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A major decline in House Sparrows in central Edinburgh

H E M DOTT & A W BROWN

A recent British national decrease in House Sparrows is now recognised, though evidence comes mainly from non urban census plots in southern Britain. Counts presented here show that House Sparrows in the centre of Edinburgh have become about 10 times less numerous over a recent 15 year period, and have contracted in distribution, while other bird species in the same place have shown no such change. Possible causes are discussed but no specific reason for the decrease has been determined.

Introduction

The House Sparrow *Passer domesticus* increased greatly with the spread of human population (Cramp & Simmons 1994) though overall numbers of the species in Britain reached their highest level about the early 1970s and then a slight decrease began (Summers-Smith 1988). From 1978-88 the numbers visiting suburban gardens in Britain decreased by 15-20% (Marchant *et al* 1990). Recent statistics reveal that the decline of numbers in Britain has continued since the early 1980s (Crick *et al* 1998, Glue 1998), and the *New Atlas* (Gibbons *et al* 1993) shows a contraction of range especially in Scotland and Ireland.

However, these national trends are largely based on census data derived from farmland and woodland plots, the majority of which are in southern Britain; birds of urban and suburban habitats have not been adequately monitored (Balmer & Marchant 1993, Crick 1998, Summers-Smith 1999b). Local surveys have also shown declines but these too have been mainly in south Britain (Marchant *et al* 1990, Summers-Smith 1993, Easterbrook 1999) and little information has been published for Scotland and northern England (da Prato 1989, Summers-Smith 1999a). This paper presents evidence of a serious decline of House Sparrows in the centre of Edinburgh, Scotland, which has been referred to in Murray *et al* (1998).

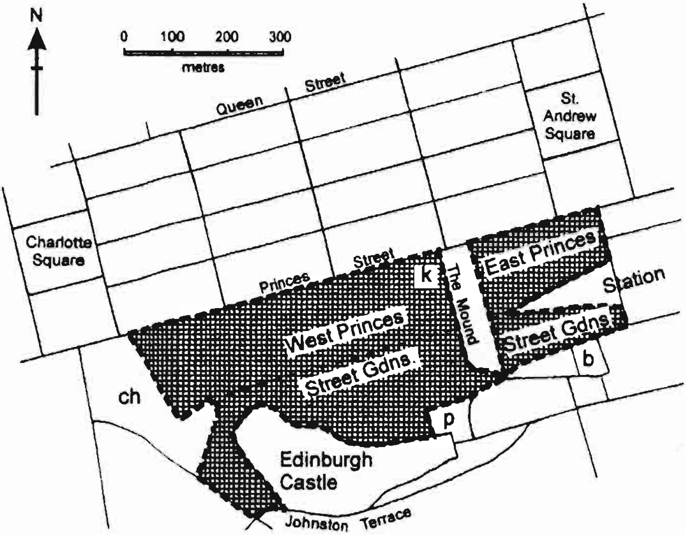
Study areas

The 'Core Study Area' is Princes Street Gardens, in the centre of the City of Edinburgh. Princes Street Gardens cover c20 ha ($0.2km^2$) and consist of areas of mown grass, sloped rough grass, asphalted walkways, a keeper's house, bandstand buildings, plentiful mature and young trees, many evergreen and deciduous shrubs, rose bushes, perennial herbs and annual bedding plants. A railway runs through the Gardens in the lowest ground and a street, The Mound, divides the Gardens into West Princes Street Gardens and East Princes Street Gardens (see Figure 1).

Adjoining the Core Study Area are further 'green' areas comprising the grounds of 2 churches to the west, Edinburgh Castle and crags to the south, private gardens at the southeast corner of West Princes Street Gardens, and gardens of a bank at the south edge of East Princes Street Gardens (Figure 1). None of these 'green' areas held House Sparrows in 1997-99. Apart from these areas, Princes Street Gardens are surrounded by busy streets, tall commercial buildings and a large railway station. In terms of bird habitats, these conditions including the layout within Princes Street Gardens have not altered significantly since the 1950s or earlier.

The 'Wider Study Area' covers a more extensive c350 ha ($3.5km^2$) part of central Edinburgh and

Figure 1 ***The Core Study Area: Princes Street Gardens in central Edinburgh and some surrounding streets and features.***
■ ■ ■ ■ *boundary of Princes Street Gardens = Core Study Area (shaded),——— streets or other boundaries, — — railway,* b *bank gardens,* ch *church grounds,* k *keeper's house,* p *private gardens.*



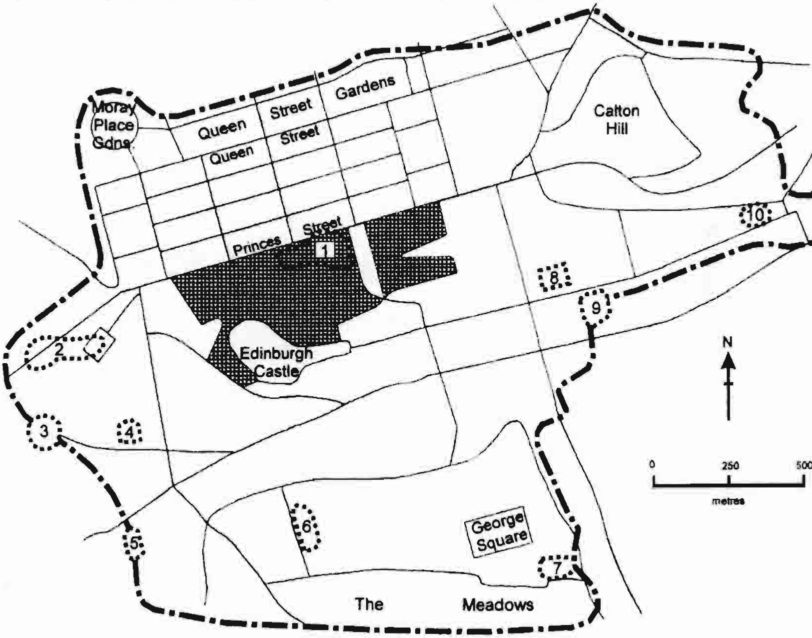
surrounds the Core Study Area. It comprises mainly urban habitat of old and recent commercial and administrative buildings, 4-5 storey tenement housing of 100-200 years old with small rear communal gardens or yards, and other features such as some municipal squares and gardens and the open spaces of Calton Hill and the north half of The Meadows (Figure 2).

Methods

House Sparrows were searched for and counted in the whole of Princes Street Gardens (the Core Study Area) in both the early 1980s and in the late 1990s. In the winters of 1982-84, AWB counted House Sparrows and other birds up to 4 times per month. Over counting could have occurred due to double counting of mobile birds, and under counting due to the presence of concealed birds or birds which may have been on buildings facing onto the Gardens, although AWB believes none of these factors were significant. These counts were done near mid day in variable weather conditions.

In the 1990s HEMD noticed that a major change in numbers appeared to have occurred, and during most of 1997-99 he counted House Sparrows at least once every month throughout Princes Street Gardens with subsidiary observations on many additional dates. These counts were made in variable weather but not in very wet, windy or misty conditions, between 0800 and 1800 GMT though better counts were usually obtained between 0900 and 1500 GMT. Counts were of birds seen and heard. Double counting of individual birds was negligible as movements of the small numbers present could be watched, and it is believed that no birds were on buildings facing onto the Gardens during most of the counts. Under counting must have occurred on some days due to birds remaining

Figure 2 ***The Wider Study Area in central Edinburgh, surrounding the Core Study Area (shaded). Only selected streets are shown. ——— streets or other boundaries, • • • • • locations (1-10) where House Sparrows occurred February 1998 - July 1999. ▬ ▬ ▬ limit of area within which no House Sparrows were found February 1998 - July 1999 except at locatins 1-10.*** **HP** ***Holyrood Palace,*** **1** ***West Princes Street Gardens,*** **2** ***Rutland Square-Atholl Crescent,*** **3** ***Dewar Place-St David's Terrace,*** **4** ***Chuckie Pend,*** **5** ***Tollcross School,*** **6** ***Lauriston Gardens,*** **7** ***Meadow Lane-Boroughloch,*** **8** ***N Gray's Close-Chalmer's Close,*** **9** ***S Gray's Close-Blackfriars Street,*** **10** ***Campbell's Close.***



concealed and silent, though bread thrown by the counter or other people helped to draw birds from cover on some occasions. Counts presented are the highest obtained in each month, thus minimising any problem of under counting. Less regular counts were made of all other bird species as well.

In the Wider Study Area in 1997-1999 HEMD observed House Sparrows and other bird species throughout the year, so that all parts of the Area were visited at least on a few occasions and some on many occasions. These observations aimed to detect presence or absence and approximate numbers of House Sparrows and other species.

Results

The counts of House Sparrows recorded in West and East Princes Street Gardens, the Core Study Area, are presented in Table 1. A large decrease in numbers between the early 1980s and the late 1990s is immediately obvious.

In the 1982-84 period, the counts on 8 and 15 Dec 1982, and 16 Feb 1983 are among the lowest, and more rain occurred on these dates than the others.

Table 1 ***Numbers of House Sparrows counted in Princes Street Gardens, Edinburgh - the Core Study Area.***

A. All counts made in 1982-84.

Date	West Princes Street Gardens	East Princes Street Gardens	Total
8 Dec 1982	122	26	148
15 Dec1982	152	16	168
22 Dec 1982	164	33	197
7 Jan 1983	225	102	327
20 Jan 1983	156	90	246
26 Jan 1983	182	52	234
2 Feb 1983	172	85	257
10 Feb 1983	95	62	157
16 Feb 1983	99	27	126
25 Feb 1983	333	47	380
4 Mar 1983	230	24	254
5 Jan 1984	139	39	178

B. Highest counts obtained in each month in 1997-99.

Date	West Princes Street Gardens	East Princes Street Gardens	Date	West Princes Street Gardens	East Princes Street Gardens
Mar 1997	10	0	Jun 1998	19	0
Apr 1997	16	0	Jul 1998	28	0
May 1997	16	0	Aug 1998	23	0
Jun 1997	8	0	Sep 1998	19	0
Jul 1997	22	0	Oct 1998	17	0
Aug 1997	38	0	Nov 1998	14	0
Sep 1997	35	0	Dec 1998	16	0
Oct 1997	9	0	Jan 1999	10	0
Nov 1997	23	0	Feb 1999	16	0
Dec 1997	27	0	Mar 1999	16	0
Jan 1998	29	0	Apr 1999	12	0
Feb 1998	17	0	May 1999	9	3
Mar 1998	10	0	Jun 1999	26	0
Apr 1998	15	0	Jul 1999	20+	0
May 1998	12	0			

The mean of the 1980s counts excluding those 3 is 248, suggesting that a minimum of c250 birds is likely to have been the true population in Princes Street Gardens in the winters of the early 1980s.

In the 1997-99 period, the highest counts obtained in most months are probably a good indication of the true numbers, as already indicated.

The 1990s numbers show evidence of seasonal variation. In July-August 1997, June-July 1998 and May-July 1999 up to c12 juveniles, judged by traces of yellow gape, were noted, so the higher counts obtained during May to September each year included young birds. The June1997 count was late at 1645-1730h which probably accounts for its low figure. Fairly high numbers appeared to continue during the 1997-98 winter until at least January, after which numbers declined until the following summer period of new recruits. This may contrast with 1982-83 when there were substantial counts in January and February, though whether any seasonal pattern occurred then is uncertain as counts were not continued.

These data show that from at least 250 House Sparrows in Princes Street Gardens in the winters of 1982-84, numbers declined to c15-30 birds in the winters of 1997-99; a level just 10% of those present 15 years earlier. Numbers were slightly higher in summers than in winters in 1997-99 including newly fledged juveniles.

The distribution of House Sparrows in Princes Street Gardens also diminished. In the early 1980s they occurred throughout the West and East Gardens, although they were most numerous along the principal walkway with seats and refuse containers. During 1997-99 House Sparrows were never seen in East Princes Street Gardens except on one day on 13 May 1999, when 3 were present but not seen on days before or after. In the West Gardens their range had contracted to the close vicinity of the keeper's house (Figure 1), where they entered under the roof eaves of this building to roost and nest, and where they made much use of evergreen bushes. Occasionally, birds moved further along the main walkway from the keeper's house but were never seen elsewhere in the Gardens. On rare occasions they perched on and called from buildings in Princes Street overlooking the keeper's house, usually in early morning before traffic noise reached its high daytime level. In 1999 one pair nested in an air vent on one of these buildings; otherwise the only known nests were in the eaves of the keeper's house.

On 2 occasions House Sparrows were noted moving out of the Gardens. On 7 October 1997 one bird separated from a group of 7 and flew high southeast over The Mound and beyond. On 8 January 1998, of 4 birds which flew up, 3 returned to the hedge below while the fourth flew high westwards and disappeared from sight over buildings near the west end of Princes Street.

Whilst House Sparrows have declined greatly in Princes Street Gardens there is no evidence that other common species of birds there have decreased. Wren *Troglodytes troglodytes*, Dunnock *Prunella modularis*, Robin *Erithacus rubecula*, Blackbird *Turdus merula*, Song Thrush *T philomelos*, Blue Tit *Parus caeruleus*, Great Tit *P major*, Carrion Crow *Corvus corone*, Starling *Sturnus vulgaris*, Caffinch *Fringilla coelebs* and Greenfinch *Carduelis chloris* all bred in the Gardens in 1982-84 and 1997-99 and some additional species may have also. Both authors' observations indicate that the abundance and distribution of these species and others were broadly similar in the 1970s-80s and the late 1990s. Feral Pigeons *Columba livia*, which feed in the Gardens and breed on surrounding buildings, were estimated as up to 560 birds in 1982-83 and up to 340 birds in 1997-99, although counts varied from month to month. Apart from the recent appearance of Lesser Black-backed Gulls *Larus fuscus* breeding on overlooking buildings (Dott 1996), there has been no obvious trend of change in numbers of any common breeding birds in Princes Street Gardens over the last 15-20 years, except for the 10 fold decrease in House Sparrows.

In the Wider Study Area House Sparrows were largely absent. They were present only at locations mostly isolated from each other by considerable distances, shown in Figure 2. These locations held only small numbers of House Sparrows ranging from 2-7 birds per site, except for one site, abandoned overgrown rear gardens between North Gray's Close and Chalmer's Close, with c16. The total for the whole Wider Study Area was c45. A group not included in the above was c5 House Sparrows seen between Johnstone Terrace and Grassmarket on 2 January 1998 which apparently moved or disappeared, as none was found there on several searches in 1998-99. Earlier information for the Wider Study Area is lacking, although AWB has records of up to 9 House Sparrows at Queen Street Gardens and St Andrew Square in winter 1982-83 where none was seen in many visits in 1997-99, and the authors and others are in no doubt that Sparrows were more numerous and widespread in the Wider Study Area in the 1960s-80s than now.

Discussion

It is not obvious why House Sparrows should have decreased drastically in central Edinburgh. In Princes Street Gardens there has been an increase in evergreen and broadleaved shrubs, and habitat for many birds may have marginally improved as these have matured over the last ten years. Pesticide use is minimal and has decreased; bark mulch is now used to suppress weeds and herbicides are no longer used in the Gardens except occasionally along concrete edges (City of Edinburgh Council *pers comm*). On account of these factors alone, it would be unlikely that invertebrates are less available to birds now than before the Sparrow decline. However, the general level of city centre pollution remains an uninvestigated potential cause of invertebrate decrease, and measurements of vehicle effluent gases show that the highest levels in Edinburgh occur in city centre streets near Princes Street Gardens and that these levels are well above national average figures (City of Edinburgh Council 1999). People discard scraps and deliberately feed birds in Princes Street Gardens to an apparently similar extent now as in recent decades.

It could be that maintenance of central city buildings has improved so that fewer holes or crevices are available for Sparrows to nest in. However maintenance staff of at least one large property overlooking Princes Street Gardens do not recall that Sparrows were ever a problem, in contrast to Feral Pigeons which have necessitated preventative measures for many years. In the Wider Study Area there is similarly no indication that the habitat has become less suitable for Sparrows: on old and new buildings there are abundant ledges, ventilators, external pipes, rain gutters and crevices on which Feral Pigeons and Starlings bred in 1997-99 throughout the Area, suggesting that potential nesting opportunities for House Sparrows must be widespread. Also Chaffinches, Robins, Blackbirds, Dunnocks and Blue Tits held territories widely through the Wider Study Area in heavily built up places with minimal plant growth, indicating that these small passerines could find nest sites and food to attempt to rear young in many urban sites where House Sparrows were absent.

Predation on Princes Street Gardens House Sparrows seems to be slight or insignificant. Sparrowhawks *Accipiter nisus* were infrequent visitors to the Gardens in 1997-99, and small birds other than House Sparrows showed no apparent decrease in numbers. Signs of avian predators were rarely found; Feral Pigeon remains were seen 4 times in 1997-99. Tawny Owls *Strix aluco* were apparently absent. Domestic cats *Felis catus* were never seen in 1997-99 by the authors in the Gardens or surrounding streets, and Gardens staff know only of one cat in the church grounds west of the Gardens that is fed by people. Foxes *Vulpes vulpes* have increased greatly in Edinburgh in the last 2 decades though no indications of their presence in the Gardens were noted in 1997-99. Up to c15 Grey Squirrels *Sciurus carolinensis* live in the Gardens and up to 2 Brown Rats *Rattus norvegicus* were seen occasionally, but it is highly unlikely that any of these mammals would cause Sparrows and not other birds to decline.

House Sparrow distribution is not known to correlate negatively with that of other birds in Britain though this is the case in suburban habitat in Australia (Woodall 1996). Feral Pigeons can be presumed not to have affected Sparrow numbers through competition in central Edinburgh as their numbers have probably decreased (see above) and Summers-Smith (1999a) also concludes that Pigeons are not generally a cause of Sparrow decline. The recently arrived Lesser Black-backed Gulls in Princes Street (Dott 1996) do not seem to impinge on the life of the local Sparrows in any way.

It has been shown that proximity to highway traffic noise can reduce the density of breeding songbirds up to a distance of several hundred metres (Reijnen *et al* 1995). In the Gardens close to Princes Street traffic noise is highly intrusive to the human ear and it could be that the vocalisations of House Sparrows are less effective at communicating through such noise than those of other birds.

The House Sparrow decline in central Edinburgh could be a result of a more general decline. A recent analysis of national data shows a reduced survival rate of first year Sparrows during 1976-94 when the national population was in decline, compared with the rate during the previous period of stable population (Siriwardena *et al* 1998); however this analysis relates particularly to farmland and factors operating in urban habitats may be different. In Europe, studies have shown some urban Sparrow populations to be non sustainable and dependent upon immigrant surplus birds from neighbouring suburban populations (Heij & Moeliker 1990), and it would follow that if suburban Sparrows ceased to produce surplus then the urban Sparrows would decline (Summers-Smith 1999a). This is consistent with observations in Edinburgh. Throughout Edinburgh's older suburbs of c50-100 years of age Sparrows have declined (Murray *et al* 1998). House Sparrows now have a discontinuous distribution through these older suburbs, and, on average, are resident in probably well under 50% of streets (HEMD *pers obs*). It is possible that the high winter numbers in Princes Street Gardens in 1982-84 included birds that had moved there from surrounding older suburbs and that the decline in the latter is reflected in the low numbers now present in central Edinburgh.

In Edinburgh's more recently built outer suburbs we know of no evidence of change in House Sparrow numbers. In towns outside Edinburgh with recent low rise housing, such as at Musselburgh, Livingston and Tranent, House Sparrows presently appear common (HEMD *pers obs*). In Tranent there were c350 Sparrow "territories" per km^2 in the 1980s (da Prato 1989) and numbers visiting a bird table there have remained fairly similar from then until now (SRD da Prato *pers comm*).

Density of House Sparrows in the Core Study Area dropped from c1250 birds per km^2 in 1982-84 to 75-190 birds per km^2 in 1997-99. These levels are comparable with the highest and lowest densities previously known for House Sparrows in towns (Summers-Smith 1988). In the Wider Study Area in 1997-99 densities were as low as 20 birds per km^2. As Sparrows were also found to be absent in many places beyond the limits of the 350 ha Wider Study Area, the actual House Sparrow density in an area greater than 3.5 km^2 of the centre of Edinburgh was below 20 birds per km^2 in 1997-99. The decline documented in this paper is far more drastic than national figures reveal or other studies suggest, although one recent piece of evidence from a Glasgow suburb (Summers-Smith

1999a) hints that there could be a serious decline in that city also.

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The summer status and distribution of Greylag Geese in north and west Scotland

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The numbers and distribution of Greylag Geese were recorded in north and west Scotland in late August 1997. The census found a minimum of 10,000 geese, comprising 1258 adult pairs, 3220 goslings and 4264 non breeding adults. Principal concentrations were found on the Uists (3311), Coll & Tiree (2366), Sutherland (1262) and Orkney (1114). The current population estimate is discussed in relation to the historical status of Greylag Geese in this area of Scotland, and other groups of the same species in Britain.

Introduction

The Greylag Goose *Anser anser* used to breed in the wild in the East Anglian Fens, Lancashire, the Lake District and probably many other parts of Britain before the reed marshes and fens were reclaimed for agriculture in the 17-19th centuries (Owen *et al* 1986). By the early 20th century the species was restricted to north and west Scotland, but between 1930 and 1970, flocks were again established in many parts of the country, especially in west Galloway and in England (Atkinson-Willes 1963, Owen *et al* 1986) and many were derived from eggs or goslings from the native stock on the Uists. Most of the indigenous birds are now restricted to the Uists, Harris/Lewis, Coll/Tiree, and the northern and westernmost areas of mainland Scotland and associated coastal islands. Greylag Geese also breed in Shetland and Orkney although proven breeding is a recent occurrence and the provenance of these birds is unknown.

At the end of the 19th century, the Greylag Goose still bred in considerable numbers in Scotland in the Outer Hebrides, the northwest coast and in Caithness/Sutherland (Berry 1939) but not in Shetland and Orkney (Holloway 1996). It was, however, subjected to almost continuous persecution. For many years it appears that few nests escaped destruction, and birds were killed both in and out of season. A dramatic decrease in numbers and contraction in range began at the end of the 19th century and continued for the first 30 years of the 20th century. The chief causes were persecution by crofters, whose corn and oats the geese damaged, especially in autumn, and excessive sport shooting on estates. Increasing motor traffic, egg collecting and summer trout fishing on previously undisturbed lochs and, in the 1930s, an increase in the numbers of Great Black-backed Gulls *Larus marinus* which can kill broods of young geese, may also have contributed to the reduction in numbers. Certainly by 1920, the species had ceased to breed on North Uist, and Berry (1939) reported that '..in Scotland as a whole, the Greylag appears in danger of extinction as a breeding species..'.

Clearly small pockets of Greylag Geese survived in the north and west of Scotland, and since the 1960s, numbers of geese have shown a period of gradual increase (Owen *et al* 1986, Thom 1986). Changes in legislation in Britain, beginning with the 1954 Protection of Birds Act, reduced the number of ways in which Greylag Geese could be taken or shot, and at the same time, a number of protected areas were established (eg Loch Druidibeg, South Uist). Also during the same period, Greylag Geese began to take advantage of the higher quality herbage available on improved grasslands. These changes occurred concurrently and the net effect has been to reduce winter mortality.

The remnant groups of native Greylag Geese restricted to the very north and west of Scotland through persecution at the end of the last century became isolated, and in terms of numbers, probably reached a low point in the first half of the 20th century (Berry 1939). A small degree of dispersal from the remnant stock was sufficient to colonise either new areas, or possibly former breeding areas, albeit in a rather restricted band from Colonsay, along the west coast and probably as far north as the northern isles.

On cultivated islands, recent increases in the numbers of Greylag Geese is thought to be partly due to greater breeding success and recruitment, resulting from an increase in the quality and quantity of improved pasture since the 1960s (Paterson 1991) and also reduced persecution during the close season.

Recent attention paid to migratory populations of geese in Scotland (eg Scottish Office, 1996) exposed an apparent gap in our knowledge of the status and distribution of Scotland's only native breeding goose. Hugh Boyd attempted to count breeding Greylag Geese in Scotland using an aerial survey in 1959. However, the sheer scale of the task in such remote areas, and the retiring nature of the families, precluded a full assessment being made. No real attempt at a coordinated census has been attempted since. Surveys of Greylag Geese in 1989-91 (Brown & Dick 1992) and in 1990 (Delany 1993) did not focus on the north and west of Scotland, and breeding survey fieldwork in 1988-1991 (Gibbons *et al* 1993) did not aim to establish numbers in post breeding flocks. This paper describes the results of a survey of post breeding Greylag Geese in late summer 1997.

Methods

Most Greylag Geese moult in July close to the breeding areas, and small flocks tend to gather in remote upland or secluded coastal areas. After the moult, the geese move often only short distances to agricultural feeding areas. Thus it seemed sensible to undertake a survey during the late summer when birds had moved away from more inaccessible areas. Counts of Greylag Geese took place during the last 2 weeks of August 1997. Most monitoring involved checking suitable post breeding habitat on foot or by car. Monitoring took place north and west of Glen Mor between Fort William and Inverness, although counts were also undertaken in west Argyll as far south as the Kintyre peninsula and on islands to the west. Local knowledge of the status and distribution of summer flocks was sought and used wherever possible. Casual observations were sought from birdwatchers and hill walkers through the publication of requests for information in appropriate magazines and newsletters. When a flock of geese was located effort was made to identify goslings (through plumage characters) in order to assess the proportion of young. Observers were asked to note the habitat type the geese were encountered on.

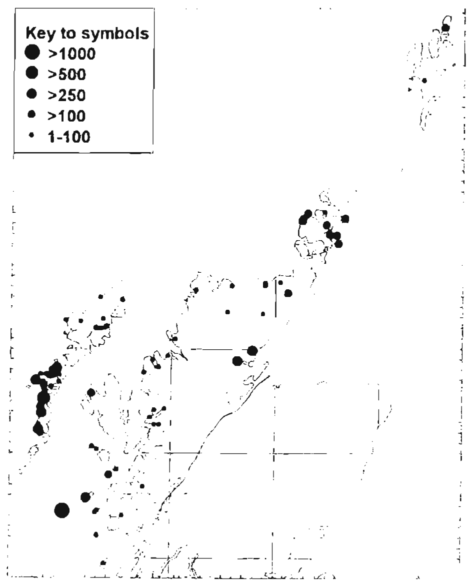
Overall coverage was comprehensive with few, if any, seemingly suitable mainland areas missed. Large areas of north and west Scotland were unchecked due to their apparent unsuitability (essentially land higher than 200m, or coastal areas lacking suitable feeding areas). Many small offshore unihabited islands were not checked either, although where Greylag Geese were known to occur through *a priori* knowledge of local counters, every effort was made to check these sites. For example there are several hundred small islands in the Sound of Harris where occasional pairs of Greylag Geese are known to breed. Yet it also known that by mid August the nesting islands are largely abandoned in favour of one or 2 large inhabited islands where the Greylags feed on managed grasslands. However, we are conscious that Greylag Geese in north and west Scotland can be found in remote areas, thus the results of the census must be treated as an absolute minimum.

Results

The total counted was a minimum of c10,000 birds, including approx 3320 young of the year. The distribution of Greylag Geese is shown in Figure 1 and Table 1. Principal concentrations were found on the Uists (3311), Coll & Tiree (2366), Sutherland (1262) and Orkney (1114). The distribution of Greylag Geese in August 1997 was largely concurrent with the breeding distribution reported for the 1988-91 Breeding Birds Survey (Gibbons *et al* 1993) and 58% of 10km squares that held breeding geese in 1988-91, held post breeding flocks in 1997. Comparing the two distribution maps shows a shift away from remote upland areas to lower lying agricultural land, although the distances involved are relatively small. Greylag Geese were primarily encountered on agricultural land 55%, Table 2, with most favouring improved grasslands. However, many geese were also found close to natural wetlands.

The average flock size was 62 (n=66 flocks), and the overall proportion of young recorded in sample flocks was 32.2% (n=1391 aged). The average brood size was 2.56 goslings (n=154 broods), and assuming that each brood was accompanied by 2 parents, this equates to approximately 1258 adult pairs and 4264 non breeding adults. The breeding success was similar to the long term average for the Uists (27%, 1987-93, Mitchell 1999). Mitchell (1999) noted that early breeding at a relatively low altitude and the absence of a long

Figure 1 ***The distribution of Greylag Geese recorded in north and west Scotland during late August 1997.***



migration may increase gosling survival compared to Greylag Geese breeding in Iceland for example. Loch Loyal (Sutherland) is an important moulting site for non breeding geese from other parts of north Scotland (see below).

Inner Hebrides

Coll/Tiree

The presence of Greylag Geese in summer on Coll/Tiree appears to be rather poorly documented. According to local crofters, the presence of geese in the summer has only been noticeable in the last 30-40 years (I McDonald *pers comm*) There appears to be no historical records of breeding prior to the early twentieth century, although after an increase during the

Table 1 ***The numbers of Greylag Geese recorded in north and west Scotland in late August 1997.***

Inner Hebrides	
Coll	291
Tiree	2075
Colonsay	86
Treshnish Isles	104
Mull	154
Eigg, Small Isles	72
Muck, Small Isles	200
Canna, Small Isles	16
Outer Hebrides	
North Uist	1670
Benbecula	595
South Uist	1046
Harris/Lewis	268
Northwest Scotland	
Acharacle, Lochaber	40
Eilean Tioram, Lochaber	14
Kirton, Lochaber	94
Plockton, Lochaber	46
Isay, Skye	100
Achiltibuie, Wester Ross	40
Inversdale, Wester Ross	13
Loch Carron, Wester Ross	56
Longa Island, Wester Ross	12
Mungasdale, Wester Ross	63
Tournaig, Wester Ross	56
Tournapress, Wester Ross	11
Caithness/Sutherland	1262
Northern Isles	
Orkney	1114
Mainland, Shetland	20
Unst, Shetland	100
Total (minimum)	**9618**

1940s post breeding flocks reached 50-100 birds (Owen *et al* 1986). In 1938, a pair bred on Coll for the first time in many years, and further records suggest numbers slowly increased from that time (Boyd 1958, Sharrock 1976).

Winter numbers on Coll/Tiree appear to have increased from c670-920 individuals in 1985-87 (Stroud 1988) to c2900 in 1997 (c22% per annum, Figure 2). The combined (Coll/Tiree) count of 2366 in August 1997 is some 500 birds fewer than that recorded in the previous winter. With the addition of several hundred goslings hatched in 1997, this is somewhat surprising. Charlie Self, counting on Coll, noted that the number of geese he found was lower than he had expected. He had previously encountered 443 adults and c300 goslings earlier in the summer and had expected to find 700+ geese during the time of the census. The geese were probably still in the more remote areas of this island and thus led to an underestimate of the real number summering there.

On Tiree, principal post breeding concentrations occured on Loch Rhiagain, Loch an Eilean, and Loch an Phuill. On Coll, large post breeding gatherings were found on Loch Cliad, Ballyhaugh, Loch nan Cinneachan, Loch Anlaimh and on the headlands around Crossopol Bay.

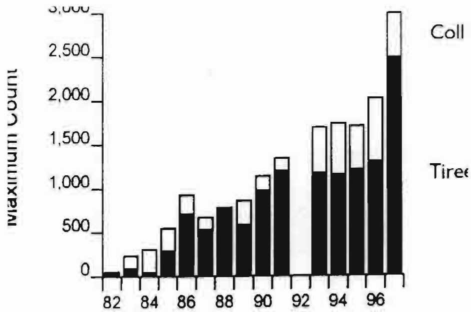
Table 2 ***Habitat type of Greylag Geese flocks recorded in north and west Scotland in late August 1997 (sample size 3924).***

Improved grassland	37.4%
Barley stubble	8.3%
Unimproved grassland	5.2%
Set aside	5.2%
Natural loch	14.4%
Saltings/mud/marsh	14.4%
Sea loch	12.6%

Other islands

Small numbers of Greylag Geese breed on other Hebridean islands (eg 25 adults and 7 young on Colonsay in 1995; 6 broods on Mull in 1995, Argyll Bird Report). The combination of secluded,

Figure 2 ***Numbers of Greylag Geese recorded in winter on Coll & Tiree, 1982-1997. Data from annual Argyll Bird Reports and Alan Leitch, pers comm.***



undisturbed offshore islands, together with nearby grazing meadows favours small pockets of geese. On Islay, records of Greylag Geese in the summer have been few although the potential for colonisation appears to be only a matter of time.

Outer Hebrides

The Uists

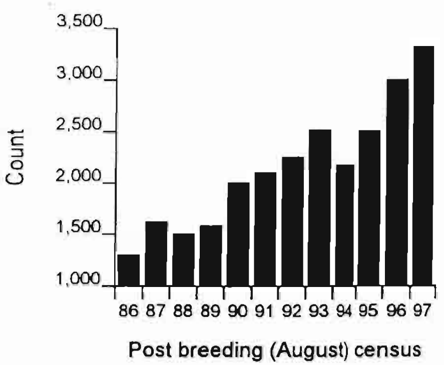
Records of Greylag Geese go back to the 18th century, when attempts were made by crofters to keep the geese away from their autumn cereal crop (McKay 1980). By 1920, some 200 pairs were still reckoned to breed on South Uist, but it seems the numbers had been even higher (Baxter & Rintoul 1953). Certainly by the same year the species had ceased to breed on North Uist. The reasons for the decline were partly the changes in land tenure and growing persecution by crofters and partly the overshoot on the estate in the years up to 1914. At that time, the geese on South Uist were afforded no close season, and large numbers were shot in March and April. The only legal protection was a ban on the taking of eggs (Owen *et al* 1986). Numbers appear to have reached a low point by the 1930s (Berry 1939) but from the 1940s onwards there seems to have been a noticeable increase.

Counts of Greylag Geese were undertaken on the Uists in 1968-72, when c700-800 individuals were recorded (Newton & Kerbes 1974). Numbers increased to 1676-2000 by 1982 and the number of breeding pairs increased from about c140 (Sharrock 1976) to c 200-300 over a similar period (Thom 1986). Regular counts on the Uists since 1986, suggest an increase from at least c 1600 birds in the mid 1980s (Paterson 1986) to c 3300 individuals in 1997 (c12% per annum, Figure 3). Breeding occurs on coastal sites in heather *Calluna vulgaris*, grass/rush stands and low scrub. Principal post breeding concentrations occured on machair areas on the west of the archipelago at Balranald/Clettreval, Ath Mhor, Berneray, on Benbecula and several sites on South Uist.

Harris/Lewis

On Harris/Lewis a small dispersed group now numbers over 200 individuals. No systematic count during the summer had been carried out previously thus the rate of change cannot be estimated, however, it seems likely from previous observations that the numbers now are larger than in the last 30 years. During the Second World War and the following 20 years or so Greylag Geese were harassed by random and indiscriminate shooting of migrant geese on almost all estates but more so on Barvas, Galson and Stornoway Trust Land. Illegal, untimely and careless burning of moorland and heather clad islands on freshwater lochs destroyed nests. The

Figure 3 ***Numbers of Greylag Geese recorded in late August on the Uists, 1986-1997. Data from Mitchell (1999) and Roderick McDonald.***



taking of eggs for rearing geese for Christmas was prevalent during the same period. The introduction of the American Mink *Mustela vison* in the mid fifties may also have led to some local decreases in numbers. Breeding seemed then to be confined to Eilean Mor on Loch Orosay, south of Stornoway, and even there local butchers were said to be taking flightless young for the pot.

In Harris, the main breeding grounds are now on Lochs Steisevat and Moracha and associated waters behind Leverburgh and on some of the islands in the Sound of Harris, such as Pabbay, Killegray, Sleicham and Heisker. Families have been reported also from the east coast of south Harris at suitable lochs such as Plocrapool. In Lewis, a similar Anserine diaspora has taken place with a diminution of pressure on the local geese in winter and spring and Greylag Geese seem to be increasing in number. Families may now be found on many freshwater and sea lochs where they were hitherto unknown to the present generation. The widespread establishment of reseeded moorland, especially in Lewis, since the 1950s, initially intended for cattle but degraded by sheep has doubtless been to the Greylags advantage. An assessment of the breeding distribution has not been undertaken and is not considered practicable owing to the size and diversity of the area.

Northwest Scotland

There have been infrequent records of Greylag Geese inhabiting the coast of Wester Ross and Sutherland during the last 40 years. For example, Greylag Geese appear to have been present in very small numbers on the Summer Isles and Skye (H Boyd *pers comm*, Holloway 1996), with breeding occurring on several offshore islands. In 1997, Greylag Geese were still thinly distributed, although flocks of up to 100 birds were noted in several places. Many of the coastal areas are unsuitable for supporting large flocks. Although low, offshore breeding islands are relatively plentiful, the availability of suitable lowland, undisturbed grazing areas, and a safe roosts is limited and this may contain future population growth.

Caithness/Sutherland

Due to the size and inaccessible nature of Caithness/Sutherland, summer counts have not achieved full coverage, although numbers there were thought to be stable at c 2200 for the last ten years (F Symonds, *pers obs*). Alan Wood recorded 1437 moulting Greylag Geese in July 1992 at Loch Loyal and, in 1994, Ian Stenhouse found 1100 Greylag Geese at 6 moulting lochs during a road transect, including 846 at Loch Loyal. In 1997, 896 Greylag Geese were recorded moulting at Loch Loyal. The count for Caithness/Sutherland in 1997 (1262 geese) therefore, appears low although this may be consistent with a reduction in the size of the moulting flock at Loch Loyal.

Northern Isles

Orkney

There are no historical records of Greylag Geese breeding or summering in either Orkney or Shetland (Holloway 1996, E Meek and D Okill, own data), and nesting was first recorded as recently as the mid 1980s (Pennington 2000). It seems likely that the current numbers summering there derive from birds originating from Sutherland, or possibly, small numbers of over summering Iceland Greylag Geese (see Pennington 2000 for a summary). In Orkney, these have been augmented with a few birds deliberately released for hunting (C Booth, *in litt*). Two Greylag Geese marked in Sutherland in July 1996 were recorded in Orkney in winter 1996/97, indicating that there may be some, albeit modest, connection between the mainland and Orkney. Summer counts suggested c 50 pairs in 1993/94 (and c200 non breeding birds) on Orkney and c200 birds in total on Shetland. The 1997 count of 1114 Greylag Geese on Orkney is the largest ever recorded and is probably not fully comprehensive in light of the fact that breeding is occurring on small, uninhabited islands which were not visited during the survey. Nesting is now taking place on moorland areas and around lochs on the Mainland, Shapinsay, Gairsay, Stronsay, Sanday, Burray, Copinsay and probably Rousay, as well as on a series of small islets, in the waters offshore from these larger islands. Post breeding concentrations occur on freshwater bodies close to the breeding sites, and in the case of the smaller islets, on the sea. The greatly increased wintering population of Greylag Geese in Orkney in recent years has begun to cause considerable worries amongst the local farming community and at least one farming organisation has called for action to be taken to reduce numbers. The presence now of considerable numbers outside the winter period is raising the degree of antagonism even further.

Shetland

Pennington (2000) documents the increase in numbers and range of breeding Greylag Geese since the 1980s and a concurrent increase in reseeded hillsides during the period of colonisation has evidently favoured the species. In light of recent, more thorough coverage it seems the count of 120 birds in 1997 was low. Pennington (2000) suggested the colonisation of Shetland was by Icelandic breeders short stopping yet without any evidence from ringed individuals there remains the possibility that the birds breeding here originated from the mainland Scotland stock, or even a mixture of the 2.

Dispersal from breeding areas

Ringing studies on the Uists, Coll and Tiree and in Sutherland confirm the rather sedentary nature of the Greylag Goose in north and west Scotland. For example, of 500 Greylag Geese ringed on North Uist only 7 have been recorded away from the Uists. On Coll/Tiree, over 400 Greylag Geese have been ringed in 1998-99 and none have been seen away from the islands.

However, some minor movement between the offshore island and groups on the west coast of mainland Scotland was sufficient to promote and retain genetic mixing and, through dispersal, further the establishment of new breeding colonies. Of the 7 records of movements away from the Uists, 5 birds were recorded on Tiree, one went to the north coast of Lewis and another moved south to Colonsay. The use of individual marks (plastic leg rings and collars) has shown that while the majority of birds move very little, a small minority do move sufficiently to promote genetic mixing with other stock. It seems likely therefore, that the colonisation of Coll/Tiree in the middle of the 20th century resulted from birds moving southeast from the Uists.

Recoveries and sightings of Greylag Geese marked at Loch Loyal (Sutherland) in 1996-97 have been reported from Orkney and along the west coast of Easter Ross suggesting that this site is an important moulting ground for birds from an area greater than the Sutherland breeding sites.

A record of 800-1000 Greylag Geese on Muck on 12 September 1997 when the summer population was estimated at 200 birds appears too early to be Greylag Geese from Iceland and suggests a major post breeding movement, although it is not known where these birds may have originated from or what caused the movement.

Discussion

The range of this stock of Greylag Goose, for now, is still restricted to areas of north and west Scotland. This would enable the development of a conservation plan for these geese to guide national conservation and management actions, since this would involve relatively few organisations. For management purposes, the Greylag Geese breeding in north and west Scotland may be regarded as the remnants of the native stock (see Mitchell 1999). They are relatively sedentary although some minor movement between islands and mainland areas aids dispersal to new areas. However, the status of the native groups needs to be fully examined in light of the various reestablishment schemes carried out from the mid 1930s. Delany (1993) found approximately 2000 reestablished Greylag Geese in Scotland in areas to the south and east of the Great Glen (*eg* Perthshire). These are derived from reestablishment projects carried out by landowners, the Nature Conservancy, the Wildfowl Trust and various shooting clubs (Sedgwick 1975). Many of these reestablished birds derived from eggs or goslings from the native stock on the Uists (Sedgwick 1975, Atkinson-Willes 1963). The gradual spread of the reestablished Greylag Goose north has been coincidental with the recent increase in numbers and spread of the native Greylag Goose south. However it may be safely predicted that eventually the 2 stocks will interbreed and Greylag Geese will once again nest over much of Britain. Morphologically, there appears to be no difference in measurements between the two stocks (WWT unpublished data) and it might be argued that since much of the reestablished stock derived from native birds they are genetically comparable too. Perhaps higher land surrounding the Great Glen merely remains as a physical barrier between future integration.

The 1997 survey was the first successful attempt to cover the whole range of the indigenous stock. However, future monitoring of the distribution and numbers of breeding Greylag Geese will probably necessitate a full survey of not only the north and west of Scotland but also of the rest of Britain in order to assess the extent of integration of the 2 stocks. The continuation of ringing programmes should help to monitor the progress and pace of integration.

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A survey of Storm Petrels on Priest Island in 1999

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The Storm Petrel population of Priest Island, Wester Ross was censused in July 1999 using the tape playback method. Habitat specific response rates were calculated for the 4 main breeding habitats on the island: boulder beach, stone wall, scree, heath/grassland. Response rates in different habitats showed significant variation - 0.36 to 0.48. Three of the habitats were completely censused while, due to the large area of this habitat, heath/grassland was surveyed by sampling densities in randomly placed quadrats. The population estimate was 4,400 (95% confidence limits = 3,300 - 6,100) Apparently Occupied Sites, putting Priest Island amongst the largest counted colonies in Scotland. Over half the birds were at a low density in the extensive heath/grassland habitat. The accuracy of the technique, its resource requirements and potential improvements are discussed.

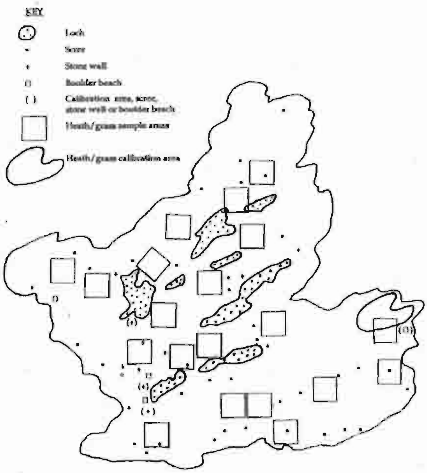
Introduction

The difficulties of censusing Storm Petrels are well documented; they are completely nocturnal and nest in cavities or burrows on remote islands (Ratcliffe *et al* 1998b). However, the proportion of the world population breeding in Britain and Ireland (estimated at 51-65%, Lloyd *et al* 1991) makes the development of accurate and repeatable census techniques extremely important. Much work has been carried out in the last 5 years to develop census methods using diurnal playback of the males' purr songs (Mainwood *et al* 1997, Gilbert *et al* 1998, Ratcliffe *et al* 1998a,b, Vaughan & Gibbons 1998). This work culminated in the publication of an agreed method of Storm Petrel monitoring which should be robust and repeatable (Gilbert *et al* 1999). One of the most important aspects of this method is that response rates to tape playback are estimated separately for each survey and breeding habitat, rather than using generic response rates.

This paper reports the results of a survey of Priest Island, Wester Ross in July 1999 using the above method. Priest Island is an RSPB reserve, managed principally for its Storm Petrel colony and is a key site for these birds in north west Scotland. Previous population estimates have varied from 2,300 pairs (Mainwood *et al* 1997) to 10,000 pairs (Dennis 1976). The paper also develops a new analysis of response rate from calibration plots. The practical application of the technique, which is the first time it has been used to census a key colony, and its use where Apparently Occupied Sites (AOS) are dispersed at low density over a large area, are discussed.

Priest Island is located in the coastal waters of the Minch and is 137.5ha in size. The island encompasses a wide range of habitat types but a wet heath/acidic grassland mosaic predominates. There are also significant cliffs and freshwater lochs and some small areas of remnant woodland. The island usually hosts 11 species of breeding seabird, though most populations are small. Storm Petrels breed in 4 habitats: heath/grassland, stone walls, scree, and boulder beach. Boulder beach and stone walls were easy to define and locate. Scree was less easy to locate because it was often covered in dense vegetation (eg heather, bracken). The heath/grassland habitat was by far the most

Figure 1 ***Map of Priest Island showing calibration plots and survey sites.***



difficult to survey. Storm Petrels here were found to be breeding in cracks in peat under deep vegetation throughout the island. Responses to tape playback suggested that AOS were located, seemingly at random, throughout the whole of this habitat. We did not find the concept of 'subcolonies', as has been used in previous studies appropriate in describing the distribution of AOS in this habitat.

Methods

Calibration Plots

Only a proportion of Storm Petrels will respond to the tape playback of the male's purr song in a single visit so in order to calculate correction factors, calibration plots were established in the 4 habitat types following the methods described in Gilbert *et al* (1999). The areas chosen were typical of the habitat type while the size of each calibration plot was intended to give a minimum of 50 AOS by the end of the calibration period (7 days). However, this was not possible for boulder beach due to the small total number of birds in this habitat. Plots varied in size from 10's of metres in stone wall to around 2ha in heath/grassland.

The tape recorders used were 2 Sony Walkman WM-EX182 with Saisho SP10 speakers and 2 Aiwa HS-GS194 with JVC A-210 speakers. The recorder and speakers were mounted on a wooden board for easier use in the field.

The purr song was played for 10 seconds every 2 metres throughout the stone wall, scree and boulder beach calibration plots. Speakers were held within 0.5m of the wall or ground. Due to the scale of the heath/grassland habitat, the purr song was played approximately every 10 m (see also main survey methods). All responding burrows were marked with sticky tape or pegs as an AOS. Over 7 days the rate of discovery of new AOS had fallen to 5% or less (Gilbert *et al* 1999). The cumulative numbers of AOS were plotted and response rates were estimated using the analysis described in Appendix 1.

Main Survey

The methods used were again those outlined in Gilbert *et al* (1999). The census survey technique (ie a census of the complete habitat area) was used for the stone wall, scree and boulder beach habitats. In stone walls, the purr call was played for 10 seconds every 2m. In screes and boulder beaches up to 4 fieldworkers walked in transects 2m apart and again played the purr call for 10 seconds every 2m.

The scale of the heath/grassland habitat (94.68ha - measured taking account of the topography of the habitat) meant that it was not practical to survey the whole of this habitat. Instead, the sample survey technique was used in which approx. 20% of the habitat is surveyed. The habitat was divided into 100 one ha (100m x 100m) squares. Twenty squares were then chosen using random numbers. If a square had a significant (greater than

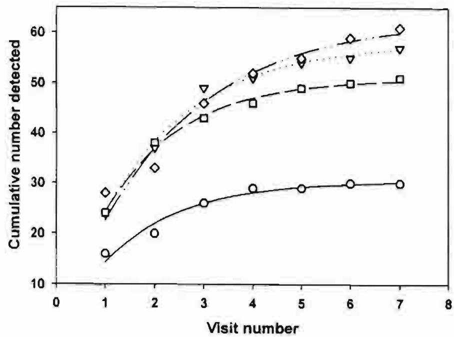
10%) area of water within it then the closest square without water was used instead. The squares were walked by 4 fieldworkers 6m apart, thus covering an approximate 25m transect in each sweep. Thus a one hectare square could be covered in 4 sweeps. The tape recorder was played every 10m for 10 seconds. Thus, the furthest from an AOS that a tape was played was 5m. While the intensity of tape playback was not as great as in the other habitats the time involved in a more intensive method would have been prohibitive. Ratcliffe *et al* (1998b) found a significant decline in response rate with lower volume of recording and also an indication (not significant) of reduced response with distance from AOS, though they only tested up to 2m. In this study responses were heard up to 10m from the tape recorder and it may be that the main limiting factor is the ability of the fieldworker to hear the response, particularly in a breeze. Thus, a criticism of this method is that it may produce an underestimate of AOS.

Results

Calibration Plots

Figure 2 shows the cumulative number of AOS over time for the calibration plots within each habitat. The asymptote for each habitat was calculated to give the total number of AOS for each plot (see Appendix 1). Table 1 shows the response rates (with 95% confidence intervals for each habitat). The response rates in scree and boulder beach were significantly higher than those in walls and grassland.

Figure 2 ***The cumulative total of Storm Petrel AOS detected in each habitat plotted agains visit. Points represent observed data, lines represent the fitted values derived from substituting the values in Table A into equation 1 (see Appendix 1). Circles and solid line = boulder beach; squares and dashed line - scree; triangles and dotted line = wall; diamonds and dotted/dashed line = heath and grassland.***



Main Survey

Table 2 shows the total number of responses recorded for the 3 census survey habitats and the number of responses recorded in the heath/grassland random squares. The extrapolated figure for the whole heath/grassland habitat has been calculated from the average density in the 20ha of sampled squares multiplied by the 94.68ha of this habitat on the island. Bootstrapping (Greenwood 1991, Ratcliffe *et al* 1998a) was used to calculate

Table 1 ***Estimates of response rates (proportion of the asymptote detected on the first visit) with the upper and lower 95% confidence intervals (UCI, LCI).***

Habitat	Response rate	LCI	UCI
Boulder beach	0.472	0.400	0.535
Stone wall	0.418	0.379	0.454
Scree	0.475	0.448	0.500
Heath/grassland	0.359	0.273	0.435

Table 2 ***Calculation of AOS from the main survey for the 4 breeding habitats plus the total population estimate for the island.***

Habitat	total no responses	extrapolation to total habitat area	AOS (after correction for responses rate)	95% confidence limits (after bootstrapping)	95% confidence limits of correction factors
Boulder beach	25	(25)	53	—	47–63
Stone wall	72	(72)	172	—	159-190
Scree	679	(679)	1429	—	1358-1516
Heath/grassland	206	975	2716	2149-3270	1774-4300
Total	-	1751	4370	—	3338-6069

the 95% confidence limits for the heath/grassland habitat. The number of AOS for each habitat has been calculated based on the response rates in Table 1. The heath/grassland and scree habitats together held 95% of the breeding population. The total population of Storm Petrels on Priest Island from this survey is 4,370 AOS (95% CL 3,338 - 6,069)

Discussion

Ratcliffe *et al* (1998b) reported that response rates could vary from 0.11 to 0.56 depending on a variety of variables. They recommended that a colony specific correction factor (ie measured at the colony that year but not taking habitat into account) should be calculated for each survey. This recommendation was extended to habitat specific correction factors by Gilbert *et al* (1999). The results reported here confirm that this approach is necessary, given the range of response rates from the 4 different habitats.

The population estimate from this survey is roughly twice that of Mainwood *et al* (1997) and half that of Dennis (1976). The latter estimate was little more than a guess based on trapping rates in mist nets compared to those recorded for Skokholm. The former estimate was the first systematic survey of Priest Island and, interestingly, the total number of responses recorded (1637) was very similar to that recorded in this study (1751). The difference in the estimated population is due to the correction factors used. Mainwood *et al* (1997) used a factor of 1.37 based on published male and female response rates plus a correction factor equation developed by James & Robertson (1985). Thus the correction factor was roughly half that of those used in the current study. It is encouraging that the total responses recorded in the field are broadly similar in both studies. Clearly, the crucial difference was due to the correction factor and the colony and habitat specific approach taken in this study, plus the mathematical calculation of the total number of AOS in the calibration plots. Therefore, the best estimate to date of the Priest Island Storm Petrel population is about 4,400 AOS. This suggests that Priest Island is one of the largest colonies in Scotland. Recent estimates for other key colonies are: Auskerry, Orkney - 3,600 (Wood 1997); Treshnish Isles - 5,000 (Gilbert *et al* 1998); Mousa, Shetland - 6,800 (Ratcliffe *et al* 1998a).

The suggestion from previous studies that Storm Petrel breeding distribution is clumped into "sub colonies" eg Mainwood *et al* (1997), Gilbert *et al*

(1998) is not borne out by the experience of this survey. Storm Petrel AOS were found throughout the heath/grassland habitat in a seemingly random fashion and it is suggested that a randomised survey of at least 20% of the habitat is the most appropriate way to survey petrels breeding in this type of habitat. In our view, it is not possible to locate all burrows or "sub colonies" in this habitat, as suggested in Gilbert *et al* (1999), unless a systematic tape playback method is used.

The amount of work required in this type of survey is significant. Approximately 42 man days were required to complete this one survey. This is principally because correction factors must be calculated for each habitat over a period of about 7 days. To carry out similar surveys on key colonies to assess baseline populations and then monitor them would require major resources. The results in Fig 2 suggest it may be worthwhile investigating whether a shorter calibration period (eg 5 days) would give an acceptable level of accuracy for habitat specific correction factors.

Whilst the method employed is, without doubt, the most accurate available to date, some concern must remain over its accuracy. For example, the least accurately censused habitat (heath/grassland) contained over half the population. Further work to improve the main survey technique in large scale, low density habitat would be helpful.

Initial results from a smaller Storm Petrel colony on Eilean Hoan, Durness, suggest that tape playback methods result in a population estimate of approximately one third of that from mark/recapture mist net results conducted in mid June when the number of non breeders at the colony should be minimal. While there are significant difficulties associated with interpreting results from mark/recapture studies at breeding colonies, the du Feu method can be used to estimate the number of birds that have used the site during the trapping period (du Feu *et al* 1983, Amengual *et al* 1999, M. Hounsome, *pers comm).* During the next 2 years, it is hoped to carry out studies on both Eilean Hoan and Priest Island to compare results from the 2 methods.

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Storm Petrel at breeding cavity. *Hugh Insley*

Appendix 1

The cumulative number of AOS detected for each of the 4 calibration plots was modelled using the equation:

$$y = a(1 - e^{-bx}) \qquad \text{Equation 1}$$

This predicts the number of AOS detected (y) on a given visit (x) according to the exponential (e) proportional rate of increase (b) to the asymptote (a). The coefficient of (a) is the total number of AOS present in the study plot if sampling was continued for longer. The values of the coefficient were estimated by minimising the sum of the squared deviations of the observed values from those predicted by iteratively varying the values of the coefficients in the equation. The values for (a) and (b) in each habitat are given in Table A (±1se).

The values of the coefficients for (b) were substituted into the equation $1-e^{-b}$ in order to estimate the proportion of the total population detected on the first visit (ie the response rate). The upper 95% confidence intervals can be determined from the equation $1-e^{-b-(se*1.96)}$ and the lower 95% CI from the equation $1-e^{-b+(se*1.96)}$, where SE is the standard error given in Table A.

Table A ***Coefficients of (a) and (b) estimated from regression equations (±1 standard error). The values in brackets in column (a) are the total number of AOS detected by visit 7. Subtracting these values from the estimate of (a) gives a figure for how many AOS were present but not detected by visit 7.***

Habitat	**a**	**b**
Boulder Beach	30.48 ± 0.85 (30)	0.64 ± 0.065
Wall	58.03 ± 1.08 (57)	0.54 ± 0.033
Scree	50.95 ± 0.55 (51)	0.64 ± 0.026
Heath and Grassland	62.76 ± 3.22 (61)	0.44 ± 0.064

Egg sizes of crossbills in Scotland

H A McGHIE & R W SUMMERS

The Scottish Crossbill is intermediate in size between the Common Crossbill and Parrot Crossbill and would be expected to lay eggs of an intermediate size. However, examination of the sizes of crossbill eggs collected in the Highlands of Scotland confirms that they are not significantly different from Common Crossbills. Thus, Scottish Crossbill eggs are either similar in size to those of Common Crossbills or many of the eggs collected in the Highlands actually refer to Common Crossbills.

Currently it is thought that 3 species of crossbill breed in Scotland: the Common Crossbill *Loxia curvirostra*, Scottish Crossbill *L scotica* and Parrot Crossbill *L pytyopsittacus*, though the latter is rare (Gibbons *et al* 1993). However, because of similarities in plumage and overlap in biometrics (Knox 1976), identification is not always straight forward (Knox 1990a). The Scottish Crossbill has a bill depth and wing length intermediate between the Common Crossbill and the Parrot Crossbill, though it is closer to the Common Crossbill in these measurements (Knox 1976). It has been argued that the Scottish Crossbill must be regarded as a full species because it maintains this intermediate size despite repeated invasions of the other crossbill species into Scotland (Knox 1975, Voous 1978). Although it is accepted as a full species (BOURC 1980), there are many aspects of its status and biology that are unknown because it is difficult to identify in the field (Knox 1990a), so it has been categorised as data deficient (Tucker & Heath 1994).

One might expect the egg sizes of Scottish Crossbills to be intermediate between Common and Parrot Crossbills, given that the Scottish Crossbill is intermediate in wing length and presumably body size. However, Jourdain, cited in Nethersole-Thompson (1975), gives mean values for 100 Scottish Crossbill eggs (mean length x mean breadth = 21.64 x 15.9mm) which are lower than those of 100 Common Crossbill eggs (22.12 x 16.11mm). This prompted an examination of crossbill eggs in museum collections.

Methods

Crossbill eggs were measured from the collections in Inverness Museum and Art Gallery, the National Museum of Scotland (Edinburgh) and the Natural History Museum (Tring). Full clutches from Scotland, England and Scandinavia were examined. Lengths and breadths were measured to the nearest 0.1 mm with Vernier callipers; all measurements were taken by HM. Mean lengths and breadths were calculated for each clutch to account for within clutch variations in size. An index of egg volume was derived from length x breadth^2.

Crossbill clutches from England were accepted as being from Common Crossbills because Scottish Crossbills are unknown in England and Parrot Crossbills are rare (Gibbons *et al* 1993). Likewise, Parrot Crossbill clutches collected in Scandinavia were accepted as being correctly identified. Species identification of crossbill clutches from Scotland was not attempted but only clutches collected from the Highlands of Scotland, within the supposed range of the Scottish Crossbill (Nethersole-Thompson 1975, Gibbons *et al* 1993), were used in analysis. The crossbill clutches were mainly collected in the early part of the 20th century, but there is no evidence to suggest that the Scottish Crossbill has undergone a significant change in range since then.

Results

There were significant differences in length and breadth between the 3 groups of crossbills (Table 1). Parrot Crossbill eggs were significantly longer and broader than those of Common Crossbills ($t = 4.9$, $P<0.001$ and $t = 4.0$, $P<0.0001$, respectively), though there was overlap (Table 1). Likewise, the lengths and breadths of crossbill eggs from Scotland were significantly different from those of Parrot Crossbills ($t = 4.9$, $P = 0.001$ and $t = 2.7$, $P = 0.007$, respectively) but not from Common Crossbills ($t = 0.85$, $P<0.4$ and $t = 1.29$, $P = 0.2$). The mean length of the Scottish eggs was actually smaller than the Common Crossbills.

A similar pattern emerged using indices of egg volume. Egg volumes of Parrot Crossbills were signifcantly greater than those from Common Crossbills ($t = 0.55$, $P = 0.59$) (Table 1).

Discussion

The egg measurements of the Common Crossbills from Scotland were similar to those quoted by Nerhersole-Thompson (1975) and confirmed that those from Scotland were not intermediate between Common and Parrot Crossbills. It is possible that eggs measured by Jourdain were included in the present study.

Egg size variation within a species, and presumably between closely related species, is mainly related to the size of the female (O'Connor in Campbell & Lack 1985). Therefore, the results are unexpected. One possibility to account for this anomaly is that

Table 1 ***Lengths, breadths (mm) and indices of volume (length x breadth^2 (cm^3)) of eggs from Parrot and Common Crossbills and crossbills from the Highlands of Scotland.***

	Parrot Crossbill	Common Crossbill	Highland Crossbills
Number of clutches	20	79	105
Length Mean	22.96	21.96	21.84
SD	0.79	0.83	0.96
Min	21.71	20.27	24.37
Max	24.19	24.18	24.37
Breadth Mean	16.44	16.00	16.10
SD	0.50	0.43	0.52
Min	15.72	14.75	14.78
Max	17.46	17.03	17.29
Index of Mean	6.22	5.63	5.67
Volume SD	0.49	0.43	6.85
Min	5.51	4.53	4.21
Max	7.31	6.59	6.85

ANOVA on egg length: $F(2,201) = 13.3$, $P<0.001$
ANOVA on egg breadth: $F(2,201) = 6.5$, $P<0.002$
ANOVA on egg volume: $F(2,201) = 13.1$, $P<0.001$

many of the clutches collected in Scotland were primarily from Common Crossbills, given that Scottish and Common Crossbills breed sympatrically (Knox 1990b). At least 78 of the 105 clutches were from one site: Fairburn Estate, near Dingwall, Ross-shire. Harvie-Brown (undated) gives an indication of the scale of breeding and nest finding at Fairburn; upwards of 50 nests were found in 1901, only 2 in 1902, but over 50 in 1903. Although the main egg collector did not differentiate between Common and Scottish Crossbills in the collection catalogue, other ornithologists who collected clutches from Fairburn classified them as Scottish Crossbill eggs. The clutches were collected from old plantations of Scots Pines *Pinus sylvestris* and Hybrid Larches *Larix x eurolepis*, from Scots Pines lining drives and avenues, and remnant Caledonian pinewoods (clutch record cards). This concords with Pennie's (1950) description of Fairburn in the early part of the 20th century. These tree species and stand types are known to be used by both species of crossbill. For example, Common Crossbills in Norfolk make use of Scots Pines (Nethersole-Thompson 1975) so one cannot rely on habitat as a means of identification.

Even if the sample from the Highlands did contain Common Crossbill clutches, one would still expect the average measurements to be higher. Given that the crossbills from the Highlands had eggs which were only 0.7% greater in volume from the Common Crossbills, it does suggest that there is little difference in egg sizes of Common and Scottish Crossbills. However, the only way to determine the true sizes of Scottish Crossbill eggs is to obtain measurements from clutches where one is absolutely sure of the identification of the adults.

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Density and habitat associations of Barn Owls in East Ross

H A McGHIE

An area of 146km² of Mid Ross was searched for Barn Owls between 1995-9. A total of 27 home ranges was located and the mean occupancy rate during the breeding season was 95%. The mean altitude of nest sites was 48m asl and 93% of pairs were below 100m asl. Breeding sites were regularly spaced below 100m asl, and the mean nearest neighbour distance was 1461m; density was high locally at 18 pairs per 10km square. The majority of nest sites were in tree cavities, mainly in Ash and Beech, although a wider range of structures was used for roosting. Areas that held breeding Barn Owls had a higher number of potential nest sites than areas that did not, but there was no difference in the amount of feeding habitat. Nest sites and roost sites had lower levels of disturbance than unused sites and a greater area of rough grassland within 400m; unused sites were significantly further from nest sites than were roosts.

Introduction

The populations of Barn Owls *Tyto alba* around the Moray Firth are of special interest as they represent the most northerly populations in the world of this cosmopolitan species (Glue 1976). Notwithstanding the marginal nature of these populations, Thom (1986) drew attention to the existence of a population at high density in the Inner Moray Firth and Black Isle areas in East Ross and East Ness. Shawyer (1987), however, considered the Inner Moray Firth population to be critically low and in need of primary protection as part of a nation wide strategy for Barn Owl conservation. Between 1995-99 I carried out a systematic search with the intention of establishing the density and habitat associations of part of this population.

Study area and methods

The study area consisted of 146km² of Mid Ross with 115km² of agricultural land, 22km² of forestry plantations and 9km² of moorland. The exact limits are not given in order to protect Barn Owl nest sites, which are vulnerable to disturbance, and in accordance with the wishes of landowners who kindly granted full access to land. The area was mainly developed over Old Red Sandstone, (ORS) mainly below 75m above sea level (asl) in the east; this increased to 250m asl in the west over Moinian Schist with low ground restricted to the floors of alluviated glacial valleys. Good quality farmland, both mixed and arable, was widely distributed to the east but was limited to valley floors in the west. Sport shooting interests were found in most areas providing numerous coverts, shelter belts and estate plantations. Exotic conifer plantations largely separated agricultural areas at low altitudes from higher ground, where the marginal hill ground and moorland were used as sheep grazing.

The area was intensively and systematically searched for the presence of Barn Owls in 1995 and 1997-99. All suitable structures (ie relatively quiet buildings, cliffs, quarries and areas with old trees away from the centre of forests) were checked for roosting or nesting Barn Owls. The methodology was essentially the same as that of Project Barn Owl organised by the BTO/Hawk and Owl Trust. Information on 'white' or 'screech' owls was also requested from landowners, farmers, gamekeepers, naturalists and residents. Each apparently suitable site was checked at least twice per year to establish occupancy in the breeding

(April-September) and non breeding (October-March) seasons. Occupancy of sites was determined from sightings of Barn Owls entering or exiting sites and from signs including pellets, droppings, feathers and white fluff around tree holes or on beams at potential sites. A mirror and a torch mounted on the end of a walking stick was used to check unoccupied sites to ensure there was a suitable cavity available. The number of home ranges was established by observing pairs in and around confirmed or strongly suspected breeding sites; checks of several sites per night were made to demonstrate simultaneous occupancy of sites by different pairs.

Disturbance was kept to a minimum and birds were not flushed from sites; nest contents were not checked, so that breeding outcome was often not established. Confirmation of breeding was taken from eggshell fragments below nests, adults carrying prey into apparently suitable sites and sounds and sightings of young.

Suitable roosting and nesting sites and potential feeding areas consisting of rough grassland patches, wide verges, woodland edges and field edges, ditches and riverside vegetation were recorded onto 1:25,000 Ordnance Survey maps. Disturbance at each apparently suitable site (ie structurally capable of holding roosting or breeding Barn Owls) between April-September was scored on a scale of 0-2. A score of 0 denoted no known human disturbance; a score of 1 denoted regular but non-persistent human disturbance, as where vehicles were stored in buildings; a score of 2 denoted regular and prolonged human disturbance, as when buildings were used as workshops or for livestock. Whilst this system was largely qualitative it was felt that some measure of disturbance was better then none. It was appreciated that sites that were heavily disturbed during the day could be used as nocturnal roosts by Barn Owls.

Habitat features within an 800m radius of confirmed or strongly suspected nest sites were compared with features within 800m radius of 40 randomly selected points in farmland, 30 of which were below 100m asl and 10 of which were above 100m asl. This was done to determine whether there were any differences in habitat between areas that held breeding Barn Owls and areas that did not. Habitat features were measured from the 1:25,000 maps. Verges were given an approximate value of 2m in width and wide verges were double counted. Barn Owls are known to range further than 800m but as this area would encompass the main home range it is probable that habitat features within this area would be important in habitat selection (Taylor 1994, Cramp 1985). Habitat features within 400m of nest sites, roost sites and unused sites were compared within each home range, to establish selection of habitat features for nesting and roosting. Only one roost site was known to be more than 800m from the main nest site, thus falling outside the 800m radius defined above; this site was included in calculations. For each habitat feature, the mean values of all roosts and all unused sites within each home range were used so that there was one value for each nest sites, roosts and unused sites for each habitat feature for each home range. This was necessitated by the varying number of roosts and unused sites in different home ranges: each home range had to carry equal weighting as the intention was to compare habitat features around the different types of site (nest sites, roosts, unused sites) within, rather than between, home ranges. Statistics follow Fowler and Cohen (BTO Guide 22) throughout.

The nearest neighbour distance for each known or strongly suspected breeding site was measured from 1:25,000 maps. Random points were generated using Microsoft Excel and plotted on maps in order to test the actual spacing of nests against a random distribution. Expected distances could not be simply calculated from the area and number of points alone as not all of the area was available to breeding Barn Owls because of the lack of feeding and/or nest and roost sites in areas of forestry and moorland (see Table 1). The first 27 randomly generated points which lay within 1km² containing apparently suitable nest sites and feeding were used; points which fell in 1km² lacking sites and feeding were rejected as these were not available to Barn Owls for breeding.

Table 1 *Use of 1km² of National Grid by Barn Owls 1995-99.*

	Feeding	Suitable Sites	<100m asl Breeding	<100m asl Summer (not breeding)	<100m asl Winter only	<100m asl Unused	>100m asl Breeding	>100m asl Summer (not breeding)	>100m asl Winter only	>100m asl Unused
Farmland	Y	Y	18	16	1	1	8	10	6	13
	Y	N		9	3	8		5	2	14
	N	N								1
Forestry	Y	Y	1					2		4
	Y	N		1		2			2	10
Moorland	Y	Y						1		
	Y	N								4
Urban	Y	Y						1		
	Y	N				3				

Number of 1km²

Results

Number of pairs and occupancy

Barn Owls were confirmed or strongly suspected of breeding in 27 home ranges between 1995-99. This produced a maximum density (ie with 100% occupancy) of one pair per 5.41km² or 18 pairs per 10km square. One of these areas was used for breeding in 1995 and 1996 only, although this area had previously held a breeding pair in the 1970s. Evidence for former breeding was received from three additional areas: 2 former home ranges became amalgamated following the destruction of nest sites in each home range c1993. Two higher altitude nest sites, at 130m and 160m asl, were each used for one year only in 1984 and 1971 respectively. Breeding was confirmed at least once between 1995-99 in 15 of the 27 home ranges and strongly suspected from the remaining 12 sites on the basis of the persistent presence of pairs over several years. Occupancy of home ranges was very high throughout the period of study, varying from 83% (winter 1998/9, 24 checked) to 100%. The occupancy rate of known or strongly suspected breeding sites between April-September was 100% in 1995 (20 checked), 100% in 1997 (23 checked), 96% in 1998 (26 checked) and 85% in 1999 (27 checked).

Distribution

Barn Owls were well distributed below 100m, using 71% of 1km² during the breeding season for breeding or hunting; an additional 6% of 1km² were used in winter only (Table 1). Barn Owls were much less widely distributed above 100m asl, using 42% of 1km². Barn Owls were much more widely distributed in farmland than in woodland or moorland, where suitable sites were absent or uncommon. Barn Owls used 77% of farmland 1km² below 100m asl during the breeding season but only 40% of farmland 1km² above 100m asl. A higher proportion of farmland 1km² above 100m asl was used only in winter when compared with farmland 1km² below 100m asl. Below 100m asl, 95% of squares with suitable sites and feeding were used during the breeding season whilst 49% of squares above 100m asl were used. The mean altitude of nest sites was 48m asl (SD=38m, n=27); only 2 nest sites were above 100m (110m and 180m asl) and occupancy at both of these sites was irregular.

Spacing between pairs

The mean nearest neighbour distance was 1461m (SD=421, n=27) and a significantly higher proportion of nests were separated by 1200-1600m than would have been expected if nests had been randomly distributed (P<0.01, chi-squared test, 2 degrees of freedom after grouping to bring expected values above 5)(Table 2). Only 2 pairs of sites were separated by less than 1000m. One of these sites was used for 2 years only (breeding confirmed at both sites in both years), and a busy road that was bordered by thick woodland which was unused by Barn Owls separated the other pair of sites. Pairs were very regularly distributed below 100m asl, where there were many areas of suitable feeding with apparently suitable nesting and roosting sites. Spacing was much less regular above 100m asl where there was less suitable habitat and where owls were not so widely distributed.

Use of structures

Barn Owls used tree cavities as the main nest site in 24 of the 27 home ranges (89%)(Table 3). This is a higher proportion than quoted by Blaker for England (1933, 43%), Sharrock for Britain (1976, 39%), Bunn *et al* (1982, 32%) or Taylor for South Esk (1994, 9.9%) but similar to Taylor's (1994) value of 74% for a small study area near Edinburgh. Of 68 little disturbed sites examined (scores 0 and 1, see Methods) 79% were in tree holes so that the high proportion of tree nesting found in this study was a consequence of the relative abundance of large, old trees and the relatively small number of quiet buildings. There was no evidence for selection in favour of tree sites or against buildings (*contra* Shawyer 1987). When all alternative nest sites known to have been used at any time within the study area were considered, the proportion in trees fell to 69% (n=39) although those in buildings would be more likely to be found in the absence of intensive fieldwork.

Beech *Fagus sylvaticus* and Ash *Fraxinus excelsior* were equally important as nest sites, together constituting 63% of all nest sites used from 1995-99 (Table 3). Glue (in Bunn *et al* 1982) found Beech and Ash to comprise 20% of nest sites in an English study compared with 56% in Oak and Elm.

Table 2 ***Nearest neighbour distances between confirmed or strongly suspected nest sites.***

	Number of confirmed or strongly suspected breeding sites					
	0-400m	**400-800m**	**800-1200m**	**1200-1600m**	**1600-2000m**	**>2000m**
Observed		2	2	16	3	4
Expected[1]	2	7	7	2	5	4

1 Based on measurements between 27 randomly generated points in 1km² with suitable sites and feeding habitat (see Methods)

Table 3 ***Use of structures within 800m of confirmed or strongly suspected nest sites by Barn Owls 1995-99.***

	Number of structures					
	No of home ranges in which present	**Confirmed breeding**	**Suspected breeding**	**Roosts**	**Winter only**	**Unused**
Ash	15	5	5	14		3
Beech	15	6	3	4		11
Horse Chestnut	2	1	1	1		
Oak	4	1	1	2		
Farms	26	2		1	9	26
Disused buildings	9	2	1	3	2	3
Cliff/quarry	2					2
Box hedge	1			1		
Grey Poplar	1		1			
Wych Elm	1			1		
Sycamore	3			1		2
Cherry	1				1	
Lime	2		1	1		
Hay barns	19				15	13

Main nest sites in trees were along field edges (7), in or close to the edge of small clumps of broadleaved trees (7), in quiet road or trackside avenues (5), in solitary trees (3) and in scattered parkland trees (2). The mean distance to the nearest A or B road was 407m (Table 5) and none nested or roosted within 20m of these roads. Almost all trees used for breeding were plantings from the Victorian era although some were probably older. Nest sites in solitary and parkland trees were all within 200m of cover (eg thick conifers). Of the 24 main nest sites in trees, 22 (92%) were in the trunk, 1 was in a large hollow branch and one was in a large suckering growth ('witches' broom'). All trees were alive; 3 did not have full crowns but were sheltered by the crowns of adjacent trees. The mean height of nest entrances in trees was 2.98m (SD=0.58, n=24, maximum=4m) which was lower than the modal height of 3.5-6.0m found by Glue. This was probably attributable to differences in structure of Ash and Beech and Elm and Oak, rather than to differences in selection by Barn Owls. Regularly used nest sites in buildings were in a loft, a ruin and in the chimney of a disused building.

A wider variety of structures were used as breeding roosts. Roosts known to have been used during the breeding season were adjacent (<20m) to nest sites in 12 home ranges; in 4 home ranges with greater spacing between possible roost sites, the mean distance to 7 roost sites was 600m, with a maximum distance of 900m. In one home range, roosts were 600m, 600m, 800m and 900m from the nest site, and the site that was 900m distant was used as an alternative nest site in 1998. Barn Owls were also thought to roost in thick conifers (see Taylor 1994), at least occasionally, but these were not searched.

All of the roost sites used during the breeding season were considered to have been located in 23

Table 4 ***Habitats in which Barn Owls were recorded hunting.***

	Number of home ranges in which recorded	
	Important feeding habitat	**Of which recorded as main feeding habitat**
Patches of rough grassland[1]	20	12
Woodland edge	8	0
Open scrub	10	1
Waterside and ditches	17	2
Tracks and roadside verges	11	1
Field edges	16	4
Young forestry plantations	1	1

1 Includes marshy areas and field headlands

Table 5 ***Habitat features within 800m of nest sites and randomly selected points within farmland.***

	Nest sites		**Randomly selected areas within farmland**				**Significant differences[1]**
	a		**b**		**c**		
			Below 100m asl		**Above 100m asl**		
	n=27		**n=30**		**n=10**		
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
No of quiet suitablesites[2,5]	2.70	0.87	1.37	1.35	0.90	1.29	a>b a>c b>c
Waterside & ditch (km)[5]	2.95	0.11	1.21	0.90	1.16	0.10	a>c
Distance to nearest main road (m)[3]	407.19	2.55	384.86	3.30	936.92	1.81	None
Total rough grassland (ha)[5]	12.59	2.49	10.10	2.97	11.00	3.26	None
Woodland edge (km)	3.54	1.90	3.50	2.17	3.40	2.04	None
No of disturbed sites[2,4,5]	2.57	1.48	2.24	1.59	2.04	1.71	None

1 $P<0.01$, one tailed Mann-Whitney U tests for differences in medians (performed on untransformed data)
2 Number of sites with disturbance scores 0 and 1 (see Methods)
3 Distance to nearest A or B grade road
4 Number of sites with disturbance scores of 2 (see Methods)
5 Mean and standard deviation figures are back transformed from the log(x+1) distribution

home ranges, based on observations of emerging adults. Barn Owls used only one site, including the nest site, in 4 home ranges (2 of which were in large spacious buildings with plenty of room for breeding and roosting). Barn Owls used 2 sites in 10 home ranges, 3 sites in 7 home ranges and 4 sites in 2 home ranges (mean=2.3, SD=0.88, n=23). The majority of roosts used during the breeding season were not used outside the breeding season. Barn Owls commonly resorted to hay barns in winter, normally between September and February. When all structures used throughout the year for breeding and roosting are considered, Barn Owls used one site in 4 home ranges, 2 sites in 7 home ranges, 3 sites in 6 home ranges, 4 sites in 4 home ranges, 5 sites in one home range and 7 sites in one home range (mean=2.78, SD=1.44, n=23).

Habitat usage

Observations and records of hunting Barn Owls were collected from 24 of the 27 home ranges (Table 4) and although these were not done on a systematic basis the results were considered to give a good indication of habitat usage as records were collected from a large number of land users over a number of years. Barn Owls hunted over a variety of grassland and open habitats but were not known to hunt commonly over forestry plantations, cultivated land or settlements.

Barn Owls tended to frequent areas with quiet suitable roost and nest sites significantly more than other areas but there were no significant differences in the amount of feeding habitat between used and unused areas (Table 5). This was taken to indicate that the distribution of Barn Owls was limited by the availability of suitable quiet sites rather than by the availability of feeding habitat.

Within each territory, nest sites and roost sites did not differ significantly in terms of any of the habitat features quantified. However, in 12 of 13 home ranges where there was more than one cavity available, Barn Owls used the largest cavity for breeding, the exception being where Barn Owls nested in a tree with a smaller cavity but with much better shelter. Barn Owls roosted in trees that were significantly closer to the nest site than were unused sites (Table 6).

Potential competitors and predators

Five Tawny Owl *Strix aluco* nests were located in the course of the present study; Tawny Owls generally nest in more enclosed woodland and in smaller cavities (Mikkola 1983) and only one of the sites was considered suitable for Barn Owls. Tawny Owls and Barn Owls nested less than 10m from each other in 1995 and 1996 in one area. Pine Martens *Martes martes* were known to have bred successfully in a tree normally used by Barn Owls in 1994 but the owls subsequently reoccupied the site in 1995. One site was taken over by feral cats in c1994 but was found to have been reoccupied by Barn Owls in 1999. Wildcats *Felis silvestris* bred close to Barn Owls in another home range but there was no evidence of animosity and the owls were known to have bred successfully in most years between 1994-99.

Discussion

This study found Barn Owls to occur at 18 pairs per 10km square, a very high density (Shawyer 1987). This density was thought to extend throughout the Old Red Sandstone district of Mid Ross and some distance around the Cromarty and Beauly Firths. Barn Owls were very thinly distributed west of the Old Red Sandstone district: less than 5 sites were probably occupied regularly between 1995-99, although fieldwork was less extensive and not systematic in that area.

The Barn Owl would appear to have been rare or absent from the study area in the 19th Century (Holloway 1998) and 2 lines of evidence suggest

Table 6 ***Habitat features within 400m of nests, roosts and unused sites within each home range.***

	Nests n=27		Roosts n=19		Unused sites n=26		Quiet unused sites[1] n=11		Significant difference
	a		b		c		d		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Disturbance score[1,3]	0.29	1.20	0.51	1.31	1.77	1.44			a<c b<c
No of quiet sites[2,3]	1.88	1.34	2.76	2.64	0.99	1.49	1.47	1.55	a>c b>c
Distance to nest (m)[2]			88.41	6.88	595.32	1.57	628.41	1.65	b<c b<d
Woodland edge (m)[3]	673.75	7.15	583.82	5.00	655.29	2.25	793.48	1.94	None
Rough grassland (ha)[3]	3.52	3.21	2.72	3.31	3.13	2.95	4.99	2.67	a>c
Waterside vegetation (m)[3]	710.38	4.01	810.97	2.11	559.97	4.12	651.4	1.70	None
No of farms[2]	0.71	0.38	0.41	0.48	0.74	0.26	0.12	0.26	None

1 See Methods. Quiet sites defined as those with disturbance scores of 0 or 1

2 P<0.01, one-tailed Wilcoxon's test for matched pairs (performed on untransformed data)

3 Mean and standard deviation figures are back transformed from the log(x+1) distribution

that this was still the case in the early part of the 20th Century. Firstly, there are no Barn Owl eggs in the comprehensive William Stirling of Fairburn egg collection (c1890-1910) or in any other collection in Inverness Museum and Art Gallery (eg McGhie 1994), although Pollock (1902) recorded the species in a short list of birds in nearby Kilmorack parish (Invernessshire). Secondly, only 3 Barn Owls were submitted to an Inverness firm of taxidermists between 1912-69 from the area presently under study (McGhie 1999). Other birds of prey were being submitted in considerable numbers at this time and this suggests that the Barn Owl was rare, especially as it is one of the most popular species for taxidermy. The Barn Owl was not recorded for East Ross in the 1920s, although it is marked as resident in all surrounding vice counties (Baxter and Rintoul 1928). Baxter and Rintoul (1953) later described the species as 'by no means rare in Rossshire'. Two sites just outside the study area which were occupied by Barn Owls in the 1950s were still occupied in the 1990s and were though to have been occupied more or less continuously between these dates. Barn Owls were recorded for several squares in the Moray Firth basin during the period of the The Atlas of Breeding Birds in Britain and Ireland. (Sharrock 1976).

There would seem to have been an increase in the number of pairs of Barn Owl in the Inner Moray Firth since Headlam noted the presence of 'a few pairs' (in Bunn *et al* 1982). Shawyer (1987) estimated that there were 10 pairs in the whole of Ross-shire and considered the population to be critically low. The New Atlas (Gibbons *et al* 1993) shows how Barn Owls spread in all directions into $10km^2$ in which they were not encountered during the 1968-72 Atlas period and Crooke (1999) stated that the number of pairs had increased steadily throughout the 1990s. Many of the nest sites included in the present study were known by land users and residents to have been occupied by Barn Owls before the 1990s and these sites would appear to have been previously overlooked, although breeding was rarely confirmed. Some new sites have certainly been occupied by Barn Owls since the late 1980s however.

The Barn Owl is one of several species that approach the northern limit of their British, and sometimes world, distributions in the Moray Firth area; these species may be presumed to be especially sensitive to cold winters (Percival 1991). Mild winters in recent years may have increased overwinter survival in Barn Owl, and also Kingfisher *Alcedo atthis* (see Dennis 1995), resulting in the spread of Barn Owls into previously unoccupied areas in the Great Glen, the Black Isle and northwards into south east Sutherland. Barn Owl populations are known to have increased breeding success and overwinter survival since the mid 1970's (Percival 1991), which may also be linked with declines in pesticide levels in Barn Owls (Newton 1991).

Barn Owls can be threatened by disturbance or destruction of nest and roost sites, and the loss of feeding habitat. Following disturbance in the present study, birds in 3 home ranges switched from buildings to nearby tree sites. Nest boxes were provided in 3 other home ranges to try to retain Barn Owls when the main nest site had become unsuitable or unstable. Most sites were considered to be fairly secure for the immediate future, excepting tree felling, as Barn Owls were not breeding in very dead trees. Few hardwood trees have been planted since the Victorian era and this could lead to a future shortage of suitable nesting trees.

Road casualties were recorded from 8 home ranges (30%) between 1995-99 and probably occurred undetected at more. In another 8 home ranges they were unlikely to occur because of their remoteness from busy roads. Barn Owls were killed almost annually at one site but the site was always reoccupied and often succeeded in producing some young. Housing developments threaten Barn Owls in many home ranges: green field sites on steep banks at the edge of woodland, which are very attractive to developers, are also important as a feeding habitat for Barn Owls.

All landowners were informed of the presence of Barn Owl nest and roost sites on their land, and that these were some of the most northerly Barn Owls in the world. This was done to try to reduce the risk of tree nest sites being felled inadvertently. The provision of further nest boxes in areas with suitable feeding habitat but insufficient quiet sites may attract further pairs of Barn Owls and increase the population.

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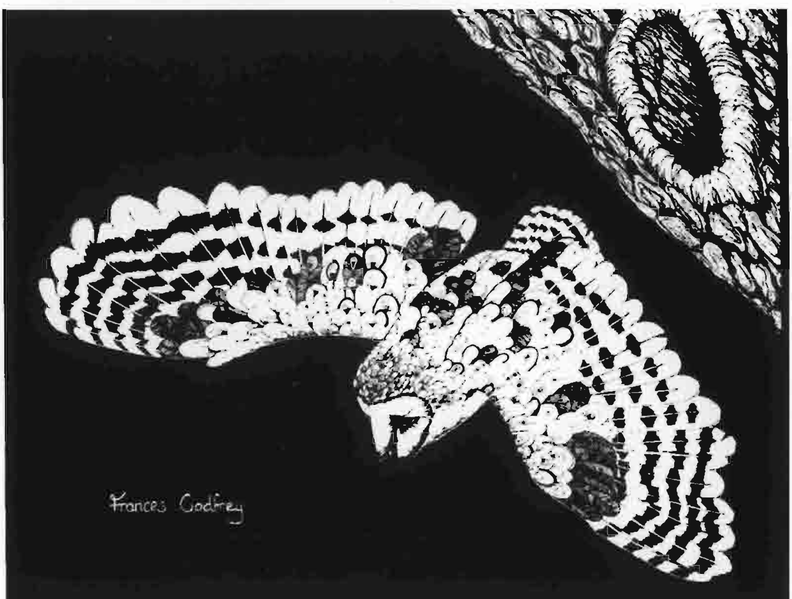

Barn Owl

The breeding success of a population of Lapwings in part of Strathspey 1996-1998

P FRENCH, H INSLEY, G SIRIWARDENA & N BUXTON

During a 3 year study of breeding Lapwings from 1996 to 1998 on 287ha in Strathspey, Scotland, 630 nesting attempts were monitored. Mean clutch size (3.6) and brood size at hatching (3.0) remained constant over the study period. Nest failure rate did not vary significantly between years and nest survival from laying to hatching was around 60%. However, there were very highly significant differences in the daily failure rates for nests across the 8 different study sites used, which ranged in habitat from drained, improved pasture to marshy rough grazing. Combining all 8 sites, survival of chicks from hatching to fledging varied between 9.5% (in 1996) and 17.5% (in 1997). These survival rates indicated a production of between 0.29 and 0.46 chicks per nesting attempt, which, allowing for replacement clutches, would at most have equated to between 0.38 and 0.77 chicks per breeding pair.

Introduction

Lapwing populations have been falling across many parts of western Europe for several decades (eg Reichholf 1996, Broyer & Benmergui 1998) and these declines have consistently been associated with changes in farming practice leading either directly or indirectly to reduced breeding success (Baines 1989 & 1990, Shrubb 1990, Berg *et al* 1992, Triplet *et al* 1997). In Britain the most recent survey indicated that breeding Lapwings in England and Wales have declined from an estimated 123,000 pairs in 1987 to just over 63,000 pairs in 1998, a fall of nearly 50% (Wilson 1999). Although Scotland was not included in the 1987 survey, an estimated 92,000 pairs were found in the survey of breeding waders in lowland Scotland carried out in 1992 and 1993 (O'Brien 1996) and the 1998 BTO Lapwing survey, which attempted to estimate the population for the country as a whole, calculated the Scottish breeding population as 69,800 pairs (Wilson & Browne 1999). Since the confidence limits for these 2 surveys overlap no decline can be imputed from the lower estimate derived from the 1998 survey. Nevertheless, the Lapwing population in Scotland is now apparently higher than that in all of England and Wales, and there are clear indications of problems there. Results from Breeding Bird Survey squares in Scotland indicate a statistically significant 28% drop in numbers between 1994 and 1998 (Noble *et al* 1999).

This study of Lapwings breeding in the immediate surroundings of the village of Newtonmore in Strathspey, at an overall density of up to one pair per hectare, attempted to determine whether the apparently strong breeding populations of Lapwings in the Highlands were changing over time by studying their breeding success and trying to determine if this was sufficient to maintain the local population, or even to export juveniles to other British breeding populations.

Methods

During the 3 breeding seasons 1996 to 1998, an intensive study was carried out of the breeding Lapwings on 287 hectares of Strathspey close to the village of Newtonmore. The study area (which was divided into 8 non contiguous sites) was watched intensively and searched in the period between the last week in March and the second week in June each year to locate and monitor all Lapwing nesting attempts. Most nests were located by remote observation of sitting birds using a telescope with, in the more distant or difficult cases, the observer being directed to the nest by an assistant using hand held radios. The same techniques were used to locate chicks. Individual nests were marked and numbered, and breeding success was monitored through repeat visits while the nests were still active (ie until hatching or failure was observed). 68% of nests were visited sufficiently close to hatching for chick production to be measured directly (ie when the chicks were still hatching or were still present or nearby). When this brief period was missed, success or failure was assessed on the basis of the presence or absence of eggshell and on whether its appearance suggested hatching or failure. Damaged or crushed eggshells were clear indications of failure, whereas the presence of fine fragments or hatched eggshells were taken to indicate successful hatching. A completely clean empty nest was taken as a sign that the nest had failed with the eggs being removed by predators either before or after desertion.

As seasons progressed it became increasingly difficult to distinguish between late first clutches and repeat clutches by pairs replacing earlier failures. Rather than introduce any false precision by trying to split the results for first clutches from those for repeat nesting attempts, all recorded breeding attempts have been included in the analysis. We consider the implication of this practice for our results in the discussion.

Because of the difficulty of following the post hatching progress of nidifugous young, attempts were made to monitor progress by examining all groups of Lapwings in the study area until early July in an attempt to count the number of fledged young produced. In the absence of colour ringing, the total number of fledged young necessarily had to be taken as the sum of the maximum counts recorded at each flock or group location, with several counts being made at each site during late June and early July. These counts of juvenile birds were assumed to represent the minimum production from each of the sites, and it was accepted that they would underestimate the total production of fledged young. As observed in other studies (Redfern 1982, Galbraith 1988, Johansson & Blomqvist 1996) chicks were found to move considerable distances, often immediately after hatching, and although no attempt was made to colour ring chicks it was assumed that there was little chance of movement in and out of the study sites prior to fledging. This was not unreasonable because the study sites were selected because they represented islands of suitable habitat containing loose colonies of breeding Lapwings. Where study sites were adjacent to other equally suitable areas there was usually a physical barrier to interchange such as the A9 trunk road, the railway, the River Spey or an extensive area of unsuitable habitat. Both immigration and emigration are unlikely, therefore, to have been significant.

Description of the study area

The study area lay between the Cairngorm Mountains to the east and the Monadhliath Mountains to the west in the Central Highlands of Scotland. It stretched along approximately 10km of the River Spey (approximately 230m AOD) in the Badenoch district of Inverness-shire. The 8 study sites ranged in size from 7ha to 86ha and are mapped and described in Fig 1, Table 1, respectively.

Figure 1 ***Map of the area of Strathspey in which breeding Lapwings were studied between 1996 and 1998.***

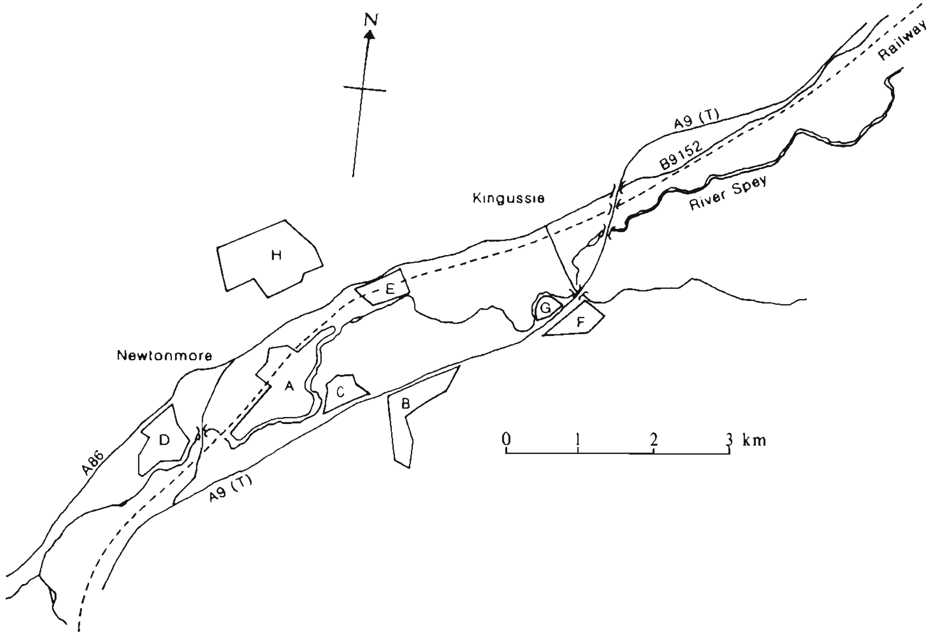

Table 1 ***Description of the sites around Newtonmore, Strathspey, used to study Lapwings between 1996 and 1998.***

Site	Area(ha)	Altitude (m) above river flood plain	Land cover and drainage status	Grazing regime
A	68	0-10	Golf course on light sandy soils with closely mown greens and fairways and semi natural floristically rich rough grading into agricultural ground to the west where the ground becomes more acid and peaty, changing through unimproved wet heath to damp improved grassland	Golf course ungrazed but closely mown. To west heavily grazed by sheep throughout the year.
B	33	10	Flat semi improved grassland, with wetter, more rushy areas to the north. Much of the area is uniform vegetation, with an isolated clump of trees.	Heavily grazed by sheep and cattle. Divided into a number of smaller paddocks probably used most intensively at lambing

C	18	10-20	To the south a fenced paddock of improved mossy grassland. Slightly lower ground to the north is wetter grass and rush pasture.	Intensively stocked with sheep at the south end. The north end was grazed and poached by by cattle and sheep.
D	36	0	An extensive area of semi natural grassland on the western floodplain of the Spey, interspersed with a number of wetter, more rushy areas.	Grazed by sheep. Probably most intensively during lambing.
E	22	0	East of the railway semi natural grassland, on the river floodplain. To the north lies a small boggy area and pools formed from relict river channels. West of the railway the area is fairly wet improved grassland.	Heavily grazed through out the year and poached by sheep and cattle in winter. Used as a lambing park in spring.
F	17	20	Flat improved grassland lying either side of a marshy burn.	Grazed but not heavily.
G	7	0	Open wet sedge and grassland adjacent to the river with trees along one side.	Heavily grazed and tracked by sheep.
H	86	>40	To the east mixed arable and improved grassland, but grades upwards to the north west through semi natural wet grassland and felled woodland into wet moorland grazings and grouse moor.	Arable ungrazed during the breeding season. Improved grass heavily grazed by sheep and rabbits. Grouse moor less heavily grazed.

Analysis

Breeding productivity per nesting attempt across the 8 sites and 3 years was assessed by estimating clutch and brood sizes, hatching success and daily nest failure rates. The latter were calculated using a formulation of the Mayfield method (Mayfield 1961 & 1975) which takes into account the number of days over which a nest is monitored and therefore avoids any bias resulting from the absence from a data set of nests that failed before they could be found. All variables were calculated as a property of individual nesting attempts. Nests in which no eggs hatched (for any reason) were treated as whole nest failures and hatching success was calculated as the proportion of the clutch that hatched successfully in nests that did not fail. All the variables taken from the nest data were analysed using generalized linear models in the GENMOD procedure of SAS (SAS Institute, Inc 1996), with site and/or year as categorical independent variables. Daily nest failure rates were estimated using a logit linear model with a binomial error term, in which success or failure over a given number of days (as a binary variable) was modelled with the number of days over which the nest was exposed during the egg period as the binomial denominator (Crawley 1993; Etheridge *et al* 1997; Aebischer 1999). The number of exposure days during the egg period was calculated as the mid points between the maxima and minima possible given the timing of nest visits recorded (note that exposure days refer only to the timespan for which data were recorded for each nest and do not represent the full length of the egg period). Hatching success was also modelled with a logit link and binomial errors, brood size forming the numerator and clutch size the binomial denominator. Individually, clutch and brood sizes were modelled with identity links and normal errors. The significance of the variation between sites was tested by comparing the fit of each model incorporating the sites with that of an intercept only (constant) model using a likelihood ratio test (SAS Institute, Inc 1996).

Results

Table 2 summarises the results for the 630 nests located over the 3 years 1996 to 1998. Although the sites searched were the same in all 3 seasons there was a sharp decrease from 254 nesting attempts located during the 1996 breeding season to 181 in 1997 and 195 nests located in 1998. In 1997 a heavy snowfall during the first week of April disrupted most of the early nesting attempts, and made accurate recording of the first clutches difficult, so that the number of nesting attempts recorded may not have been a complete record. The mean clutch size laid and number of chicks hatching at successful nests did not vary significantly within or between seasons. The average number of young hatched in nests surviving to hatching ranged from 3.01 in 1998 to 3.19 in 1996. There was, however, great variation in apparent chick survival to fledging, but because of the methods used to count fledged chicks these data have to be treated with caution. The proportion of hatched chicks surviving to fledging ranged from 9.5% in 1996 to 17.5% in 1997. When all 3 years' data were combined, comparison between the 8 different sites (Table 2) revealed very highly significant differences in the daily failure rate of nests. Average nest survival was calculated as 1-(the daily failure probability to the power of the average length of the incubation period in days), converted to a percentage. An incubation period of 27 days (Cramp & Simmons 1983) was assumed for all nests: although this ignores any variation in the length of incubation, it produces figures that are more easily interpretable than daily failure rates. For all 3 years combined nest survival in sites C, F and H was above 70%, whereas in sites B, D, and E it was below 50%, with sites A and G intermediate at 63%.

When all sites were lumped together comparison of nest failure rates between years showed that the daily failure rate was remarkably consistent. There was a very slight trend towards increasing nest survival, from 58.7% in 1996 to 64.9% of nests surviving to hatching in 1998 (Table 2). However, lumping the data in this way masked considerable variation in nest failure rates between and within sites in different years. When the significance of the interaction between sites and years was tested, to see whether different temporal variation had occurred across the different sites, the interaction term was highly significant (Table 3). Nest failure as a result of predation was usually difficult to identify with certainty because the evidence was usually an empty nest with no sign of what had caused the egg loss. Identifiable predation accounted for 3.8% of all nest failures, and the true figure was almost certainly much higher since many unidentifiable cases would have been attributed to the unknown category (Tables 4 & 5). In 1998 when 40 separate nesting attempts were found in site B only one was lost as a direct result of agricultural activity, being crushed by a tractor, a further 17 simply disappeared and although attributed to 'unknown' were probably predated. The high number of clutches found in that site and year was almost certainly the result of replacement clutches laid after these losses. Site D was adjacent to an active Common Gull (*Larus canus*) colony and suffered a particularly high failure rate in 1997. Although this was again noted as being due to unknown causes it was almost certainly due to the gulls taking clutches. The high rates of clutch loss at some sites in 1997 may have been due to delayed laying. As noted above heavy snowfall during the first week of April resulted in the loss of most early clutches and may have resulted in the subsequent replacement clutches coinciding with a peak in the food requirements of predating species such as corvids. In the Dombes Region of France, Broyer & Benmergui (1998) found that early clutches were less susceptible to predation and had higher hatching rates than late clutches. In site E, 9 out of 20 clutches were destroyed as a

Table 2 ***Summary of the data collected on Lapwings breeding around Newtonmore, Strathspey between 1996 and 1998 and comparison of nest failure rate across the 8 study sites over the 3 years (Likelihood Ratio Test: Chi squared=33.12, 7df, p=0.0001). Methods used to calculate the various parameters are described in the text.***

Site (Fig 1)	A	B	C	D	E	F	G	H	Total
1996									
No clutches	70	29	24	15	20	32	25	39	254
Mean Date Found	24.4	30.4	2.5	29.4	4.5	18.4	14.4	5.5	26.4
Daily Nest Failure Rate	0.025	0.035	0.011	0.012	0.046	0.014	0.007	0.015	0.020
% Nest Survival	49.8	38.3	73.4	71.3	27.8	68.4	82.3	67.4	58.7
Mean Clutch Size	3.60	3.52	3.50	3.80	3.45	3.72	3.88	3.56	3.62
Mean Brood Size	3.15	3.00	2.80	3.25	3.25	3.31	3.40	3.22	3.19
Total Young Hatched	154	49	59	45	39	81	75	108	610
% Hatching Success#	85.4	87.1	82.4	81.3	86.7	86.0	89.5	87.9	86.1
Total Fledged Young	6	5	8	10	0	8	6	15	58
% Chick Survival	3.90	10.20	13.56	22.22	0.00	9.88	8.00	13.89	9.51
Prod per Attempt	0.09	0.17	0.33	0.67	0.00	0.25	0.24	0.38	0.23
1997									
No clutches	47	30	8	11	11	33	11	30	181
Mean Date Found	23.4	23.4	12.4	2.5	25.4	20.4	15.4	22.4	22.4
Daily Nest Failure Rate	0.019	0.020	0.019	0.076	0.015	0.000	0.073	0.010	0.018
% Nest Survival*	59.0	58.0	60.0	11.9	66.2	100.0	13.0	76.3	61.6
Mean Clutch Size	3.83	3.57	3.50	3.45	3.27	3.82	3.73	3.70	3.69
Mean Brood Size	2.79	2.63	2.50	4.00	3.00	3.18	3.00	3.31	3.02
Total Young Hatched	112	60	33	8	23	126	12	106	480
% Hatching Success#	70.9	67.7	71.4	100.0	75.0	87.1	75.0	84.3	78.8
Total Fledged Young	20	8	9	4	3	16	4	20	84
% Chick Survival	17.86	13.33	27.27	50.0	13.04	12.70	33.33	18.87	17.50
Prod per Attempt	0.43	0.27	1.13	0.36	0.27	0.48	0.36	0.67	0.46
1998									
No clutches	44	40	20	12	9	25	6	39	195
Mean Date Found	28.4	26.4	30.4	4.5	5.5	20.4	5.5	30.4	28.4
Daily Nest Failure Rate	0.005	0.031	0.009	0.021	0.071	0.030	0.010	0.008	0.016
% Nest Survival*	86.6	42.6	78.0	56.6	13.5	43.6	76.5	81.1	64.9
Mean Clutch Size	3.59	3.75	3.70	3.75	3.56	3.40	3.67	3.64	3.63
Mean Brood Size	3.22	2.88	2.80	3.00	3.00	3.31	3.00	2.83	3.01
Total Young Hatched	133	53	42	21	21	43	19	94	443
% Hatching Success#	87.3	75.4	75.0	75.0	75.0	87.8	81.8	78.1	81.0
Total Fledged Young	9	7	3	0	8	13	3	14	57
% Chick Survival	6.77	13.21	5.08	0.00	38.10	30.23	15.79	14.89	12.87
Prod per Attempt	0.20	0.18	0.15	0.00	0.89	0.52	0.50	0.36	0.29
Failure/survival rates 1996-98 combined									
Daily Nest Failure Rate	0.0167	0.0281	0.0119	0.0284	0.0412	0.0123	0.0169	0.0105	
Lower Confidence Limit	0.0124	0.0207	0.0064	0.0177	0.0264	0.0079	0.0099	0.0068	
Upper Confidence Limit	0.0225	0.0381	0.0220	0.0452	0.0636	0.0190	0.0289	0.0163	
% Nest Survival*	63.4	46.3	72.3	45.9	32.1	71.6	63.1	75.1	

Hatching success was calculated as the % of eggs hatching in nests surviving to hatching.
* Nest survival was calculated as the Mayfield daily survival rate to the power of the length of the incubation period in days, so is not equal to the percentage of nests that were successful.

Table 3 ***Comparison of nest failure rate between years (1996 to 1998) and study sites for Lapwings breeding around Newtonmore, Strathspey (Likelihood Ratio Test: Chi-squared = 70.079, 14df, p = 0.0001). Percentage nest survival was calculated assuming our incubation period of 27 days (see text for details).***

Site	Year	Daily nest failure rate	Lower confidence limit	Upper confidence limit	Nest survival %
A	1996	0.0255	0.0173	0.0374	49.8
	1997	0.0194	0.0113	0.0331	59.0
	1998	0.0053	0.0022	0.0127	86.6
B	1996	0.0349	0.0199	0.0604	38.3
	1997	0.0200	0.0108	0.0367	58.0
	1998	0.0311	0.0197	0.0488	42.6
C	1996	0.0114	0.0043	0.0300	73.4
	1997	0.0188	0.0061	0.0565	60.0
	1998	0.0092	0.0030	0.0281	78.0
D	1996	0.0125	0.0040	0.0380	71.3
	1997	0.0759	0.0400	0.1396	11.9
	1998	0.0209	0.0087	0.0492	56.6
E	1996	0.0462	0.0264	0.0797	27.8
	1997	0.0152	0.0038	0.0585	66.2
	1998	0.0714	0.0300	0.1604	13.5
F	1996	0.0140	0.0073	0.0266	68.4
	1997	0.0000	0.0000	0.0000	100.0
	1998	0.0303	0.0168	0.0538	43.6
G	1996	0.0072	0.0027	0.0190	82.3
	1997	0.0727	0.0368	0.1387	13.0
	1998	0.0099	0.0014	0.0666	76.5
H	1996	0.0145	0.0076	0.0276	67.4
	1997	0.0100	0.0041	0.0237	76.3
	1998	0.0077	0.0035	0.0171	81.1

direct result of agricultural practices in 1996, 5 during field rolling and 4 by stock trampling the eggs. Stocking of farm animals in site E was again intense in 1998 when, out of 9 clutches found, 3 were trampled by stock and 3 simply disappeared. Comparing the causes of nest failure between sites (Table 4) and between years for all sites combined (Table 5) showed that, overall, agricultural operations or stock directly accounted for only 5.0% of nest failures.

Discussion

Variation in Lapwing nest failure rates has repeatedly been related to intensity of agricultural management, leading either directly to clutch destruction through damage by agricultural machinery and operations, or trampling by stock (eg Shrubb 1990; Berg *et al* 1992; Triplet *et al* 1997; Broyer & Benmergui 1998), or indirectly to high predation rates on fields where nests were exposed through cultivation or intensive grazing pressure (Baines 1990), although Galbraith (1988) found that predation rates were higher on rough gazing than on arable land. Although there were significant differences in the nest failure rates within sites between years and between sites within years in this study, overall nest survival, for all

Table 4 ***Causes of failure for Lapwing nests on 8 study sites around Newtonmore, Strathspey over the 3 years 1996 to 1998 (all 3 years combined). Note that the simple percentage success rates given here are not equivalent to the Mayfield derived nest survival rates in Tables 2 and 3.***

Area		Numbers and percentage of nests						
		Successful	Failing due to specific causes					Total
			Agric	Trampled	Other	Predation	Unknown	
A	No	118	6	0	5	14	18	161
	%	73.3	3.7	0	3.1	8.7	11.2	
B	No	59	2	1	3	3	31	99
	%	59.7	2.0	1.0	3.0	3.0	31.3	
C	No	53	0	3	2	2	3	52
	%	80.8	0	5.8	3.8	3.8	5.8	
D	No	21	1	0	1	1	14	38
	%	55.3	2.6	0	2.6	2.6	36.9	
E	No	21	5	5	0	0	9	40
	%	52.5	12.5	12.5	0	0	22.5	
F	No	70	3	2	0	1	14	90
	%	77.8	3.3	2.2	0	1.1	15.6	
G	No	29	0	0	3	0	10	42
	%	69.1	0	0	7.1	0	23.8	
H	No	88	1	2	2	3	12	108
	%	81.5	0.9	1.8	1.8	2.8	11.2	
Total	No	448	18	13	16	24	111	630
	%	71.1	2.9	2.1	2.5	3.8	17.6	

sites and years combined, was around 60%. It is not known whether this rate of nest survival was adequate to ensure sufficient reproduction of young Lapwings to replace post fledging and adult mortality. However, while 40% of nesting attempts failed between laying and hatching, the apparent loss of chicks between hatching and fledging (from 82.5 to 90.5%) appears to have been far more significant and appeared to be the main factor determining success in Lapwings in this study. Analysis of Lapwing mortality rates in Denmark using ringing recovery data has indicated that, to maintain a stable population, each breeding pair needs to produce an average of 1.18 fledged young *per annum* (Bak & Ettrup 1982), while an estimate of mortality rates in British Lapwings using ringing recovery data from 1963-1992 (Catchpole *et al* 1999) calculated that 0.56 fledged young per year were required for the population to maintain itself (note that this assumes that 50% of females do not breed until they are 2). Over the 3 years of this study the productivity ranged from 0.23 young per attempt in 1996 to 0.46 in 1997. Lapwings are single brooded, although they will replace clutches lost during the first half of the incubation period (Hegyi & Sasvari 1998). Overall nest survival was around 60% so that at most 40% of the nesting attempts recorded could have been replacements. Adjusting the figures to allow for this potential margin of error indicates that even if 40% of all nests were replacements, the productivity was no greater than 0.38 in 1996, 0.48 in 1998 and 0.77 chicks per breeding pair in 1997. These estimates suggest that only in 1997 was productivity sufficient to replace mortality. For the study population to have been self sustaining, our estimates of productivity per nesting attempt suggest that each pair must have been failing at least once, and probably twice, on average, before making a successful breeding attempt –

Table 5 ***Comparison of causes of nest failure between years (1996 to 1998) for Lapwings breeding around Newtonmore, Strathspey (all sites combined). Note that the simple percentage success rates given here are not equivalent to the Mayfield derived nest survival rates in Tables 2 and 3.***

Year		Successful	Numbers and percentage of nests Failing due to specific causes					Total
			Agriculture	Trampled	Other	Predation	Unknown	
1996	No	176	6	3	5	12	52	254
	%	69.3	2.4	1.2	1.9	4.7	20.5	
1997	No	131	6	5	1	6	32	181
	%	72.4	3.3	2.8	0.5	3.3	17.7	
1998	No	141	6	5	10	6	27	195
	%	72.3	3.1	2.6	5.1	3.1	13.8	
Total	No	448	18	13	16	24	111	630
	%	71.1	2.9	2.1	2.5	3.8	17.6	

this seems unlikely, not only because the length of the breeding season is limited, but also because small chicks were not found late in the summer.

The nest survival rate for nests over the 3 year period remained consistent at around 60%, which suggests that the decrease in nesting attempts recorded was likely to have reflected a decline in the number of nesting pairs present. The alternative hypothesis that the number of pairs present remained constant, but that each pair made fewer nesting attempts *per annum* was not credible. Baines (1990) showed that Lapwing breeding densities decreased by 74% on pastures and by 56% on meadows following agricultural improvement, and that fledgling production was 63% lower on improved areas. Although the level of stocking in the study areas was intensive over all 3 years, no changes in agricultural practice were apparent. Examination of the causes of nest failure (Tables 4 & 5) suggest that agricultural practices led directly to the destruction of only around 5.0% of all nesting attempts, although it was very likely that they also led indirectly (through lack of cover) to losses by predation. In Baines' (1990) study almost twice as many simulated clutches were predated within 24 hours on improved pastures as on unimproved. At lower breeding densities, the strength of communal nest defence is reduced such that all nests become more vulnerable (Berg, 1996). However, a direct nest failure rate of around 40% does not appear sufficiently low to account for the observed population declines. Indeed, clutch size, brood size at hatching and nest survival all appeared to be sufficient, across the years considered, to maintain the breeding population (but not to increase it). Chick mortality, however, does appear to have been high. Although there was no evidence to indicate the age after hatching at which chicks were being lost, adverse weather is more likely to have affected the survival of young than older chicks. Younger chicks will have been more vulnerable to predation, although both these effects would be very difficult to measure in a nidifugous species like Lapwing. These factors were likely to have contributed to the between year variations in chick survival (Table 2). Although we have not attempted to relate farming practice to chick survival in this study, these relationships have often been investigated previously (eg Galbraith 1988; Shrubb 1990; Reichholf 1996; Johansson & Blomqvist 1996; Triplet *et al* 1997) and it is clear that under the current agricultural regimes practised in this part of Speyside, Lapwings are unable to breed successfully enough to maintain their numbers. Although there was an increase in the annual total of nesting attempts in the study area from 181 to 195 between 1997 and 1998, there was a 23% reduction in the number of nests found between 1996 and 1998. A 28% reduction in breeding Lapwing abundance was observed on Scottish Breeding Bird Survey squares between 1994 and 1998 (Noble *et al* 1999). While it may be difficult to make a valid direct comparison between the BBS figures and this 3 year study in a limited area, both figures suggest that the current situation where over 50% of all breeding Lapwings in Britain are found in Scotland (Wilson & Browne 1999) may be only a temporary phenomenon, and that, despite its currently relatively healthy size, the Scottish population cannot be regarded as a source potentially supplying other UK populations.

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Lapwing at nest scrape *Bobby Smith*

Observations of wintering Ring Ouzels and their habitat in the High Atlas Mountains, Morocco

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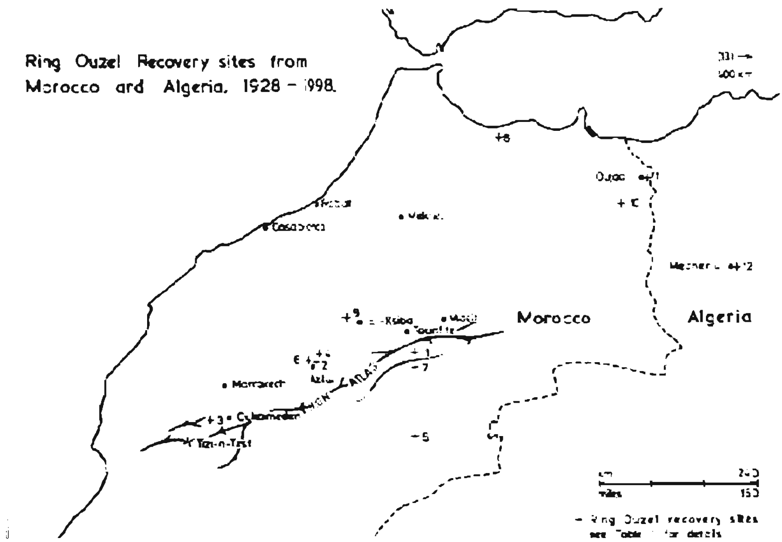
A study of the breeding biology of the Ring Ouzel in Glenesk, Angus, which involves the ringing of both chicks and adult birds, has yielded one recovery from Morocco. The High Atlas Mountains of North Africa are considered to be one of the Ring Ouzel's more important wintering grounds. To date 11 British ringed birds, including 2 Scottish ringed chicks, have been recovered from Morocco and 2 from Algeria, one a chick ringed in Scotland. In January 2000 members of the Tay Ringing Group visited Morocco and located wintering flocks feeding on Juniper bushes along the arid northern foothills of the High Atlas Mountains.

Introduction

The principal wintering quarters of the Ring Ouzel (*Turdus torquatus*) have been identified as Southern Spain and Northwest Africa (Blondel 1962, Niethammer 1955, Zamora 1990). The first arrivals on wintering grounds in Northwest Africa reach the Middle Atlas Mountains from early October and the High Atlas from late October (Thevenot *et al* in prep). The information from the British Trust for Ornithology Ringing Scheme of North African recoveries of Ring Ouzel from Great Britain totals 11 from Morocco and 2 from Algeria. (Figure 1, Table 1). Although the sample size is small some conclusions can be drawn from the dates and ringing locations. The 3 Orkney and Kent ringed birds according to the criteria used by Durman (1976) are of possible Scandinavian origin. As far as the Lincolnshire, Isle of Man, Yorkshire and Sussex birds are concerned, no assumption of their origin could be made. Of the total recoveries only 5 (4 chicks and one juvenile) can definitely be attributed to the British population and 3 of the chicks and the juvenile were ringed in Scotland. The limited recoveries in North Africa are widespread and no conclusions are possible apart from their preference for the upland areas in the Atlas Mountain region. The recoveries are possibly limited by the terrain and the unrepresentative distribution of observers in the region.

On the wintering grounds the birds occur in open coniferous woodland on bare stony slopes and are especially abundant in Phoenecian Juniper *Juniperus phoenicea* and Spanish Juniper *Juniperus thurifera* or in mixed woodland of Holm Oak *Quercus ilex* and Prickly Juniper *Juniperus oxycedrus*, often near sources of water (Thevenot *et al*, *pers comm*). Juniper berries are known to be the main food source in North Africa (Blondel 1962, Heim De Balsac 1931). A more comprehensive study of the birds' winter feeding, carried out in the Sierra Nevada in South East Spain, showed that juniper berries from *Juniperus communis* make up around 90% of the diet (Zamora 1990).

The breeding biology of the Ring Ouzel is currently being studied in the area around Invermark, Glenesk, Angus, Grid Reference NO4380 (Arthur 1994). Although the Invermark study area appears to hold a stable population, Ring Ouzels are in decline in other areas of Scotland, notably the



southern uplands, as well as in Wales and parts of England. Comparison between the 1993 BTO Breeding Atlas and the 1999 RSPB Ring Ouzel survey indicates a reduction in the occupancy of breeding territories of around 40% (Wotton *pers comm*). In recent years the leading UK Conservation Groups have placed the Ring Ouzel on their Amber List, the criteria being a decline between 25%-49% in the breeding population or range over the previous 25 years. The reason for the decline is not apparent, but the studies currently underway in the Moorfoot Hills, Glenesk and Glen Clunie may give further information (Burfield *pers comm*, Rebecca 2000).

The Angus Glens in the East Grampians are probably one of the most important breeding grounds in Scotland for Ring Ouzel. They currently appear to hold a stable population in a habitat which has not changed for some considerable time. While we are improving our knowledge of the breeding biology of this species, we felt it would be beneficial to extend our study to observing the birds in winter.

Aims

As the High Atlas Mountains are considered to be one of the Ring Ouzel's more important wintering grounds, a trip to Morocco was organised by 4 members of the Tay Ringing Group from 23 January to 2 February 2000. The objectives of the trip were to locate wintering flocks, study their habitat use, identify their main food source and record the altitude they were found at.

Whenever it was practical, birds were checked for colour rings in the hope of sighting birds from any of the 4 British study areas: Angus, Aberdeenshire, Lothian and Shropshire. A further aim was to identify potential mist netting sites for a possible future follow up ringing study, should permission be granted by the Moroccan authorities.

Logistics and methods

Plans for the trip developed very quickly following informal discussions during the 1999 Scottish Ringers' Conference in November. A great deal

Table 1 *Ring Ouzel recoveries from North Africa.*

	Ringing details			Finding details	
No	**Date**	**Location**	**Age/sex**	**Date**	**Location**
1	17/09/1959	Gibraltar Point, Lincolnshire	Adult male	26/02/1962	Oujda, Morocco
2	03/10/1963	The Calf, Isle of Man	Juvenile female	15/12/1965	Nr Azilal, Morocco
3	26/09/1966	Yorkshire	Juvenile male	10/12/1968	Tizi-n-Test, Morocco
4	28/05/1975	Kent	Adult female	15/11/1976	Nr Azilal, Morocco
5	10/09/1977	Sussex	Juvenile male	13/12/1977	Nr Alnif, Morocco
6	23/05/1980	Trefil, Tredegar, Gwent, Wales	nestling	14/02/1982	Tilouguit, Nr Azilal, Morocco
7	28/06/1982	Penicuik, Lothian	nestling	21/11/1982	Amouguer, Goulmimia, Morocco
8	21/10/1987	Noss Farm, Wick, Caithness	Adult male	15/03/1988	El Allig, Bou Saada, Morocco
9	24/04/1988	North Ronaldsay, Orkney	Adult male	10/04/1989	Kasba Tadla, Beni Mellal, Morocco
10	10/09/1994	Invermark, Glen Lee, Angus	Juvenile	23/11/1995	Jerada Region, Nr Oujda, Morocco
11	22/05/1998	Glen Clunie, Aberdeenshire	nestling	05/11/1998	Ait Yaddou, Nr Aberdouz Mts. Morocco
12	28/05/1928	Kirkconnel, Dumfries & Galloway	nestling	15/03/1929	Mecheria, Algeria
13	12/04/1989	North Ronaldsay, Orkney	Adult male	24/10/1990	Aler Prov., Tizi Ouzou, Algeria

of research was done including gathering information from previous trips to the High and Middle Atlas (Ryall, 1993 *pers comm*, Smith, 1965, Allport *pers comm*). From the information available, target areas were chosen. These were: Tounfite (1941m altitude, lat 5 15°W, long 32 28°N), the pass of Tizi-n-Test (2092m altitude, lat 8 15°W, long 30 50°N), and Oukaimeden (2650m altitude, lat 7 50°W, long 31 7°N).

Maps of a selection of areas of the High Atlas were obtained from Hamish Brown who operates the Atlas Mountains Information Services from his base in Burntisland, Fife. For general travelling we used the Michelin Morocco map 959. For more detailed work, maps at a scale of 1:100,000 and 1:200,000 were used. These were produced by the Moroccan military in the 1960s and were of varying quality but the best available.

A 4 wheel drive vehicle with a driver and cook was hired through Hotel Ali in Marrakech. Their help with navigation, language, security, provisions, camping and hotel accommodation proved invaluable, allowing us to spend most of our time in the field.

Survey work was carried out in 4 areas: Bou-mia, south of El-Ksiba, Tounfite, Oukaimeden and Tizi-n-Test. Observations were carried out around these areas in various habitats wherever vehicular access was possible. Regular stops were made on the routes chosen and excursions on foot, of one to 3 hours, were made to observe and record all birds seen. The route taken during the survey work is shown in Figure 2.

Summary of sightings of Ring Ouzels and other thrushes in the High Atlas Mountains together with habitat notes

24 January 2000 Familiarisation tour from El-Ksiba south to El-Arba, east to Aghbala, north to El Khemis and back to El-Ksiba (175 km). Several areas of Prickly Juniper located but no sightings of Ring Ouzel, one Redwing *Turdus iliacus*, 10+ Blackbirds, *Turdus merula*.

25 January 2000 13.00-17.00 20 - 30 km south of Tizi-n-Isly - along route 1903 to Imilchil (1500 to 1700m) 15+ Ring Ouzels encountered in open mixed woodlands, Prickly Juniper, Phoenician Juniper and Holm Oak with some Aleppo Pine *Pinus halepensis*. Also observed flocks of 20+ and 50+ Redwings, 3 Mistle Thrushes *Turdus viscivorus* and 4 Blackbirds.

26 January 2000 18.00 On late arrival at Tounfite area (1950 m) 2 Ring Ouzels plus 20+ Redwings, 2 Blackbirds north of Tounfite. Ring Ouzels seen on dry stony slopes with a scattering of Juniper, mostly Phoenecian along river banks.

27 January 2000 09.30-11.30 14.30 15.40 On slopes of Bou Chouari, immediately south of Tounfite (c1980m) - 6 Ring Ouzel observed feeding on berries of Red-berried Mistletoe *Viscum cruciatum* growing on Hawthorn *Crataegus sp* among Prickly Juniper and Holm Oak on dry stony slopes. 2km north of Tounfite west side of road at c1920m (site 'A') - 80+ Ring Ouzels, 8 Mistle Thrushes, 5+ Redwings and 6+ Blackbirds actively feeding on Juniper, mainly Phoenecian some of which very heavily laden with berries. At water source close to previous location on the east side of road (site 'B') 10+ Redwings 10+ Song Thrushes 40+ Ring Ouzels drinking at water source, fed by spring in dry gully with steep rocky slopes sparsely covered by mainly Phoenician Juniper. Some of these bushes were heavily encrusted in droppings from *Turdus* spp, indicating regular use of the site.

16.20 2.5km north of Tounfite 2+ Ring Ouzels with 20+ Redwings feeding on Phoenician Juniper and drinking at stream at side of road.

28 January 2000 07.30-10.00 10.30-11.40 12.00-13.00 13.10 14.00-14.40 Revisit to site A 30+ Ring Ouzels, 15+ Blackbirds, 12 Mistle Thrushes feeding on Juniper spp. Revisit to site B 30+ Ring Ouzels, 10 Redwings. 3km north of Tounfite following water course of the Oued Oudrhes downstream from ford, 20+ Ring Ouzels, 6+ Redwings, 6+ Blackbirds, 8+ Song Thrushes coming to water and perching in Hawthorn and other bushes overhanging small pools. Juniper spp and Holm Oak scattered on dry stony slopes. At principal water source 2 - 3km downstream from ford 40+ Song Thrushes, 5+ Redwings, 12+ Blackbirds and 30+ Ring Ouzels drinking from stream where cover of scrub and trees was at its most dense. 6km north of Tounfite - 2 Ring Ouzels 10km north of Tounfite - 3 Ring Ouzels, 3+ Redwings and 2+ Blackbirds.

31 January 2000 10.40-15.30 Route S501 to Tizi-n-Test (2000m) around noon between 118km marker and 128km marker from Marrakech 15 Ring Ouzels, 5 Mistle Thrushes and 2 Blackbirds observed feeding among scattered vegetation of Prickly Juniper and Holm Oak with some Phoenician Juniper and pine.

1 February 2000 8.00-12.30 Route S513 to Oukaimeden (2650m) Previous reports recorded Ring Ouzels in the Oukaimeden area but none were observed during our visit. Moderate amounts of Juniper both Prickly and Phoenician but many trees with few or no berries. 20+ Redwings observed among Phoenician on return from Oukaimeden, plus 5 Blackbirds and 7 Mistle Thrushes.

No colour ringed birds were observed.

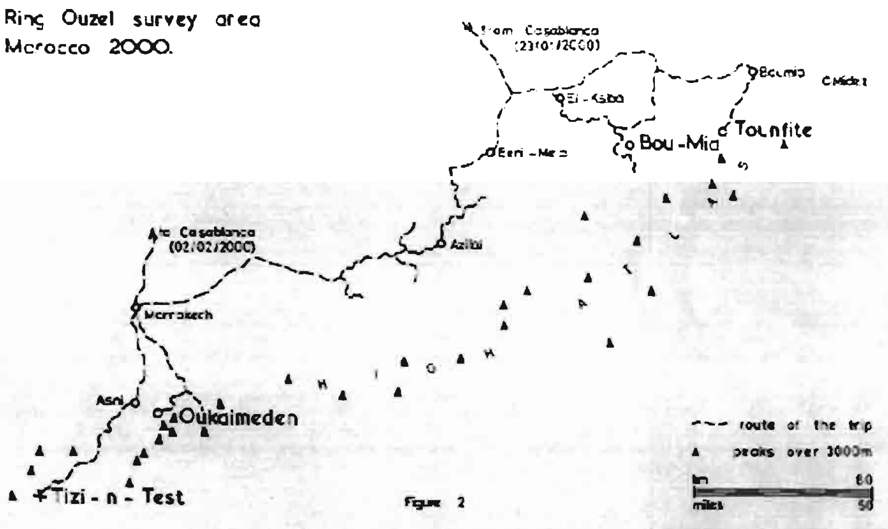


Figure 2

Conclusions

Our preliminary research had led us to speculate that the destruction of Juniper habitat in parts of Morocco may be directly linked to the decline of the Ring Ouzel in the UK. Certainly, there are cases of deforestation in the Middle Atlas (Ryall and Green, 1994). Morocco is a poor country with an expanding population and wood is an important source of domestic fuel. However, our observations showed that in most cases the removal of timber was limited to the scale dictated by the use of basic hand tools and local transport by donkeys. A large percentage of the Juniper trees had evidence of branches being chopped away over a long period of time, leaving partly pollarded, gnarled stumps, many probably of considerable age. Very little evidence was found of complete removal of trees. Likewise, the Holm Oak trees were being managed in a similar way but in this case the younger branches carrying the less prickly leaves higher up in the trees were being gathered as fodder for goats, sheep and cattle. Natural regeneration, although limited in scale, appeared to be sufficient to maintain a stable tree density. Overall the wooded areas visited seemed to be 'managed' on a sustainable level, and the Berbers were living in harmony with their environment.

Due to the time scale and distances travelled, only a small number of sample sites were investigated and a relatively short time was spent in each area of suitable Ring Ouzel habitat. However, the weather conditions were excellent during the trip, which allowed useful observations to be made. Encouraging numbers of Ring Ouzels were observed once we had identified suitable habitats. These were in areas where we found Juniper to be plentiful, although well scattered, on arid, stony slopes (principally north facing) at altitudes between 1500m and 2000m.

Two species of Juniper, Prickly and Phoenician, provided the favoured berries on which most of the Ring Ouzels were observed feeding. These berries seemed to form a very high percentage of their diet, and their dry, resinous nature seemed to necessitate frequent intake of water to aid digestion. Consequently, as water was generally in short supply, concentrations of birds were observed drinking at pools, especially where suitably located bushes and small trees afforded plenty of cover.

The birds seemed to show a preference for the berries of Phoenician Juniper and this species was always present where larger numbers of the birds occurred. In some areas, juniper trees were encountered with little or no berry crop. The trees may well show annual variations of berry production with bumper crops followed by lean years. Once the birds have stripped the trees in an area they presumably disperse in their search for food, resulting in a mobile population with fluctuating numbers in any particular area throughout the winter months.

Most of the birds in the Juniper scrubland were thrushes. At least 213 Ring Ouzels were found in the short time that was spent in suitable habitat, along with at least 161 Redwings, 58 Blackbirds, 58 Song Thrushes and 27 Mistle Thrushes. Whenever possible birds were checked for colour rings but none were seen.

The largest concentrations of Ring Ouzels, totalling a minimum of 175, were observed just north of Tounfite. However, we consider it likely that similar numbers of birds are to be found wintering in suitable habitats anywhere along the northern foothills of the High Atlas between Tounfite and Tizi-n-Test some 350km to the southeast.

Acknowledgements

We would like to thank all those who assisted with information for our trip particularly the following people G Allport; C Bowden; H Brown; I J Burfield; M D Jones; B Lynch; G Rebecca; C Ryall; D Tattersfield, R Vernon and the British Trust for Ornithology Ringing Scheme for the ringing recoveries.

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Ring Ouzel at nest site *William Brotherston*

SHORT NOTES

Prey captured and attacked by Merlins in winter

It was suggested in Dickson (1988 *British Birds* 81: 269-274) that more study was needed on winter prey of Merlins *Falco columbarius* in Britain. In a subsequent quantitative note Dickson (1992 *Scottish Birds* 16: 282-284) detailed 270 hunts from 1965-92 where it was shown that 2 bird groups figured largely in the results by number: Skylarks *Alauda arvensis* and finches *Fringillidae*. The following is based on observed hunts in west Galloway to see if there has been any significant changes since 1992 in the composition of prey species attacked and captured by Merlins in winter.

A further 104 hunts were recorded between 1992 and 2000 (Table 1). All the attacks by blue and brown Merlins were directed at species usually associated with low ground and open country in winter in various habitats, mostly in farmland. Most hunts involved similar techniques as those detailed in Dickson (1996 *Scottish Birds* 18: 165-169) with low level attack flight predominating by both blue (79%) and brown (77%) Merlins. Blue Merlins were successful in 20% of hunts and brown Merlins in 16%, within the range of results given in Dickson 1996.

The prey species regularly attacked and killed between 1965-1992 and 1992-2000 are remarkably consistent with Skylarks and finches being the most frequent targets in winter. Blue Merlins attacked more finches, averaging 21g in weight in both studies (55% and 82%) than any other species. Brown Merlins consistently attacked more Skylarks (40%) averaging 37g in weight, in 1965-1992 but more finches (60%) in 1992-2000 (Table 1).

In 1965-92, 5 identified bird species formed more than 5% of kills in order of numbers: Skylark, Starling *Sturnus vulgaris*, Linnet *Carduelis cannabina*, Meadow Pipit *Anthus pratensis*, and Chaffinch *Fringilla coelebs*. Expressed by weight, Starlings emerged as the most important of kills (25%) with Skylark providing 21% of kills by weight, Lapwings *Vanellus vanellus* 17.5% and finches 11.8% (Scottish Birds 16: 282-284).

In 1992-2000 only 4 species formed more than 5%

Table 1 ***Percentage frequency of prey species attacked and killed by blue and brown Merlins in winter in west Galloway, 1992-2000.***

Prey species	No attacks by blue Merlins	% frequency	No attacks by brown Merlins	% frequency	Successful blue	Successful brown
Skylark	3	8.9	23	32.9		2
Meadow Pipit			2	2.8		2
Starling	1	2.9				
Chaffinch	6	17.6	1	1.4	2	
Linnet/Twite	22	64.7	41	58.6	4	7
Unidentified	2	5.9	3	4.3	1	
Totals	**34**		**70**		**7**	**11**

of kills: Skylarks, Meadow Pipits, Chaffinches and expressed by weight Linnets/Twites *Carduelis flavirostris* emerged as the most important of kills (87%) with Skylarks providing 6% of kills by weight, Chaffinches 4% and Meadow Pipits 3%.

Thus blue (males) in winter concentrated on the kills of the smaller bird species (16-37g) while brown Merlins (females and juveniles) seem to kill smaller to larger species (16-214g), although males did not seem to select different habitats to females nor juveniles to adults (*British Birds* 81: 269-274).

There are few other studies of winter diet apart from Warkentin and Oliphant (1990 *Journal of Zoology*, London 221: 509-563) North American study, which provides the only direct comparison, of a wintering population of Merlins in the city of Saskatoon, Canada. There they found that 3 species formed more than 5% (66% by weight) of kills House Sparrow *Passer domesticus*, Bohemian Waxwing *Bombycilla garrulus* (26% by weight) and Meadow Vole *Microtus pennsylvanicus* (5% by weight). They also found a large proportion of prey matched in summer and winter diets.

The results in this study reveal a high degree of overlap between summer and winter diets in Galloway. A significant proportion of breeding season prey in Galloway (1965-1999) is similar in composition to that in winter in which 14.3% (11% by weight) of Skylarks and 7.6% (20% by weight) of finches feature behind Meadow Pipits (57%, 24% by weight) in the table of remains found at breeding sites (Dickson, unpublished data).

R C Dickson, Lismore, New Luce, Newton Stewart, Wigtownshire DG8 OAJ

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Nestling feeding rates by Peregrine Falcons

There are few British data on the feeding rates of Peregrine Falcons *Falco peregrinus* throughout the breeding season. I obtained data at 2 sites on the coast and one inland in Wigtownshire between 1975-98 to provide an indication of the feeding rates in the nestling stage of the breeding cycle. The only other detailed account of nestling feeding rates is that given by Parker (1979, *British Birds* 72:104-114) of 64 items (number adjusted for delivered items only) in 249 hours of observation (0.26 deliveries/hour) in Wales.

Overall, the pooled number of prey deliveries brought and fed to the young in the nestling stage, but not cached, was 23 in 40 hours of observation (0.58 deliveries/hour). Martin (1980, BSc dissertation in Ratcliffe 1993, *The Peregrine*, London) noted an irregular spread of feeding times throughout the day with no particular pattern. A similar trend was found in prey deliveries in Wigtownshire when it occurred 11 times in the morning, 9 in the afternoon and 3 in the evening with no significant differences in deliveries during the day ($x^2 = 1.02$, 2df, NS). During the second half of the nestling stage, when females assisted males from the third week onwards, males still seemed to continue to act as the main provider in a male:female ratio of 4:1.

In comparison, the nestling feeding rates in Wigtownshire are higher than those recorded in Wales. Data were also calculated from some dates detailed in Treleaven (1977, *The Peregrine*, Penzance; 1998, *In Pursuit of the Peregrine*, Wheathamstead) for Cornwall. His data (delivered items only) suggests that the feeding rate in the nestling stage was 12 items in 32.25 hours of observation (0.37 deliveries/hour), lower than that obtained in Wigtownshire, but higher than the Welsh data.

Interestingly, the nestling feeding rates for Peregrines in Wigtownshire at 0.58 deliveries/hour, is identical to the feeding for Merlins *Falco columbarius* at 0.54 deliveries/hour in Galloway (Dickson 1995, *Scottish Birds* 18: 20-23).

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Peregrine family *Edmund Fellowes*

OBITUARIES

Hetty Louisa Harper
1915 - 2000

Hetty Harper *Geoffrey Harper*

Hetty Harper was born in London and when she was 6 her family moved to Devon where she grew up and went to school. She attended the University College of Exeter from 1933-36, gaining an external general degree from the University of London, and continued until 1937 to gain a teaching certificate in PE. She took up a teaching post in Bermuda in 1937 where she met Bill and they married in 1940. Bill had joined the Bermuda Meteorological Service in 1937 and they remained there until 1947. Bill was then posted to London Airport followed by a series of postings to Shetland, in England, Aden, Germany and, finally, Edinburgh after which he retired in 1977. While in these jobs they travelled widely and particularly enjoyed time on Fair Isle and in Africa and Arabia.

Hetty acquired a wide knowledge of birds before she joined the staff of the SOC in March 1975 as a much needed additional part time assistant in our Bird Bookshop. She worked on the staff until 1983. One day Hetty mentioned that Bill, who retired in 1977, was looking for something to do. It was suggested that he might be interested in Library work, he took over from Irene Waterston later that year. Hetty worked with others in the Bookshop and they developed into a good team, which enjoyed its work and also the opportunity to meet members and other customers who came to buy books. A very good rapport was built up with customers due to the friendly welcome by Hetty, her help and advice when choosing bird books for many parts of the world they were either to visit or had come from. After 8 years on the paid staff, Hetty came in regularly with Bill and did much valuable work in the Library. With Bill she always attended conferences of both the SOC and the BTO, helping him with his second hand book sales in aid of Library funds or Bookshop sales. Her knowledge and advice on these occasions was greatly appreciated. When Bill, who had been made an Honorary Member of the SOC in 1987, died in 1995, Hetty was made an Honorary Member on her own merits.

Hetty worked voluntarily in the Family Care bookshop in Edinburgh for several years until 1999. She was a very active member of the WRVS and joined the Tuesday morning team which ran the tea bar at the Princes Margaret Rose Hospital for about 15 years until 2000. One particularly enjoyable aspect of the Harper household was an invitation to dinner, normally after a Club committee meeting when Hetty was the perfect hostess. Apart from enjoying her excellent home cooking and hospitality she really enjoyed a good 'blether' on a wide range of topics and liked to be kept up to date with all the latest news in the bird world.

Hetty was a remarkable and interesting lady, kind, gentle and caring and with a strength of character and determination which belied her small stature. This was aptly demonstrated by a strenuous trip last summer through Russia by local transport with her son Geoffrey. This was quite a feat for someone in her 80s, but she took it in her stride and enthused about her experiences on her return home. Sadly, recurring cancer took its toll and she died in September after a month in Fairmile Marie Curie Centre. The Club has lost a valued member who gave great service over 25 years, and who will not be forgotten by all her many friends and family.

Alastair Peirse-Duncombe and David Clugston

Ivan Hills OBE
1914 - 1999

Ivan Hills' passion for birds was nurtured in the wilds of the Scottish Highlands. After schooling at Stow, where he was allowed to keep a pet Raven and Kestrel, he trained as a land agent and gravitated to the role of road surveyor in Sutherland. There he contributed to the construction of the roads from Lairg to Altnaharra, and by Loch Loyal to tongue and Melvich. In his spare time he searched for Golden Eagles, Peregrines, Greenshanks, Golden Plovers and Red-and Black-throated Divers, tracking down their nests on the cliffs of the hills and coast, and on the moorlands, flows and lochs. In the Grampians and Cairngorms he was amongst Dotterel and Ptarmigan and was one of the few to see nesting Snow Buntings in the years when they were Scottish breeders.

At the outbreak of World War 2, Ivan enlisted in the Seaforth Highlanders and saw active service with the Eighth Army in North Africa, Sicily, Italy and Germany, rising to the rank of Major. After demob he joined the National Trust, becoming regional land agent for Kent, Surrey and Sussex, From 1967 to retirement in 1976, Ivan Hills was the Trust's Chief land agent and based at the Trust's London Headquarters, an unappealing location but with opportunity for a say in major policy, and for travel. In this role, he promoted programmes with important wildlife conservation spin off, such as Enterprise Neptune, with the acquisition of extensive coastal properties. He continued to visit Scotland on holiday, as the best part of Britain in which to watch birds and enlarge his knowledge of them, and was never happier than when in the north.

On retirement, Ivan and his wife Mary turned their attention to Lapland, as a still more appealing northern region, and went there for 10 consecutive years in their camper van, enjoying the birds and plants of the Arctic wilderness. He became a hide photographer and sound recorder and pitted his skills as a nest finder against some of the difficult waders. His powers of endurance were tested by the 10 hours he waited by a marsh on a cold day for a Bar-tailed Godwit to change over with its sitting mate, and he and Mary found no less than 6 nests of this elusive bird. Other notable nests were those of Broad-billed Sandpiper, Little Stint, Spotted Redshank, Hawk Owl, Arctic Warbler and Little Bunting. Ivan contributed observations on breeding behaviour, display, song and sonograms on some of these species to *The Birds of the Western Palaearctic*. Ivan lectured on his birding experiences to most branches of the SOC, where the beautiful slides that he and Mary had taken were much appreciated. A genial, kindly and outward going man, he was generous in sharing his knowledge with others; and he treated everyone as equal, with an Old World courtesy that is becoming increasingly rare. He is survived by his wife Mary, and children Tom and Lucy from his first marriage.

D A Ratcliffe

The Honorable Douglas Nigel Weir
1935 - 2000

With the sudden death of Doug Weir, Scottish ornithology has lost one of its most colourful characters and gentleman naturalists. He was the third of 6 children of the Viscount Weir. It is said that he was descended from Robert Burns; although reticent about this, he was proud that, as an infant, he had been dandled on Harry Lauder's lap. Doug was educated at Eton and briefly (preferring birdwatching to academic studies) at Trinity College, Cambridge.

During World War 2, his mother evacuated the family to her native Canada where he went to a preparatory school in the Okanagan Valley of British Columbia. His North American experiences had a profound effect on him and his great love of the outdoors found full expression there. He subsequently made a number of visits to Alaska, the first in 1952, where he based himself mainly at Nyac, a gold mining community which had been established by his Canadian uncle in the Kilbuck mountains. Later he worked as an associate ecological consultant with C C Hawley for the Klondike Miners Association on methods of land reclamation following open cast placer mining at Nyac. These environmental studies were of considerable importance. While there, he also worked extensively on the birds, especially raptors of the region. In 1974, he received a Winston Churchill Travelling Fellowship to continue this aspect of his fieldwork which resulted in a major joint publication in the North American Fauna Series (No 76). He was a skilled bird skinner and specimens collected in North America were deposited in the Royal Museum of Scotland, the Natural History Museum (Tring) and zoological museums in Alaska and California. In his more reflective moments he considered himself a prophet without honour in his own land, and it is certain that his work in North America was highly regarded there.

In the early 1960s, he was the senior short term warden responsible for the day to day wardening of the RSPB's 'Operation Osprey'. Whenever he could, he also did extensive fieldwork, mainly on birds of prey in the Spey valley. He was especially active in this respect from 1964-1969 as a research assistant responsible to the RSPB's Conservation Committee. He provided virtually all the Speyside data for the 1964-1968 Golden Eagle survey of Scotland. He was also a member of the Glenmore Mountain Rescue Team during the 1970s and, after he moved to Newtonmore, of the Lochaber Team. Despite being a chain smoker, few could match him on the hill at that time. In addition to a study of the inter relationship of the breeding biology of Eagle, Peregrine and Raven, he plotted all the Buzzard nesting territories from Aviemore to Newtonmore between 1964 and 1967. This was helped by having ready access to private estates through his friendship with the landowners. To capitalise on Doug's efforts, the 2 of us worked together for 3 years on the social behaviour of the Buzzard in the Spey valley from 1969. This resulted in 4 papers, one of which he copiously illustrated. The editor never returned the beautiful original sketches. Our close association during this period cemented a friendship begun in 1962 at the SOC annual conference at Dunblane. It was soon apparent that Doug's was a most unusual talent. He was a totally intuitive field worker but, whenever it was possible to check his claims, they always proved correct. He seemed inured to physical discomfort; if he had forgotten his wellington boots, he would cross bogs in his characteristic suede desert boots. Rather than take a long detour to a bridge, he once waded the Spey for a reviving dram at a local hotel after an arduous day on the hill. His knowledge of wildlife and the relevant literature was wide. His copious drafts, all typed on an old manual typewriter, covered the desk and floor of the basement office at Newtonmore which he shared with a Buzzard and his Golden Retrievers. Numerous references to his work in *BWP* and other major publications testify to the freedom with which he contributed unpublished data, especially on birds of prey, to leading scientists of the day.

Doug was one of the 4 founding directors of the Highland Wildlife Park at Kincraig which opened in 1972. Although a commercial success, he felt there would be more security if it were part of Edinburgh Zoo and he pushed for the eventual take over of the Park by the Royal Zoological Society of Scotland in 1986. He served on its Animal Health and Management Committee (now Animal Welfare Committee) until the late 1990s. The committee's early discussions included the then new activity of breeding endangered species in a coordinated and scientific way. Doug's research on penguin breeding at the zoo contributed to the success of their new penguin exhibit - the largest in the world.

He moved to Edinburgh in 1984 and was a frequent visitor to the Bird Section of the Royal Museum of Scotland. In 1993 his specialist expertise and skills proved invaluable when the Museum's Bird Section undertook work on *Braer* oil spill bird casualties. Although contracted only for data gathering and specimen preparation, his commitment was such that he became senior author on most of the resulting publications. This determination led to the Section winning a contract from the Countryside Council for Wales to analyse bird casualties from the 1995 *Sea Empress* oil spill. In association with Museum staff, his last 2 projects involved Iceland Gulls and mortality in Buzzards, the former in press in *The Journal of the Zoological Society of London.*

Most of us will remember him at conferences, pacing the floor and gently puffing a cigarette or stroking his beard, a drink always close to hand, discoursing knowledgeably, at length, on any variety of subjects, or drawing pithy cartoons on our dinner menus. He had a natural skill as an artist, and combined a Kodak mind for detail with a rare ability to capture the essence of an animal in a few strokes of the pen. Those privileged to know him well will miss a true and trusted friend of easy charm and great good humour. He will be greatly missed.

Nick Picozzi

Doug Weir with a colour marked Buzzard *Nick Picozzi*

Goshawk one of Doug's numerous sketches

Advice to contributors

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Front Cover House Sparrow. *Tom Holden & BTO*

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