report for 1990. A 1-page unpublished report by John Mitchell in a longstanding series.

Loch Lomond, 1990 census of territorial waders. A 1-page unpublished report by John Mitchell in a longstanding series.

Moray and Nairn Bird Report for 1989. Martin Cook (Ed) 1990. A 61 pp report now out-of-print.

Moray and Nairn Bird Report for 1990. Martin Cook (Ed) 1991. 71 pp. £2.75*.

North-East Scotland Bird Report for 1990. Andy Webb (Ed) 1991. 80 pp. £3.50*. Includes six additional short articles.

North Sea Bird Club Report for 1989. Sandy Anderson (Ed) 1990. 47 pp.

Orkney Bird Report for 1990. Chris Booth, Mildred Cuthbert & Eric Meek (Eds). 70 pp. £2.50*. Includes short articles on the Mute Swan survey and on the North Ronaldsay Bird Observatory in 1990.

Outer Hebrides Bird Reports for 1986 to 1988. Peter Cunningham (Ed). Reprint held of pp. 48-63 of *Hebridean Naturalist 10*; 1990.

Perth & Kinross Bird Report for 1989. Wendy Mattingley & Ron Youngman (Eds). 30 pp. £3.00*. Includes "Perthshire's first Firecrest" and other short articles.

Perthshire (Central and Southwest) Peregrines and Ravens in 1990. Patrick Stirling-Aird 1991. A 2 pp unpublished report in a long-running series.

Shetland Bird Report for 1989. Pete Ellis (Ed) 1990. 86 pp £2.75*. Published by the Shetland Bird Club. Includes an 11 pp article on "The occurrence of warblers in Shetland 1969-88" by Kevin Osborn & Mike Pennington.

Shetland Bird Report for 1990. Kevin Osborn (Ed) 1991. Short articles include "Population changes and breeding success of seabirds on the Isle of Noss 1981-1990" by A. Silcocks (4 pp).

St Abbs Head National Nature Reserve Seabird Report 1990. K.J. Rideout & P. Norman 1991 34 pp.

St Abbs Head National Nature Reserve Bird Log 1990. K.J. Rideout & P. Norman 1991. 28 pp. A report to the National Trust for Scotland and Nature Conservancy Council, Borders Sub-Regional Office, Galashiels.

W.G. Harper

European journals in the Waterston Library

Many members are probably unaware of the wealth of material available in the Library beyond the extensive range of books. Thanks to the efforts of Bill Harper, many foreign journals are regularly received on an exchange basis and are available for members to consult. This arbitrary selection of some 50 articles is taken from the following journals received in 1991:

Netherlands:	Limosa, Dutch Birding
France:	L'Oiseau, Alauda
Switzerland:	Nos Oiseaux, Der Ornithologische Beobachter
Belgium:	Aves, Le Gerfaut, Mergus
Germany:	Die Vogelwelt, Limicola, Bonner Zoologische Beiträge, Die Vogelwarte, Ökologie der Vögel, Corax
Austria:	Egretta
Spain:	Ardeola
Italy:	Rivista Italiana di Ornitologia
Sweden:	Vår Fågelvärld
Norway:	Vår Fuglefauna, Cinclus
Denmark:	Ornis Scandinavica, Dansk Ornitologisk Forenings Tidsskrift
Finland:	Ornis Fennica, Lintumies
Iceland:	Bliki
Ireland:	Irish Birds

Articles are arranged in species order; square brackets indicate that the article is in the original language (usually, but not invariably, with an English summary – I might be able to arrange a translation for anyone interested); the abbreviated reference gives the journal number and year.

Divers to Ducks:

Lehtonen, L. Behaviour of a flock of Black-throated Divers on Lake Alakivijärvi in September 1990 – Orn Fenn 2/91.

Hustings, F. [Explosive increase in breeding Black-necked Grebes in the Netherlands 1983-89] – Limosa 2/91.

Dias, P.C. [Breeding Ardeidae of Portugal] – Alauda 1/91.

Berthelot, J.Y. & Navizet, G. [The blue nape and display of the Cattle Egret] – Nos Oiseaux 424/91.

Collins, R. & Wheelan, J. The Mute Swan in Dublin – Irish Birds 2/90.

van Dijk, K. [Origin and age composition of moulting Mute Swans on Lake IJsselmeer] – Limosa 2/91.

Olson, K.M. [Occurrence of two forms of Bean Goose in Denmark] – Dansk Orn Tidssk 3-4/90.

Fouquet, M. [Migration and overwintering of the Greylag Goose in France] – L'Oiseau 2/91.

Torsteinsson, B. *et al* [Barnacle goose consorting with pair of Greylag Geese] – Bliki 10/91.

Béroudet, P. [Transcontinental movements of young Eiders in 1988] – Nos Oiseaux 423/91.

Birds of Prey:

Draulans, D. [Breeding and nesting success of raptors ... in NE Belgium] – Gerfaut 4/88.

Blanco, J.C. *et al* [Variations in diet and foraging behaviour of a wintering Red Kite population) – Ardeola 2/90.

Willemyns, F. [Immature White-tailed Eagle stays 5 weeks in Zeebrugge] – Mergus 1/91.

Svensson, L. [Distinctions between female Hen Harrier and Pallid Harrier] – Limicola 3/91.

Joubert, B. [Timing of reproduction in Goshawk in Haute-Loire] – Nos Oiseaux 423/91.

Watelet, M. [Status of Rough-legged Buzzard in Wallonia and the invasion of 1986-87] – Aves 3/90.

Latja, R. & Savolainen, J. [Breeding records of Golden Eagle in N Finland] – Lintumies 3/91.

Fernández, C. & Purroy, F. [Geographical trends in the food habits of Golden Eagle in Navarra] – Ardeola 2/90.

Sunyer, C. & Vinuela, J. [Migration and wintering of Merlin in Spain] – Ardeola 2/90.

Grouse to Cranes:

Huber, B. & Ingold, P. [Numbers and distribution of Ptarmigan in a Bernese Oberland gamepark]– Orn Beob 1/91.

Chapatte, B. *et al* [On the aberrant behaviour of a Capercaillie in the Jura] – Nos Oiseaux 424/91.

Spidsoe, T.K. & Stuen, O.H. Age determination of Capercaillie chicks – Cinclus 2/91.

Ryelandt, P. [Status of the Corncrake in Fagne and Farmenne] – Aves 4/90.

Ryelandt, P. [Biology, status and protection of the Corncrake]– Vogelwelt 1-2/91.

Ullman, M. Distinctions between Demoiselle Crane and Crane – Dutch Birding 3/91 (original in Swedish in Vår Fågelvärld).

Waders to Auks

Dietrich, S. & Hötker, H. [Where do N Frisian Avocets moult ?] – Vogelwelt 3/91.

Alström, P. Field identification of Lesser Sandplover –[Var Fagelvarld 2/91.

Nyenhuis, H. Migration routes of Woodcock in NW Europe] – Vogelwarte 3/90.

Groen, N.M. [Origin of Black-tailed Godwits wintering in Morocco] – Limosa 2/91.

Kennerley, P. & Bakewell, D. Identification and status of Nordmann's Greenshank – Dutch Birding 1/91.

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