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Minimal numbers and habitat of breeding Dunlin in north east Scotland

R RAE & A WATSON

National surveys consider breeding Dunlin scarce in north east Scotland. We estimated at least 436 pairs on only some potential habitat. Many were on alpine land, most on moorland blanket peat, some on glen peat and dune slacks. Numbers on 4 alpine and 4 high moorland areas showed no trend in 1967-95 but on some moorland may have fallen since 1980. We saw none at 8 low level sites since 1987 after habitat loss or deterioration. Rapid methods in transects and national surveys readily overlook this skulking breeder.

Introduction and study area

Recent books (Buckland *et al* 1990; Gibbons *et al* 1993) consider breeding Dunlin *Calidris alpina* scarce in north east Scotland. Here we give a higher minimal estimate and assess habitat in the shires of Aberdeen, Kincardine and nearby parts of Angus, Perth, Banff, Moray and Inverness (Figure 1).

Methods

In 1943-86 we noted Dunlin during other fieldwork covering thousands of miles on land seldom visited by people. In 1987-97 we went specially to look for Dunlin. An egg, chick, rasping call or distraction display signified breeding and courting, nest scraping or a nest cup possible breeding.

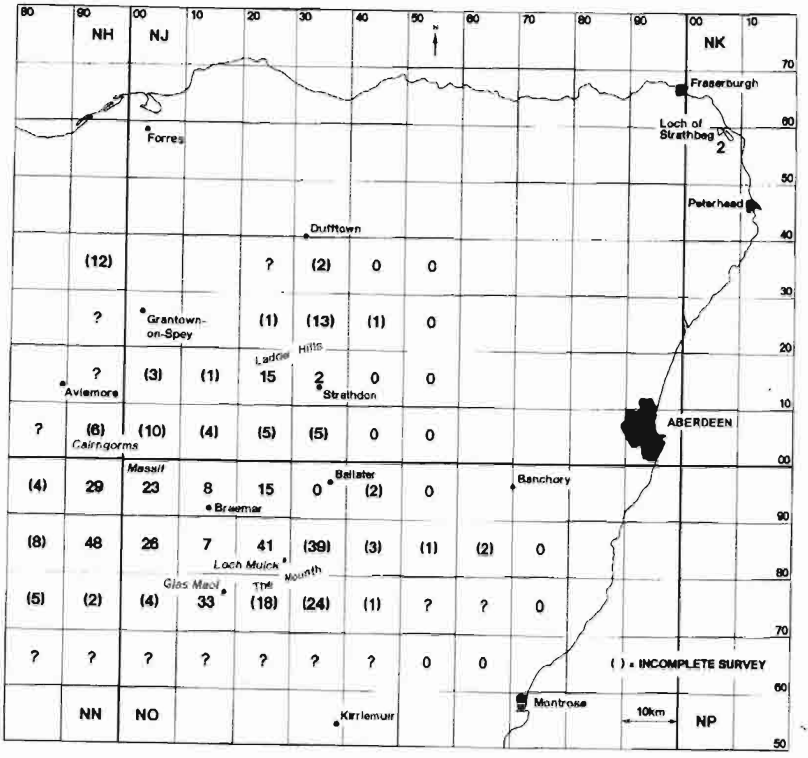
Method A involves birds with young<1 week being conspicuous on high points. On approach of a man, dog or Fox *Vulpes vulpes*, they flew from up to 100m to <10m to give distraction display, rasping calls and squeals. Method A misses birds on late nests and failed birds that have left.

Method B is to scan for the cryptic, often motionless and silent birds while walking slowly with frequent stops, zigzags and returns to previous stops. Although conspicuous when singing on calm mornings and evenings, they seldom sang on windy or warm afternoons except soon after spring arrival. Nesting birds skulked, and were easily overlooked (Campbell & Ferguson-Lees 1972).

Method C is that AW saw Dunlin adults, nests and young while counting Red Grouse *Lagopus lagopus scoticus* and Ptarmigan *Lagopus mutus* with pointing dogs (Jenkins *et al* 1963; Watson 1965). As in B, some Dunlin flushed far ahead, and were easily missed unless dogs were worked close.

Method D is to hear the dawn/dusk chorus (Watson & O'Hare 1979a & b; Watson & Rae 1987; Parr 1990). From spring arrival to having small young, Dunlin sang for c1 hour from 10-15 minutes after sunset and from >1 hour before sunrise. This can miss isolated birds; R Parr (*pers comm*) heard none at dawns near Ballater but between dawns saw

Figure 1 ***Minimum number of pairs seen in 1987-97.***
? -- potential habitat viewed from afar with binoculars
(0) -- no birds seen, apparently lacking potential habitat on farms, woods, freely drained moor and steep slopes, but only cursory inspection.
Blank squares were outside our area. Most apparently lacked potential habitat, but 4 squares south east of Forres with breeders in 1956-70 (AW) were unvisited by us since.



one on eggs. Method D requires prior daylight experience of Dunlin, walking on bogs in darkness and no strong wind or heavy rain.

The number of pairs seen in daytime searches on Glas Maol by methods A and C was similar to the number heard singing by D (Table 1). While watching Foxes, J Robertson (*pers comm*) found up to 20 pairs by method A in the 1970s at Black Burn, Loch Muick, where RR saw 10-20 pairs by A+B. Data by A+B, C and D agreed well in a Caithness study (Parr 1990). Methods A, C and D may be accurate, and B sometimes so, but need to be tested against territorial spacing (Holmes 1970). We used A, B, C and D in that frequency.

Table 1 ***Consistency within years in number of pairs seen in similar weather and date by methods A, C and D on the same area of Glas Maol.***

Year	A no dogs	C dogs	D, dawn/dusk watches
1967	6	6	-
1969	6	7	-
1970	10	10	-
1972	10	10	-
1982	6	7	7
1984	8	8	8
1986	6	7	7
1987	6	6	6
1988	6	-	6

We covered only some sites each year but assumed that each held similar numbers each year. This was valid when we visited sites in >1 year (Table 2). Of >100 sites with breeding in 1 year, all held birds when visited in a later year, bar those where there had been only 1 pair, or habitat loss.

Results

Alpine land

About 15% of pairs seen were above 800m in a) Three-leaved Rush *Juncus trifidus*, b) grass, sedge or lichen heath, and c) blanket peat (Appendix 3). Groups (territorial pairs within 150m) and isolated pairs were at 800-1100m, but above 1100m only the latter.

Most used b) and c), and a few a). Most nests on a) and b) were in tufts of rush or Mat Grass *Nardus stricta*, and some in Crowberry *Empetrum nigrum*. Some birds near paths sat tight, apparently used to people. Most nests lay near flushes, but a few were up to 400m. Birds on a) and b) nested on freely drained land, but took young to flushes, pools, lochans, or blanket peat. Flying young were on b) and c), and all Dunlin in alpine post breeding flocks of Golden Plover and Dotterel on b).

Highest nests were at 1210m on Cairn Lochan and 1230m by Wells of Dee which was a regular site in the 1930s (D Nethersole-

Table 2 ***Number of pairs seen on the same parts of 4 alpine hills in Glas Maol area and 4 high moorland ones (3 in Ladder Hills, fourth north of Ballater).***

	67	69	70	71	72	82	84	86	87	88	92	93	94	95
Glas Maol	6	7	10	6	10	7	8	7	6	6	-	-	-	-
Little Glas Maol	3	3	3	-	4	-	3	2	3	3	-	-	-	-
Cairn of Claise	2	2	3	-	-	-	-	2	3	2	-	-	-	-
Carn an Tuirc	3	3	4	-	-	-	-	-	2	3	-	-	-	-
Lecht	-	-	5	-	-	-	-	-	-	-	5	6	5	4
Carn Mor	-	-	3	-	-	-	-	-	-	-	4	3	-	4
Carn Liath	3	3	4	-	-	-	-	-	-	-	4	3	-	4
Mona Gowan	-	3	-	-	4	-	-	-	-	-	-	-	3	-

Scors Burn in Ladder Hills, 3 pairs in 1992 and 4 in 1995.

Thompson, *pers comm).* AW saw young at the Wells and others at 1150m on Feith Buidhe, and at 1140m on Garbh Uisge Beag, Lochan Buidhe, and Cnap a' Chleirich. At >1100m there was only an isolated pair in 1-2 km^2, suitable habitat being scanty.

Moorland blanket peat

Birds here formed c85% of the total seen, but we did not visit much of this habitat, so moorland may hold >90% of the population. Most were in groups (usually 3-8 pairs but up to 20). Most bred at 450-800m, the main altitude of blanket peat (Appendix 3). Some peat was uneroded, with pools and flushes on shoulders, saddles and basins. Most was eroded, with bare peat, hags, and few pools and flushes. Some of both types had meanders, oxbows and lochans.

Glen peat

This is Appendix 3's 'basin, valley and terrace peat', mostly eroded. Basin peat had vegetation like moorland peat, but several lochside and riverside mires had more sedge, less Heather and some tall rushes. In the 1930s, Loch Morlich by Aviemore held 1-2 pairs, but none after 1984 when scrub had grown (Watson *et al* 1988). In each July in 1945-47, 1-2 in alarm at Loch Davan near Dinnet probably had big young; farm stock kept plants short, but since 1960 it was ungrazed, tall sedge and scrub grew, and no Dunlin were seen since 1970. At nearby Loch Kinord, Prof D Jenkins (*pers comm*) often heard Dunlin in 1970-72 (probably 1-2 pairs), but not since. In the 1970s, 1-2 pairs bred at 300m by Dee near Braemar, but not since 1980, after high numbers of Red Deer *Cervus elaphus* overgrazed and trampled it. We saw none on Luibeg bog since 1986, after severe trampling, but they still nest on less trampled glen mires (eg Loch Tilt).

Dune slacks

At least 5 pairs formerly bred on lightly grazed slacks with pools and ditches at the Loch of Strathbeg in the late 1960s, by the late 1970s there were only 1-2 pairs, and the last known bred after 1983. After drainage in the early 1980s for more cattle and sheep, cereal was grown on one part for 2 years. In the 1990s the land began to revert to slacks and would improve with less grazing. Two pairs displayed in 1992, a pair was not displaying in 1994 and 1995, and none was seen in 1996. In late 1977 a petrochemical plant destroyed the St Fergus site, where at least 2 pairs had bred.

Main features in all sites: open water, gradient and plant height

All lay near open water, mostly alpine flushes and moorland pools. Most young were at pools, lochans, flushes, slow streams, and wet land nearby. Footprints and faeces showed much used pools. Pools used by young had shallow edges, and dried in some years such as 1994. We saw no birds at deep pools with vertical banks. Highest densities (up to 3 pairs/15 ha at 570-590m on Monaltrie Moss and 760m on the Ladder Hills) were on uneroded peat with shallow pools, flushes and nearby vegetation with much *Sphagnum.* However, density is a dubious concept where birds occur linearly on flushes or clustered at pools, and often fly to other habitats to feed.

Most were on slopes <5%, many on flats, and the few on 8-10% slopes were on flat shelves within the slope. Some in the Cairngorms bred on flats at 510m in Glen Geusachan and 860m by Loch nan Stuirteag 4km away, and not on steep land between. Another case was at 500m in Glen Derry and 850m on Moine Bhealaidh 3km away.

D Nethersole-Thompson (in Watson 1966) noted this on Speyside. All these breeding sites were on peat >2m thick, with much *Sphagnum* and many pools or flushes (Appendix 3), features absent on steep slopes due to fast drainage.

All 60 nests seen were in plants 10-20cm high, with short vegetation <10cm within 1m. We saw no Dunlin in vegetation >25cm high, and adults in <2cm were there only briefly in alarm.

Estimates of numbers

Work in 1987-97 showed at least 178 pairs breeding in 36 squares of 10 x 10km, and at least 258 possibly breeding. We searched all potential habitat in the 11 most studied squares. In 25 squares (Figure 1), not all potential habitat was visited; in only one did we visit >50%, and <25% in 21. Some unvisited land appeared from afar to be too freely drained or eroded to hold Dunlin, but the largest areas unvisited were blanket bogs with many pools in upper Feshie, Atholl-Gaick, Avon-Dorback, and northwest of Grantown. We saw some Dunlin there, but, to judge from such habitat searched more fully elsewhere, these 4 areas probably held well in excess of 100 extra pairs.

Changes in numbers between years

On 8 high areas, numbers were bigger at Glas Maol in 1970 and 1972, but changed little between decades and showed no trend (Table 2). We noticed no habitat loss or deterioration there. However, we saw no birds since 1987 on 8 low areas used by at least 15 pairs in earlier decades. Habitat was lost to industry (St Fergus) and tree planting (Abergeldie). Habitat deteriorated due to tall undergrazed plants (Lochs Davan, Kinord and Morlich), drains (Morven near Ballater), and deer overgrazing and trampling (River Dee by Braemar and Luibeg further up).

Discussion

The meaning of our current higher estimate

Appendix 1 shows big numbers and wide distribution, bar recent surveys of all species by many observers using rapid methods that readily miss Dunlin. Such surveys lack the vigilance needed to count this small cryptic bird that skulks for most of the breeding season. Also, most watchers avoid remote pathless bogs and are on the hill at 1200-1600 hours, a quiet time for Dunlin (Reed, Barrett *et al* 1983), especially in the warm sun preferred by most people. Other skulkers such as Ptarmigan and Dotterel are readily overlooked (Watson 1965; Watson & Rae 1987), and Red Grouse skulk so much that some surveys omit them (Reed *et al* 1983).

Transects for moorland birds gave densities too low and of fairly low repeatability within areas (Reed *et al* 1983), and cannot be used to calculate Dunlin density (Reed 1982). Estimates from nest finding plus ringing on 5 areas of South Uist machair on average considerably exceeded estimates on the same observers' transects, but discrepancies on individual areas ranged from 44% fewer on the transects to 50% more (Jackson & Percival 1983). With such a wide range, using the average discrepancy elsewhere would be unwise. In any case, the percentage seen on transects is likely to vary with density, season, hour, weather and whether birds have failed. A different method (point counts using supposed 'constant search effort') underestimated Dunlin densities to a varying extent on different areas (Brown & Shepherd 1993). The term 'census' is often misused in surveys of bird numbers.

Hill species cannot be counted accurately unless there is total enumeration with high repeatability. This has not been the case for breeding Dunlin, except perhaps for intensive study of individual territorial spacing as in Holmes (1970). Jackson & Percival (1983) obtained a steady cumulative total on each of 5 areas after a number of visits ranging from 5 to 13, but this is not the same as total enumeration with high repeatability on different visits.

Sharrock (1976) gave British breeding numbers as 4000-8000 pairs, and Gibbons *et al* (1993) 2 estimates of 9150 and 9900 pairs. Our data raise the UK total. Good work in Monadh Liath, Wester Ross and other peatland would raise it by thousands of pairs (cf Whitfield 1997 recently on Lewis and Harris).

Habitat

Density in Alaska was high where pools abounded (Holmes 1970). Density on the Scottish flows was related to pools and other map features (Avery 1989), which indicated many of our sites. However, we saw birds where 1:10,000 maps showed no bog or pool, but where we saw flushes, pools and bogs too small to print on maps. Dunlin abundance is related to ground characteristics between pools as well as to total pool area (Lavers *et al* 1996). Also, flushes over base rich rock on Glas Maol held far more birds than at the same altitude and aspect on Cairngorms granite. Both types can have continuous vegetation, but Dunlin food may abound more on base rich sites.

Nests were in low plants, unlike many Norwegian nests seen by RR in dwarf birch *Betula nana* and willow *Salix* spp up to 30cm. However, these were semi-open at the side, unlike tall heather, so physical structure be involved rather than height. Tall subalpine scrub is rare on UK peat due to overgrazing and burning, but we think that Dunlin would nest in it if it were here.

Decline in numbers

Since 1987 we have not seen birds at 8 low sites showing habitat loss or deterioration. The Braemar and Luibeg cases involved more Red Deer cropping plants and trampling pools. Although Dunlin numbers on 8 high areas in Table 2 changed little between years, the moorland ones had very few deer in summer and all 8 no deer in winter. The rise in deer density, including on grouse moors where deer were formerly rare, threatens Dunlin habitat. In the 1990s we saw 1000 deer at a time on Moine Mhor and the Mounth. They damage plants and peat, and trample bird nests (Thompson *et al* 1996). Gamekeepers W Potts and J Robertson (*pers comm*) noticed fewer Dunlin south of Loch Muick since a 1975-79 peak. Red deer increased two and a half times in 1966-86 in a block that includes Muick, faster than in Scotland generally (Youngson & Stewart 1996).

The Dunlin decline may be more complex; JR (*pers comm*) said fewer returned after the hard 1981-82 winter, and many die on English estuaries in hard winters (Clark *et al* 1993a). Probably Scottish breeders winter further south, but evidence from ringing is scanty and some may die in hard weather. Also, some estuary habitat has been lost to industry (Clark *et al* 1993b).

Conclusion

We reject recent statements indicating Dunlin scarcity in north east Scotland. Though

localised, they are fairly common and our estimates are minimal. Dunlin are one of several hill species easily overlooked when breeding. These are unsuitable for rapid surveys of all species by many observers.

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Appendix 1 Literature account

1 Harvie-Brown & Buckley 1895. Hinxman, a few on hilltop peat Glen Livet, many 1893 Upper Cabrach/Blackwater hilltops and glen mosses Cairnbrallan (all north of Ladder Hills).

2 Sim 1903. A few breed St Fergus links, Loch of Strathbeg and other suitable localities.

3 Gordon 1912, 1915, 1925. Bred Forvie and Moine Mhor (detail SG pers comm) and 1 on Monadh Mor.

4 Nethersole-Thompson 1966. Isolated pairs or communities wherever there are high peat mosses on Mounth and Cairngorms.

5 Watson 1966, Cairngorms area. Small groups SW Cairngorms and Moine Bhealaidh, and many Clunie-Glen Ey hills. Odd pair or 2 Abernethy foothills (D Nethersole-Thompson).

6 Nethersole-Thompson 1973. Big groups Moine Mhor. High numbers Angus and Aberdeenshire Mounth (in field with AW).

7 Nethersole-Thompson & Watson 1974. Wide distribution on map (p258). DNT, formerly 1-2 pairs Loch Morlich, and AW saw them 1947. From AW, 1 or 2 Loch Davan, pairs 1400-1600 ft Luibeg, Loch Builg, Bynack (Mar), and elsewhere, scores of pairs Glas Maol and Carn an Tuirc to Glen Clova and Lochnagar (RR later saw 37-60 pairs), also good on Glen Ey hills, Moine Mhor and Moine Bhealaidh. On a few hills, eg Cairn of Claise and Moine Mhor, more than Dotterel, and locally more than Golden Plover. Nests sparsely high Invermark, Glen Muick, Balmoral and Atholl, and Ladder Hills. Though near the mark on much visited land, this underestimated numbers on land that was then less visited by AW (the 'sparsely' cases).

8 Sharrock 1976. BTO survey 1968-72. Bred 3 coastal and 2 inland 10km squares, possibly another 4 inland.

9 Buckland *et al* 1990. Regional survey 1981-84, scarce breeder Loch of Strathbeg and 3 inland 10km squares, probably bred 6, possibly 5. We found breeders in all these.

10 Cook 1992. 1980s Moray survey, scarce breeder, in our area bred in 4 tetrad squares, including 7 pairs Lecht/Carn Mor (Ladder Hills). Others near Forres outside our area.

11 Gibbons *et al* 1993. BTO survey 1988-91,

in our area bred in 15 of the 10-km squares, plus seen in 2 inland and 1 coastal.
12 Bates *et al* 1993. 280 pairs Grampain Region and adjacent parts of Tayside and Highland, not based on Bates *et al* fieldwork, no detail on numbers or locations or sources, and coincided in time and in the 280 figure with local birdwatchers' hearsay from RR earlier in our study.

1 and 4-7 show many (and 4-7 wide distribution), 8-11 scarcity, and 12 should be discounted.

Appendix 2 Behaviour and breeding through the season

The first birds usually arrived at the end of April, but later in years of much winter snow. The earliest were singles on 15 and 20 April near Glas Maol. They arrived after Golden Plover and often after Dotterel. By early May they were on most sites, and in brief snowstorms were seen sheltering in pairs close together, but after deep snowfall they vanished till the main thaw.

First eggs hatched on 7-14 June (cf Nethersole-Thompson & Watson 1974), on the Ladder Hills <1 week earlier than on alpine Mounth land and about the same time in warm Mays, and the highest Cairngorms pairs nesting 1-2 weeks later. Snowfall delayed nesting (cf Nethersole-Thompson & Nethersole-Thompson 1986). In 1995 the Ladder Hills had far more new snow than at the same altitude by Loch Muick, and their Dunlin hatched a week later. In 1977 the main thaw on the high Cairngorms came on 18 June, and high pairs did not nest till the last week of June.

Strongly demonstrative display with young waned after 4 days and ended at about 7-8 days. Most hens vanished by the time young reached 10 days, and cocks took over (Cramps & Simmons 1983). Birds with big young >2 weeks could be seen by scanning from vantage points, at up to 200m. Work at this stage merely showed minimum adult numbers and whether young had been reared. As young 2-3 weeks old were usually apart (often 200-300m), and young from 2 broods can mingle, it was impossible to count separate broods and young per brood without ringing.

Many young were fully plumaged by mid July apart from downy tufts, and most by the end of July (cf Nethersole-Thompson & Watson 1974). Usually, young in their last half week were unattended by adults. In late July we saw young singly (occasionally 2 together) without adults, eg 5 single young on 3 hills on 18 July 1993, which could only just fly. However, young were occasionally attended by an adult or less often by a pair, eg a full grown young with a pair on 20 July 1969 on Ladder Hills. At Glas Maol on 29 July 1969, a chick about two-thirds grown was with an adult pair in alarm, and a pair in alarm with a chick almost fully grown.

Most Dunlin had gone by 1 August, and earlier in dry summers such as 1994 when most attempts failed. The last seen with young was on 9 August in Glen Esk. We saw singletons in flocks of Dotterel and Golden Plover until mid August, but such birds might be migrants.

Appendix 3 Main soils and plant communities in main breeding habitats

Dunlin on alpine land bred on
a) freely drained alpine sod podzols with a thin organic layer, and sparse vegetation dominated by Three-leaved Rush, grit and

boulders (community U9 in the National Vegetation Classification (NVC) of Rodwell 1991, 1992),
b) freely drained alpine podzols with a thicker organic layer, and vegetation dominated by Mat Grass (Rodwell's U8), or Stiff Sedge *Carex bigelowii* (U10), or lichen heath (H13 & 19), and
c) blanket peat with much Harestail Cotton Grass *Eriophorum vaginatum* (M19).

Glentworth & Muir (1963) defined peat soils as having >30cm of organic matter above mineral soil. Many big subalpine peatlands lay at 800-900m on the Mounth and at Moine Mhor and Moine Bhealaidh in the Cairngorms, and small alpine ones in the Mounth up to 1030m on Cairn of Claise by Glas Maol and to 1080m on White Mounth by Loch Muick. Each held breeding Dunlin. Alpine gleys due to waterlogging were frequent in a), b) and c) beside flushes.

Most Dunlin seen bred at 450-800m, reflecting the altitude of a) 'blanket hill peat', and b) 'flushed blanket hill peat' (1: 63 360 Soil Survey of Scotland). Most of a) had Cross-leaved Heath *Erica tetralix, Sphagnum* moss and Harestail Cotton Grass, with some Heather *Calluna vulgaris* and Deer Sedge *Scirpus cespitosus* (Rodwell's M15-17), and with less heath and more *Sphagnum* at pools (M2) and hollows. Most of b) had sedge *Sphagnum* mires (M6), or wet grassland with tall rushes *Juncus* spp (M23). Some on 'basin, valley and terrace peat' up to 550m bred in heath like a).

We saw most Dunlin on hill peat >1m thick, and highest densities on peat >2m. Plants were short, especially on wet rarely burnt land. On a flat with high Dunlin density on Monaltrie Moss, the lichen *Cetraria nivalis* at 570m indicates severe conditions; usually it is at >900m (Purvis *et al* 1992), and the lowest sites seen elsewhere on our area were at 800m on exposed ridges.

Adults used other habitats, such as flying up to 1.5km to feed at lochans where we saw none breeding. On flushed peat, a few with young were on short grass and moss with some rush tufts by slow streams and pools (eg at 400m at Abergeldie by Ballater, where RR saw at least 3 pairs in 1971 and 1972), and on wet ground without pools (eg south of Morven).

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Dunlin at nest *E Pickard*

Changes in breeding bird populations in peatlands and young forestry in north east Sutherland and Caithness between 1988 and 1995

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As part of a long term study of breeding birds in north east Sutherland and Caithness, peatland areas were surveyed in 1988, 1991 and 1995. Nineteen plots (2.5km x 2.5km) were surveyed in all 3 years. Plots were surveyed once in May and once in June. Counts of birds recorded during transect surveys were used as an index of abundance. Skylark indices showed significant declines between 1988 and 1991, and between 1991 and 1995, with an average decline of 12% per year. Indices of Red Grouse, Golden Plover, Dunlin and Meadow Pipit abundance varied significantly between years and all were lower in 1995 than in 1988. There was no correlation between changes in indices and distance to recently planted forests and no evidence of an increase in Crow numbers. These surveys suggest dramatic declines in an upland breeding Skylark population, and, together with other recent work, suggest that nationally important breeding populations of some wader species on unafforested areas of peatland in Sutherland and Caithness may have declined since the late 1980s by amounts which are comparable to earlier losses due to afforestation. Point counts were made of birds in newly planted forests in the area in 1988 and 1991 and results are presented.

Introduction

Sutherland and Caithness contain the largest expanses of peatland in Britain (Stroud *et al* 1987). The area is the stronghold for some upland bird species, holding, for example, an estimated 18% and 39% of Britain's breeding populations of Golden Plover *Pluvialis apricaria* and Dunlin *Calidris alpina* respectively (Stroud *et al* 1987), and areas of high Skylark *Alauda arvensis* abundance (Gibbons *et al* 1993). During the 1980s large areas of peatland in the area were planted with exotic conifers (Avery and Leslie, 1990), causing considerable losses of breeding waders (Stroud *et al* 1987, Bainbridge *et al* 1987).

As well as direct effects through habitat loss, the new forestry plantations may have affected breeding birds of adjacent peatlands by increasing predator populations (Thompson *et al* 1988), or by affecting the local hydrology, although one 20 year Caithness study found that hydrological impacts were limited to within 20m of the forest edge (Pyatt *et al* 1992). Stroud *et al* (1990) showed that breeding densities of some wader species in the area are lower nearer to plantations. Other studies showed that this could be explained by the nature of areas selected for afforestation, rather than any 'edge effect' caused by the plantations themselves (Avery 1989, Avery *et*

al 1989). Parr (1993) found that some moorland birds suffer higher breeding failure rates nearer to plantations, and there is recent anecdotal evidence of increases of avian and mammalian predator populations in north Sutherland and Caithness, probably resulting from the favourable habitat for such species in the new plantations and a decline in keepering intensity (C Crooke *pers comm*).

In 1988 peatland plots were surveyed to test predictions of bird numbers made using satellite imagery (Avery and Haines-Young 1990). Some of these plots were surveyed again in 1991 and 1995 and these plots formed the basis of this study.

Methods - peatland plots

Square plots of unafforested peatland in Sutherland and Caithness, 2.5km x 2.5km, were selected at random within 3 strata, defined by an index of infra-red reflectance derived from satellite imagery, such that plots with a wide range of reflectances were selected (Avery and Haines-Young 1990 and 1992). Five 2.5km straight line transects were drawn across each plot, separated by 500m, with the outermost transects 250m from the edge of the plot. Transects were orientated north south or east west, whichever was more convenient for the terrain.

In 1988, 2 surveyors surveyed 37 plots. In 1991, 2 different surveyors surveyed 31 plots, permission to survey having been denied for 6 plots. In these 2 years each surveyor visited each plot once. In 1995, a different surveyor surveyed 19 plots (Figure 1), with assistance from another surveyor for 6 visits. The 19 plots chosen for survey in 1995 were all those plots surveyed in 1988 and 1991 which were either in the catchments of the Rivers Naver and Helmsdale, or further north and east, as this was the area considered to be of greatest conservation interest (Evans 1994).

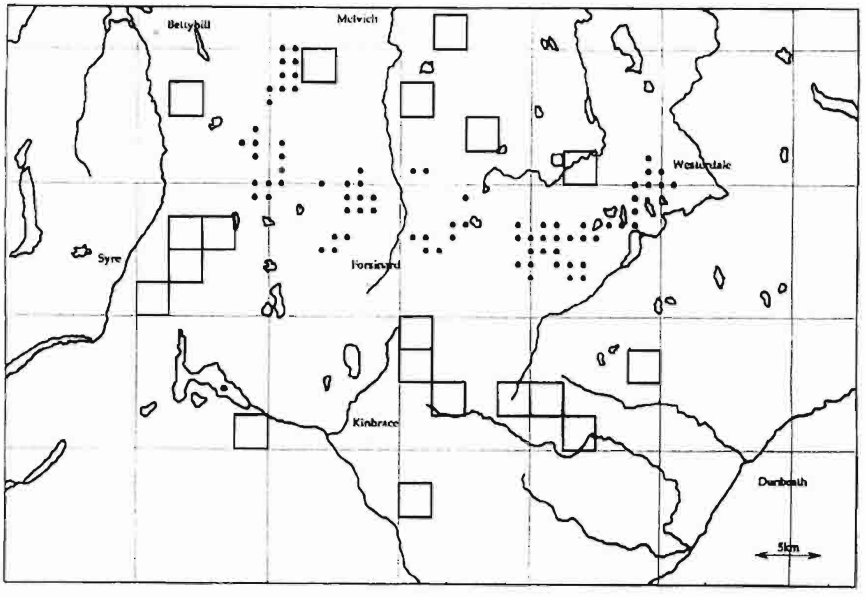
Plots were surveyed once in May and once in June by a single observer walking the transects and mapping all birds within 100m of the transect line, including common species such as Meadow Pipit *Anthus pratensis*. Surveys did not take place in continuous rain or in winds of more than 35km/hr. Surveys took place between 0900 and 1700 BST to help prevent variation in bird detectability during visits (Reed *et al* 1985, Thirgood *et al* 1995). Registrations were totalled for each visit, and the peak count (May or June) for each species for each plot was used as an index of abundance. For each plot, the distance to the nearest area of forestry, and National Grid eastings, were taken from maps to compare with changes in indices of abundance.

To determine whether counts differed between observers within years, counts of each species for each visit were compared for the 2 observers for 1988 and for 1991. Differences between observers between years could not be assessed. The visit dates for the survey years were compared for significant differences, and correlation coefficients between visit date differences and changes in indices of abundance were calculated. Counts made at the same sites on the 2 visits were compared for significant correlations, to see if counts were affected more by location than by visit date.

Methods - point counts in plantations

In 1988 and 1991, birds of new plantations in north east Sutherland and west Caithness were surveyed. Point counts were carried out at 80 sites in plantations on peatland (Figure1),

Figure 1 ***Location of peatland plots surveyed in 1988, 1991 and 1995, and forestry point count sites surveyed in 1988 and 1991.***



following the methods of Bibby *et al* (1985). Point count sites were 1km grid intersections. Sites were visited once in late April - early May and once in late May, between 0700 and 0930, and counts lasted 5 minutes. Repeat records within one point count of a bird singing from the same location were treated as records of the same bird. For each species at each point, the peak count (early or late visit) was used as an index of abundance. Planting dates were taken from forestry maps. An approximate visual estimate of the percentage cover of Heather *Calluna vulgaris* within 30m of point count sites was made in each year.

Results - peatland plots

For the 19 plots surveyed in all 3 years (Figure 1), bird abundance indices are shown in Table 1. All pair wise comparisons of years had more species showing decreasing indices than increasing indices. Differences between years were significant for Red Grouse *Lagopus lagopus*, Golden Plover, Dunlin, Skylark and Meadow Pipit. For all of these species, totals in 1995 were lower than those in 1988. For Skylark, but no other species, declines were significant for both 1988-1991 and 1991-1995 (Wilcoxon tests, $Z=-3.8$ and -3.6 respectively, $p<0.01$ in both cases), averaging 12% per year.

Table 1 ***Peatland plots - sum of peak counts for the 19 plots surveyed in all 3 years for all species recorded at more than 10 plots over the 3 years.***

	Peak number of registrations, Sum for all plots			Percentage change	Significance of differences between years
	1988	1991	1995	1988-1995	(**=p<0.01, *=p<0.05)
Red Grouse	80	130	37	-54	*
Golden Plover	313	235	209	-33	*
Dunlin	138	69	79	-43	**
Snipe	23	17	11	-52	NS
Curlew	29	36	25	-14	NS
Greenshank	23	28	23	0	NS
Common Sandpiper	12	5	10	-17	NS
Skylark	1235	565	238	-81	**
Meadow Pipit	989	577	533	-46	**
Wren	28	26	2	-93	NS
Wheatear	57	16	10	-82	NS
Crow	31	9	9	-71	NS

*Friedman 3-way ANOVA, N=19

For species showing significant differences in abundance indices between years (Red Grouse, Golden Plover, Dunlin, Skylark and Meadow Pipit), percentage change in indices of abundance from 1988-1995 was compared with distance to the nearest area of forestry, difference in dates of May and June visits, and eastings (Table 2). For Dunlin, the percentage decline between 1988 and 1995 was significantly correlated with eastings - the more easterly sites having the greatest percentage declines (Spearman correlation coefficient, $r_S = 0.53$, N=19, $p<0.05$). No other significant correlations were found.

In neither 1988 or 1991 was there any significant difference between observers in indices of abundance, except for visit 2 in 1988, when one observer recorded significantly more Meadow Pipits than the other. On visit 1, the same observer also recorded more Meadow Pipits, though not significantly more.

Golden Plover, Dunlin, Common Sandpiper *Actitis hypoleucos*, Skylark and Meadow Pipit were all recorded more often on June visits, by between 24% and 130%, while Red Grouse was recorded more often on May visits, by 45% (Wilcoxon tests, $p<0.01$ in all cases). Correlations between the 2 visits for counts of the same species at the same site were not significant in some years for some species, suggesting that within year variation between visits was often greater than variation between sites. A further test of the reliability of the survey data was carried out for the 5 species showing significant between years variation (Red Grouse, Golden Plover, Dunlin, Skylark and Meadow Pipit). Data for the 3 survey years were combined and tested to see if May counts at the 19 sites surveyed in all

Table 2 ***Peatland plots – for all plots surveyed in all 3 years the table gives the % change in abundance indices for species showing significant variation between years, eastings, forest distances and difference in survey dates.***

Plot	National grid eastings of west edge of plot (km)	Distance of edge of plot to nearest forestry (km)	Difference between visit dates (1988 date minus 1995 date) (days)		Percentage change between 1988 and 1995 in indices of abundance				
			May	June	Red Grouse	Golden Plover	Dunlin	Skylark	Meadow Pipit
3	2725	4	11	6	-80	400	0	-59	-29
4	2750	2.25	11	6	-50	200	50	-85	-22
5	2725	5.5	-12	-10	-100	200	0	-89	-34
6	2700	9	2	4	-100	-50	0	-68	-58
7	2725	2	3	5	150	-95	0	-63	-53
8	2825	0	-4	-2	-50	-50	-89	-94	-46
9	2900	4.5	14	8	0	167	-33	-95	-46
10	2925	4	11	2	0	-83	0	-91	-31
11	2950	2	-12	-21	-50	-36	-45	-91	-47
12	3025	0.75	2	-20	-100	-48	0	-89	-67
16	3075	5.75	25	26	0	-48	-63	-62	-13
18	3025	9.25	-11	-18	-100	-58	-85	-94	-78
19	3000	7	-7	-11	-67	-32	-74	-74	-49
20	2975	7.5	-7	-11	14	-68	-38	-43	-47
22	2925	4.5	1	-1	-50	-18	-15	-25	59
23	2900	0	3	-6	-56	-33	-40	-92	-77
24	2900	1.5	3	-6	-100	-23	-30	-71	-48
25	2900	11.5	21	22	-88	-60	-100	-87	-53
27	2775	10.5	-5	-4	100	-9	0	-80	-46

years were correlated with June counts. Significant ($p<0.05$) correlations were found for all species apart from Meadow Pipit (Spearman rank correlations). This suggests that for all species apart from Meadow Pipit, variation in counts between sites was greater than variation between visits, and therefore that counts for these species principally reflected the number of birds present at a particular site, rather than the visit date.

Results – point counts in plantations

Mean planting date at the 80 point count sites (Figure 1) was 1984 (range: 1980-1988). The estimated percentage of heather within 30m of point count sites increased significantly from a mean of 35% in 1988 to 60% in 1991 (Wilcoxon test, $Z=5.72$, $p<0.01$, probably because of heather colonising exposed ploughed peat, and a reduction in grazing pressure.

Point counts of Golden Plover, Skylark, Meadow Pipit were lower in 1991 than in 1988, by between 36% and 54% (Table 3). Counts of Red Grouse, Wren *Troglodytes troglodytes*, Song Thrush *Turdus philomelos*, Coal Tit *Parus ater*, Willow Warbler *Phylloscopus trochilus* and Redpoll *Carduelis flammea* increased by between 78% and 1300%. Counts of the following species were positively correlated with plantation age at point count site: Common Gull *Larus canus*, Wren, Robin *Erithacus rubecula*, Coal Tit, Willow Warbler, Chaffinch *Fringilla coelebs* and Redpoll (Table 4). Counts of the following species were negatively correlated with plantation age: Golden Plover, Snipe *Gallinago gallinago*, Greenshank *Tringa nebularia*, Skylark and Meadow Pipit.

Discussion

The declines in wader populations caused by afforestation in north east Sutherland and Caithness are well known. Recent work in the same area (Whitfield 1996) comparing surveys in 1979-87 with surveys in 1993-94 has established that recent declines in wader populations have also occurred in unafforested peatland areas. Whitfield estimates that, for Dunlin and Greenshank, similar numbers of breeding birds have been lost since new planting ceased as were lost over the same length of time when afforestation was at its peak. Whitfield also recorded Golden Plover declines. The results presented here reinforce these concerns for Golden Plover and Dunlin. If the declines recorded by this survey were representative of Sutherland and Caithness, then losses of breeding Golden Plover and Dunlin from unplanted areas in the period 1988-95 would have exceeded earlier losses due to afforestation. Applying the declines recorded from this survey to the estimated proportions of the British population of Golden Plover and Dunlin in the area from Stroud et al (1987), suggests that 7% and 17% of the British populations of these species respectively could have been lost on unafforested peatland in the area.

Elsewhere, a review of changes in populations in British breeding birds since 1800 (Gibbons *et al* 1996) suggests that Golden Plover is one of 26 species to have declined most in the last 200 years. In Ireland, the number of counties with breeding Golden Plover has declined by 63% from 1875-1 900 to 1968-72 (Holloway 1996). Gibbons *et al* (1993) show an 8% contraction in Golden Plover range between 1968-72 and 1988-91. Thom (1986) records Golden Plover declines in south west Scotland and Orkney.

Table 3 ***Point counts – variation with year of survey (sum of peak counts for all points for the 2 years of coverage, for all species recorded at more than 10 points over the 2 years).***

	Sum of peak counts		Significance of differences between years (*=p<0.05, **=p<0.01)
	1988	1991	
Greylag Goose	33	44	NS
Red Grouse	17	33	*
Golden Plover	43	20	**
Snipe	24	20	NS
Curlew	50	38	NS
Greenshank	51	27	NS
Black-headed Gull	52	38	NS
Short-eared Owl	15	9	NS
Common Gull	13	11	NS
Skylark	301	172	**
Meadow Pipit	435	280	**
Wren	19	102	**
Robin	5	8	NS
Song Thrush	1	14	**
Coal Tit	6	25	**
Willow Warbler	27	48	**
Crow	11	12	NS
Chaffinch	18	36	NS
Redpoll	21	104	**

* Wilcoxon paired sample tests, N=80.

However, Whitfield (1996) found recent increases in breeding Golden Plover populations in Lewis and Harris. Little is known about the reasons behind these changes. Recent studies in north east Sutherland (O'Connel *et al in prep*) have shown that Golden Plover feed on improved pastures up to 10km from their peatland nesting areas, but suggest that the availability of such habitat does not limit Golden Plover numbers in the study area. Elsewhere, however, such habitat may be more important, either during or outwith the breeding season. The wintering areas of Golden Plover breeding in north Scotland are unknown, however, nearby Orkney, where 2 Sutherland ringed Golden Plover have been recorded (Thom 1986), holds a large wintering population (Lack 1986).

Dunlin numbers have declined recently in upland areas of south west Scotland, probably due to afforestation (Gibbons *et al* 1993), and also in lowland areas of Scotland (Thom 1986). A recent analysis of Scottish Natural Heritage data for Sutherland and Caithness

Table 4 ***Point counts – variation with plantation age (sum of peak counts for all points for the 2 years of coverage, for all species recorded at more than 10 points over the 2 years).***

	Mean peak count (birds per 5 minute count) Plantation age at point count side:		Correlation between plantation age at point count site Mean peak count	Significant of correlation (*=p<0.05, **=p<0.01)
	5 years or less	6 to 11 years		
Greylag Goose	0.57	0.38	-0.53	NS
Red Grouse	0.28	0.30	0.22	NS
Golden Plover	0.78	0.18	-0.67	*
Snipe	0.45	0.11	-0.87	**
Curlew	0.59	0.56	-0.46	NS
Greenshank	0.70	0.30	-0.95	**
Black-headed Gull	0.35	0.81	0.28	NS
Short-eared Owl	0.21	0.05	-0.54	NS
Common Gull	0.03	0.30	0.80	**
Skylark	4.21	1.67	-1.00	**
Meadow Pipit	4.99	3.57	-0.78	*
Wren	0.07	1.55	0.97	**
Robin	0.00	0.20	0.89	**
Song Thrush	0.00	0.23	0.64	NS
Coal Tit	0.00	0.69	0.94	**
Willow Warbler	0.02	1.09	0.98	**
Crow	0.11	0.20	0.28	NS
Chaffinch	0.00	1.01	0.94	**
Redpoll	0.06	2.04	0.99	**

* Spearman correlations, N=80.

suggests an average annual decline of 7% in Dunlin numbers in Sutherland and Caithness in the period 1979-1984 (D P Whitfield, *pers comm*). The British range of Dunlin expanded between 1968-72 and 1988-91 (Gibbons *et al* 1993), although declines in areas of high density such as Sutherland and Caithness could mean that the British population has declined overall. However, peatland breeding populations have recently increased slightly in Lewis and Harris (Whitfield 1996). The fact that the greatest percentage declines in indices of Dunlin abundance occurred in the more easterly sites is hard to explain. Many of these sites held high Dunlin numbers in 1988 and were remote from the main areas of afforestation. A model of Dunlin abundance in north east Sutherland and Caithness, partly based on results from this survey, shows most of the areas of high predicted abundance to be east of Strath Halladale (Layers *et al* 1996). The analysis for this model showed that Dunlin have a preference for flatter areas with a high availability of pools, and where the ground between pool systems is dominated by short, sparse *Trichophorum cespitosum* and *Eriophorum*. Such areas are typical of the more easterly sites in this survey.

Meadow Pipit densities increase in the early stages of afforestation, starting to decline when trees are about 5 years old (Moss 1978). Point count data from this survey are consistent with this pattern (Table 4). It is possible that numbers of Meadow Pipits on moorland plots in 1988 were swelled by additional recruitment from nearby populations in the new plantations, most of which would then have been less than 5 years old. However, the evidence of some observer bias in 1988 suggests that Meadow Pipit results should be treated with caution. Similarly, of all the species showing significant between years variation, Meadow Pipit is the only one for which counts on different visits to the same site are not significantly correlated when all 3 years data are combined. This raises the possibility that the timing of visits, or the timing of breeding, could have had a significant effect on Meadow Pipit counts, possibly explaining the observed variation between years.

Skylark numbers declined by more than 50% in Common Birds Census (CBC) plots since the early 1980s (Marchant *et al* 1990). Most of these plots are in lowland England. There has been little quantitative work on Skylarks in the uplands; indeed, for many early upland surveys, Skylarks were so abundant that they were not recorded. The abundance map for Skylark in Gibbons et al (1993) suggests that north Sutherland and Caithness may have held some of the highest densities of upland breeding Skylarks in Britain. This survey suggests that breeding populations of Skylarks in some upland areas may be declining even more rapidly than those sampled by CBC plots. Little is known about the reasons for these declines in the uplands. Skylarks breeding in the peatlands of northern Scotland probably winter on farmland elsewhere in Scotland, and although little is known of the movements of Scottish birds (Thom 1986), there is little evidence of long distance migration (Dougall 1996). In Britain as a whole, the loss of winter stubbles as autumn sowing of cereals becomes more common is probably one of the main causes of decline relating to wintering habitat (Evans *et al* 1995). However, autumn sowing is uncommon in north Scotland and the Uists, where breeding Skylarks surveyed in this study may winter.

A wide range of factors may be affecting populations of peatland breeding birds, including agricultural changes, climatic

factors, changes in moorland grazing and burning practices, moorland drainage and drainage for forestry, changes in predator populations following changes in keepering patterns and land use, fence strikes, acid deposition and habitat fragmentation caused by afforestation. Such factors may be acting over a wide area in ways not easily linked to adjacent forestry and farming practices.

The fact that many species covered by this survey were recorded more frequently on June visits suggests that a repeat survey based on a single June visit might be worth considering. A similar conclusion was reached by Avery and Haines-Young (1992). However, such an approach would be highly sensitive to the timing of breeding (Thirgood *et al* 1995) so more years' data would be needed to show long term population changes.

The results of the point count surveys in plantations are generally consistent with those of similar studies elsewhere (Avery and Leslie, 1990), showing a decline in open country species, such as Golden Plover and Skylark, and an increase in woodland species such as Willow Warbler and Redpoll. The correlation between Common Gull counts and plantation age, however, was unexpected and may be a coincidental result of the small sample size (Table 3). Alternatively, it could be explained by the fact that point count sites in the more mature plantations more often fell near flight lines used by gulls moving between lochs. The non significant positive correlation between plantation age and counts of Black-headed Gull *Larus ridibundus* (Table 4) is consistent with this explanation.

Conclusions

This survey provides worrying evidence of declines in nationally important Golden Plover and Dunlin populations in areas of apparently unchanged peatland in Sutherland and Caithness. It also suggests dramatic declines in an upland breeding Skylark population. The reasons behind these declines are poorly understood and will need be addressed if these species are to remain key constituents of the bird community of this unique area.

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Numbers of wintering seaducks, divers and grebes in the Moray Firth, 1977-1995

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Numbers and distribution of seaducks, divers and grebes in the Moray Firth were monitored for 18 consecutive winters. Most sections within the firth held nationally important concentrations of at least one species. The Moray Firth as a whole held internationally important numbers of Red-breasted Mergansers and Slavonian Grebes and nationally important numbers of Scaup, Eiders, Common and Velvet Scoters, Long-tailed Ducks, Goldeneyes, Goosanders and Red-throated and Black-throated Divers. Peak numbers for individual species occurred in different months from September to April. Numbers of Common and Velvet Scoters and Goosanders declined during the study period and numbers of Goldeneyes, Red-breasted Mergansers and Slavonian Grebes increased. There were changes in the distribution of Eiders and Scaup within the firth. Oil pollution had no obvious effect during the study period, but remains a potential threat. These nationally important concentrations of seaducks, divers and grebes have had no adequate statutory protection to date.

Introduction

The Moray Firth has been regarded as an important site for wintering seaducks since the nineteenth century (St John 1845, Harvie-Brown and Buckley 1895, Baxter and Rintoul 1953, Thom 1986) although counts exist only from the 1960s onwards (Milne and Campbell 1973). When exploration for oil started in the Moray Firth in the late 1970s, accurate and comprehensive data were needed on the numbers and distribution of waterfowl in order to assess any impact that oil industry developments might have. Surveys of wintering seaduck, divers and grebes were undertaken by RSPB in 1977-78 and 1978-79 (Mudge and Allen 1980). Lower intensity monitoring was undertaken during the following 2 winters (RSPB unpublished data) and surveys throughout the winter resumed from 1981-82 until 1994-5 as part of the Beatrice Field environmental monitoring programme.

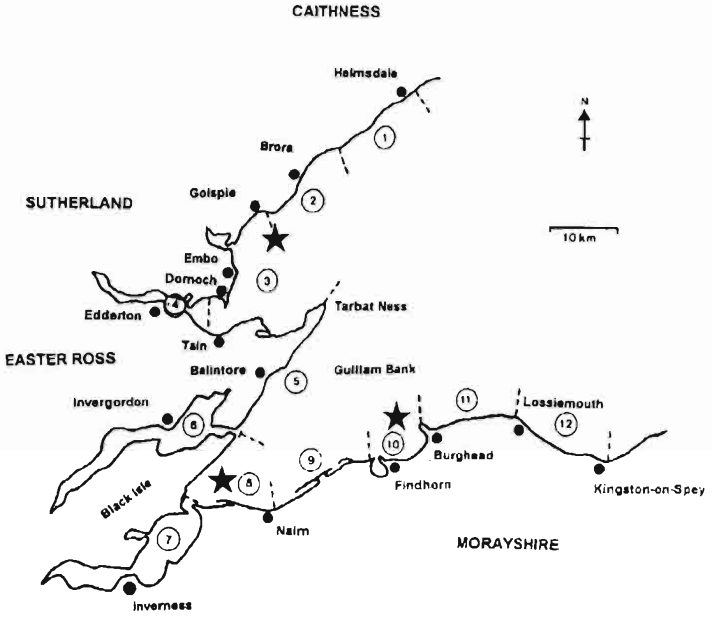
The results of this monitoring for the period 1981-82 to 1983-84 were presented by Campbell, Barrett and Barrett (1986), with supplementary papers by Barrett and Barrett (1985a) on Goldeneyes and divers (Barrett and Barrett 1985b) and by Aspinall and Dennis (1988) on Goosanders and Red-breasted Mergansers. This paper presents the results of monitoring for the whole period and discusses their implications for site safeguard purposes.

Study area

The study area extended from Helmsdale in the north to Kingston-on-Spey in the south-east and included the inner Dornoch, Cromarty and Inverness/Beauly Firths (Figure 1). The combined area is known as the Moray Firth and is described in more detail by Mudge and Allen (1980).

Daytime land based counts gave adequate population estimates for most species except Long-tailed Duck and the divers, for which supplementary land based roost counts at dawn and dusk gave improved estimates. Land based counts were supplemented by aerial and boat surveys in the earlier years of the study (Mudge and Allen 1980, Campbell et al 1986), but they were regarded as

Figure 1 ***The Moray Firth study area showing count sections: (1) Helmsdale to Brora; (2) Brora to Golspie; (3) Outer Dornoch Firth; (4) Inner Dornoch Firth; (5) East Ross Coast; (6) Cromarty Firth; (7) Inverness/Beauly Firth; (8) Riff Bank; (9) Culbin Sands; (10) Burghead Bay; (11) Burghead to Lossiemouth; (12) SpeyBay. Major Long-tailed Duck roost sites are shown by solid stars.***



Methods

The frequency of counts and the period covered by each winter's survey varied as shown in Table 1.

unnecessary in achieving adequate coverage provided daytime and dawn/dusk land based counts were made in suitable conditions. Locating the precise areas used by roosting Long-tailed Ducks could only be achieved by boat.

Table 1 ***Months in which complete surveys of the Moray Firth were carried out between 1977-78 and 1994-95.***

	Month							
Winter	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1977-78				*	*	*	*	
1978-79				*	*	*		
1979-80			*		*			
1980-81					*			
1981-82			*	*	*	*	*	
1982-83		*	*	*	*	*	*	
1983-84						*	*	*
1984-85	*	*		*		*		*
1985-86		*		*		*		*
1986-87		*		*		*		*
1987-88		*		*		*		
1988-89		*	*	*	*	*	*	
1989-90	*	*	*	*	*	*	*	
1990-91		*	*	*	*	*	*	
1991-92	*	*	*	*	*	*	*	*
1992-93		*	*	*	*	*	*	*
1993-94	*	*	*	*	*	*	*	
1994-95	*	*	*	*	*	*	*	

The study area was divided into 12 discrete sections (Figure 1), in which the birds could be counted by one person in a single day. Daytime land based counts were made from a number of points within each section, close enough together to ensure complete survey of the section, but far enough apart to avoid double counting.

Counts were carried out from soon after first light to approximately 2 hours before sunset, the earliest time that roost movements could be expected to disrupt daytime distribution patterns. Counts were carried out irrespective of the state of tide if weather conditions were suitable, ie no wind or light offshore winds and calm seas.

Coverage of the whole area was completed, weather permitting, in as short a period as possible and in geographical sequence in order to minimize the effect of any bird movements between sections. Although monthly differences in distribution were sometimes noticeable, short term changes on a large scale were not recorded.

Birds were identified to species whenever possible. In practice, it was not always possible to separate Common and Velvet Scoters or the diver species. Unidentified scoters and divers were therefore categorised as 'scoter sp' and 'diver sp' Campbell et al (1986) presented results for Common and Velvet Scoters combined. However, an attempt was made to estimate numbers for the 2 species separately (Kirby *et al* 1993). Unidentified scoters were assumed to occur

in the same ratio as the numbers of Common and Velvet Scoter which were positively identified and the 'scoter sp.' total was split accordingly for each site to give an estimate for each species. Unidentified divers often outnumbered identified birds so unidentified birds were not apportioned. Counts of specifically identified divers were recorded for the years 1983-84 onwards for the Moray Firth as a whole and for individual sections from 1987-88 onwards

The only seaduck species not counted reliably from the land during the day was the Long-tailed Duck. They are smaller, more cryptically coloured and tended to feed further offshore than the other seaducks, making daytime counts difficult. Therefore, counts were also made of Long-tailed Ducks flying to communal roosts at dusk, or 'occasionally' shortly after dawn. Daytime and roost counts were combined as follows: daytime counts for the 12 standard sections were made simultaneously with counts for other species. Roost counts were carried out as soon as possible before or after the daytime counts for the relevant section. Observations were made from points between known roosts in order to detect large scale movements of birds overflying one roost in preference for another. This was only recorded in 1978-79 when birds feeding over the Riff Bank were found to be roosting in Burghead Bay. Counts of birds flying to a roost site in one count section from a particular direction were presumed to have been feeding in the adjacent count section in the direction from which they had flown. The monthly count for each section was taken as either the daytime total or the roost count total, whichever was the higher. The resulting section counts were summed to give a monthly total for the whole study area

Long-tailed Duck roosts tended to draw birds from areas which were larger than the standard count sections. Five main areas for Long-tailed Duck were identified within the Moray Firth and the results are expressed in terms of these larger areas: East Sutherland (sections 1-4), East Ross (sections 5 and 6), Riff Bank/Inverness Firth (sections 7 and 8), Burghead Bay/Culbin Sands (sections 9 -11) and Spey Bay (section 12).

Eiders also used areas somewhat larger than standard count sections and three main areas were identified: East Sutherland (Sections 1-4), East Ross (Sections 5-6) and the Morayshire coast (Sections 9-12).

For each species peak counts rather than indices of site usage (cf Mudge and Allen 1980) were used to express population levels for each section and are presented in the tables. In practice, peak counts occurred in different months in different winters. Each of the 12 sections was considered in its own right so that peak counts for different sections could be made in different months in the same winter. For the whole Moray Firth monthly totals were taken and the peak monthly count for each winter was used in the tables and for analysis. Trends for each species were tested by calculating Spearman Rank Correlation Coefficients (2-tailed) between numbers and years.

The current status of seaducks, divers and grebes in the whole Moray Firth and at individual sites within the Moray Firth was expressed as the mean of peak numbers in the last 5 years 1990-91-1994-95 (Table 11). This is the standard way of assessing the importance of a site for a particular species (Pritchard *et al* 1992).

Results

Red-throated Diver *Gavia stellata*

Red-throated Diver was the commonest diver. Numbers normally peaked at around 410, out of a total diver population of around 440 (Figure 2a).

Red-throated Divers were recorded from all sections, though the largest numbers were found in sections also frequented by large numbers of seaducks, particularly the Outer Dornoch Firth, Culbin, Burghead Bay and Spey Bay. Large numbers were regularly observed flying out of the Inverness Firth during counts of roost-flighting Long-tailed Ducks (Table 2).

Numbers between 1984-85 and 1994-95 showed no trend (r_S =0.275, ns, n =11).

Peak numbers tended to occur in October, occasionally involving large gatherings, including nearly 1000 off Culbin in October 1982 (Barrett and Barrett 1985b) and 600 in Spey Bay in October 1987. Individual sections generally matched this pattern, apart from the Inverness Firth where peak numbers tended to occur between December and February. No spring passage was detected.

Black-throated Diver *Gavia arctica*

Black-throated Divers accounted for about 6% of positively identified divers. The most favoured areas were the Outer Dornoch Firth and Burghead Bay (Table 2).

Numbers between 1984-85 and 1994-95 showed no trend (r_S= 0.030, ns, n = 11) (Figure 2b).

Peak numbers occurred in October, December and during February-March. The importance of individual sites followed the overall seasonal pattern.

Great Northern Diver *Gavia immer*

Great Northern Divers were the least common of the three regularly occurring divers in the Moray Firth, accounting for roughly 4% of positively identified divers. Great Northern Divers tend to occur further offshore than other divers (Parrack 1986) and probably did so in the Moray Firth (Barrett and Barrett 1985b). Therefore it is likely that a higher proportion of the unidentified divers were in fact Great Northern Divers.

Great Northern Divers favoured the more open sections of the Moray Firth, particularly the Outer Dornoch Firth, Burghead Bay and Spey Bay (Table 2).

There was no trend in numbers between 1984-85 and 1994-95 (r_S = 0.418, ns, n=11). (Figure 2c).

There was no clear seasonal pattern either for the whole Moray Firth or for individual sites. Peak winter numbers were recorded in October, December, February and March.

Slavonian Grebe *Podiceps auritus*

Slavonian Grebes occurred regularly in the Outer Dornoch Firth between Dornoch and Embo, the Cromarty Firth , the Inverness Firth and Burghead Bay (Table 2). There were occasional records from Culbin Sands.

Numbers for the whole Moray Firth for the period 1984-85-1994-95 increased (r_S=0.818, P<0.005, n = 11) (Figure 2d), as did numbers for Burghead Bay for the same period (r_S = 0.736, P<0.05, n = 11). It is possible that these trends were in part influenced by more

Figure 2 ***Peak total numbers of divers and grebes in the Moray Firth 1984-85 - 1994-95. a) Red-throated Diver; b) Black-throated Diver; c) Great Northern Diver; d) Slavonian Grebe.***

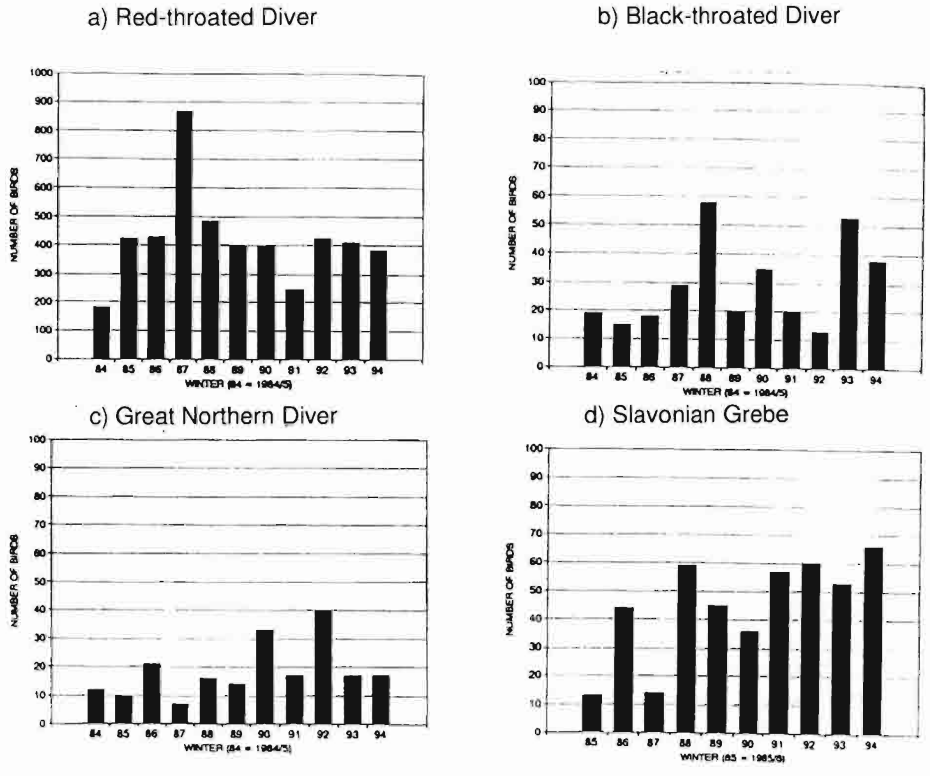


Table 2 ***Mean winter numbers of divers and Slavonian Grebes at the main sections in the Moray Firth. 1990-91 - 1994-95.***

	Outer Dornoch Firth	Cromary Firth	Inverness Firth	Culbin Sands	Burghhead Bay	Spey Bay	Whole Moray Firth
R-t Diver	80	12	154	68	74	225	459
B-t Diver	17	1	5	1	14	3	31
GN Diver	11	1	1	1	10	6	25
Slav Grebe	28	18	13	2	16	1	54

frequent surveys during the latter part of the study period (Table 1) and also by improvements in the quality of telescopes used for counting.

There was no clear seasonal pattern. Peak winter numbers were recorded in all months except September and March. This is perhaps not surprising considering that the number of birds counted depended on the weather conditions on the day of the count, in particular wind and sea state which affected the accuracy of counts of Slavonian Grebes more than other species.

Red-necked Grebe *Podiceps grisegena*

One or 2 Red-necked Grebes were recorded annually, with maxima of 6 in 1986-87 and 5 in 1991-92.

Scaup *Aythya marila*

Scaup were found almost exclusively in the Dornoch Firth, the Cromarty Firth and the Inverness Firth. Concentrations were associated with distillery and sewage outfalls at these sites. Scaup were occasionally found elsewhere, including a flock of 600 in Spey Bay in 1978-79 (Mudge and Allen 1980).

The Moray Firth wintering population peaked in most winters between 300 and 450 (Table 3) and there was no trend (Figure 3a). Numbers in the Dornoch Firth were higher (up to 650) during the early part of the study but declined latterly (r_S = -0.709. P<0.002, n=18). Peak numbers in the Cromarty Firth gradually increased (r_S= 0.920, P<0.001, n = 18). Numbers in the Inverness Firth were more variable, peaking between 50 and 200.

Numbers for the whole Moray Firth tended to peak between December and March, with most peak winter totals in February (8 out of 17 winters for which data are available). At individual sites, peaks occurred in every month from October to April with peak numbers occurring earlier in the winter (November to January) in the Cromarty Firth than in the Dornoch and Inverness Firths (December to March).

Eider *Somateria mollissima*

The most important areas were East Sutherland (Sections 1-4) and Morayshire (Sections 9-12) (Table 4). Flocks could be found off both rocky and sandy shores in these areas.

No trend was detected in peak numbers for the Moray Firth as a whole (Figure 3b). However, there was an increase on the Morayshire coast (r_S =0.732,P<0.001, n = 18) and a decrease on the East Sutherland coast (r_S = -0.589,P<0.02, n =18).

Peak numbers for the whole Moray Firth occurred during September - December and most frequently in October or November, the latter months accounting for peaks in 13 out of 18 winters. Numbers in the study area tended to drop as each winter progressed, implying that emigration to other parts of the Scottish coast occurred. Peak totals for East Sutherland occurred in October more frequently than in December but the reverse was the case for Morayshire. Peak numbers for East Ross occurred most frequently in January and February, probably reflecting dispersal of the large numbers in the north and east of the study area.

King Eider *Somateria spectabilis*

One to 3 drake King Eiders were recorded almost annually throughout the study period,

Figure 3 ***Peak total numbers of seaducks in the Moray Firth 1978-78 - 1994-95. a) Scaup; b) Eider; c) Common Scoter; d) Velvet Scoter; e) Long-tailed Duck; f) Goldeneye; g) Red-breasted Merganser; h) Goosander***

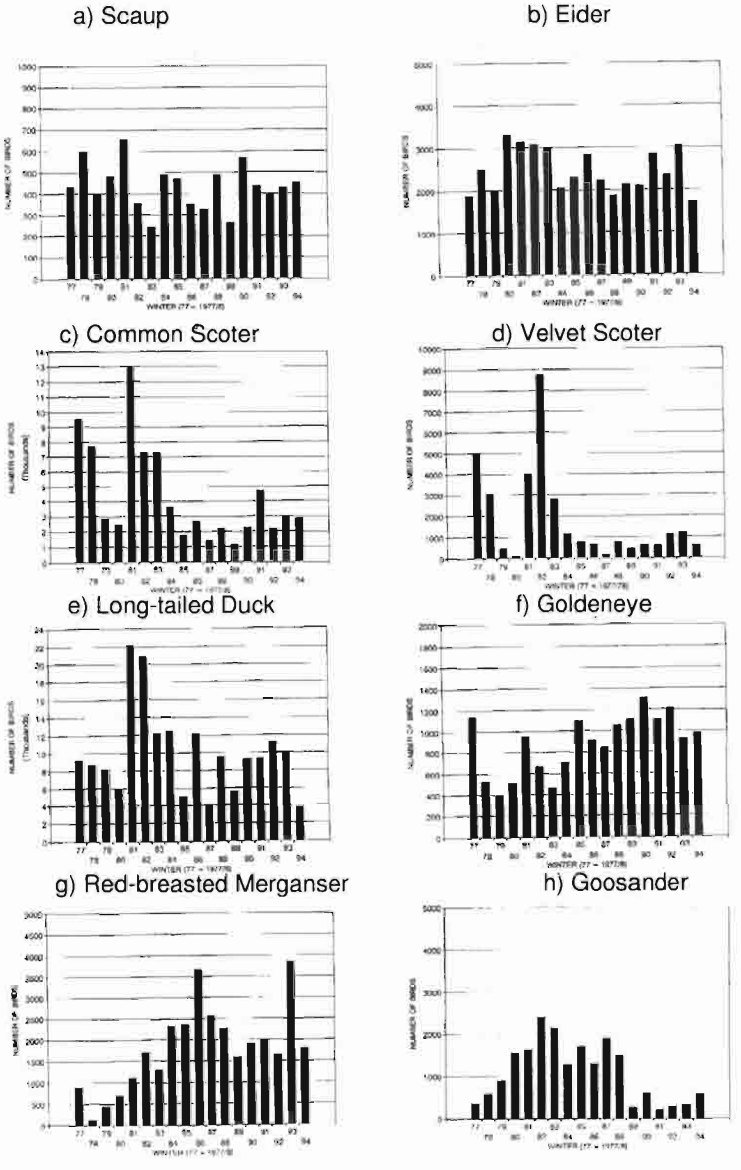


Table 3 ***Five season (* = 3 season) means of Scaup at the main sectons in the Moray Firth 1977-88 - 1994-95.***

Winter	Dornoch Firth	Cromary Firth	Inverness Firth	Whole Moray Firth
1977-78 - 1979-80	*333	*1	*49	*478
1980-81 - 1984-85	435	36	73	445
1985-86 - 1989-90	209	142	112	380
1990-91 - 1994-95	146	308	131	456

Table 4 ***Five season (* = 3 season) means of Eider at the main sections in the Moray Firth, 1977-78 - 1994-95.***

Winter	Sutherland	East Ross	Morayshire	Whole Moray Firth
1977-78 - 1979-80	*1985	*180	*573	*2125
1980-81 - 1984-85	2368	234	788	2916
1985-86 - 1989-90	1500	236	805	2273
1990-91 - 1994-95	1336	232	1258	2410

associated particularly with the Eider on the east Sutherland coast. There were also a few records from the Morayshire coast.

Common Scoter *Melanitta nigra*

Common Scoter occurred regularly in 4 sections of the Moray Firth: the Outer Dornoch Firth, Culbin Sands, Burghead Bay and Spey Bay. Smaller, occasional flocks occurred at Brora and over the Riff Bank.

During 1977-78 and 1978-79, the most important site for Common Scoter was Spey Bay, where around 6000 birds were present each winter (Mudge and Allen 1980). Numbers there declined until 1986-87 when the peak count was only 18 birds. Over the following five winters, numbers increased steadily and in 1991-92 and 1992-93 over 1000 birds were present. It was the most important site in the Moray Firth for Common Scoter in 4 out of 18 winters, including 1992-93 when peak numbers here equalled the peak numbers in Burghead Bay.

Variations in peak numbers at other sites were not as extreme as at Spey Bay. The Outer Dornoch Firth held over 1500 between 1981-82 and 1984-85, but subsequently peak numbers were about 250 in every winter except 1991-92. It was the most important site in the Moray Firth in 2 out of 18 winters. Culbin Sands had 4400 in 1981-82, but never

more than 1500 in any other winter. It was the most important site in the Moray Firth for Common Scoter in 4 out of 18 winters. Burghead Bay held peak numbers in excess of 1000 more often than any other site in the Moray Firth (12 out of 18 winters) and was the most important site in 9 winters. Numbers declined at Burghead Bay (r_s= -0.703. P<0.002, n = 18). Despite large fluctuations in numbers elsewhere, no other section showed a trend.

A decline in Common Scoter numbers for the whole Moray Firth was recorded (r_s = -0.513, P<0.05, n = 18) (Figure 3c). During 1977-78 -1978-79 and 1981-82 - 1982-83, Common Scoter numbers peaked each winter between 7500 and 13500 (Mudge and Allen 1980, Campbell et al 1986). Peak numbers failed to exceed 4000 between 1983-84 and 1990-91, and in 1989/90 reached only 1175.

During 1991-92 numbers were higher than during the mid 1980s, peaking at 4700 in April 1992.

Winter peaks occurred in every month from October to April, but most frequently in February (6 out of 18 winters). There was no clear seasonal pattern at individual sites. Each site showed a winter peak as late as April and the Outer Dornoch Firth had peak winter counts in every month from September to April, with December the most frequent (6 out of 17 winters). Numbers at Spey Bay peaked only once before December in the 17 winters for which data are available and peak counts were fairly evenly spread between the remaining months. Peak counts at Culbin occurred most frequently between December and February, while peak numbers in Burghead Bay were spread mainly between October and February.

Velvet Scoter *Melanitta fusca*

Velvet Scoter tended to occur in the sections also favoured by Common Scoter.

As with Common Scoter, the section showing the greatest variation in numbers was Spey Bay and the section with the least variation was Burghead Bay. Numbers at Spey Bay ranged from 5000 during 1977-78 to only 8 in 1986-87; numbers increased again in subsequent winters. It was the most important section in the Moray Firth for Velvet Scoters in 5 winters up to 1983-84 and none subsequently. Burghead Bay held at least 100 birds in every winter for which data were available except one. It was the most important section in 10 out of 18 winters, including every winter from 1988/-89 to 1994-95. The Outer Dornoch Firth held over 3000 in 1981-82 and 1982-83, but numbers then declined sharply and peak numbers were fewer than 100 between 1986-87 and 1990-91. It was the most important section in 2 out of 18 winters. Culbin Sands never held more than 1000 birds and was the most important section only once.

The Moray Firth total peaked at over 2500 in each of the winters 1977-88 1978-79 and 1981-82 - 1983-84, but failed to exceed 1000 in each winter from 1985/6 to 1991-92 (Table 5). The decline was not significant (r_s= -0.335, ns, n = 18) (Figure 3d).

Peak winter totals for the Moray Firth occurred in October and every month from December to April, with the highest frequency falling in April (5 out of 18 winters) followed by December and March (4 each). Peak numbers at Spey Bay were spread evenly between January and April and the only section where the majority of peak winter counts occurred in December or earlier was Burghead Bay.

Table 5 ***Five season (* = 3 season) means of Common Scoters (including apportioned unidentified scoters - see text) at the main sections in the Moray Firth, 1977-78 - 1994-95***

Winter	Outer Dornoch	Culbin Sands	Burghead Bay	Spey Bay	Whole Moray Firth
1977-78 - 1979-80	* 672	* 750	* 2791	* 4030	* 6706
1980-81 - 1984-85	2341	1566	2205	1702	6715
1985-86 - 1989-90	446	683	974	202	1838
1990-91 - 1994-95	634	749	1075	1041	2996

Surf Scoter *Melanitta perspicillata*

Surf Scoter were recorded annually and the highest number recorded in a single winter was 9 birds in 1978-79, followed by 5 in 1981-82 and 1989-90. During 1990-91 and 1991-92, 12 of 15 records of Surf Scoter were associated with Velvet Scoter and the other 3 were independent.

Long-tailed Duck *Clangula hyemalis*

Although the combination of day-time and roost counts was believed to give the best possible population estimate, the possibility remains that in some winters this method did not survey all sections adequately. In particular, the Easter Ross coast (Section 6) including the Guillam Bank in mid-firth was difficult to count. In some winters, birds using this area by day (and not counted) were regularly using the Burghead Bay roost, where they were counted. Also, it is possible, although unlikely, that some roost sites were undetected

The most important sections for Long-tailed Duck were the East Sutherland coast (Sections 1-4), the Inverness Firth/Riff Bank (Sections 7-8) and Culbin Sands/Burghead

Table 6 ***Five season (* = 3 season) means of Velvet Scoters (including apportioned unidentified scoters - see text) at the main sections in the Moray Firth, 1977-78-1994-95***

Winter	Outer Dornoch	Culbin Sands	Burghead Bay	Spey Bay	Whole Moray Firth
1977-78 - 1979-80	* 169	* 499	* 777	* 2690	* 2835
1980-81 - 1984-85	2228	225	744	1537	3357
1985-86 - 1989-90	99	193	359	37	562
1990-91 - 1994-95	223	159	519	207	815

Table 7 ***Five season (* = 3 season) means of Long-tailed Ducks at the main sections in the Moray Firth, 1977-78-1994-95***

Winter	Sutherland	Riff Bank/ Inverness Firth	Burghead /Culbin	Spey Bay	Whole Moray Firth
1977-78 - 1979-80	* 1252	* 4602	* 2719	* 1595	* 8723
1980-81 - 1984-85	3975	1225	9538	702	14741
1985-86 - 1989-90	1303	2115	4814	304	7281
1990-91 - 1994-95	998	2588	4864	1257	8744

Bay (Sections 9-11). Roosts for these areas were, respectively, between Brora and Golspie, over the Riff Bank and in Burghead Bay (Figure 1). Smaller numbers were found off the East Ross coast and in Spey Bay. Distribution between the 3 most important sections changed considerably over the study period. The Riff Bank, which held large numbers in the winters 1978-79 and 1990-91 had few in the intervening years. Large numbers were found along the East Sutherland coast in the early to mid-1980s, but many fewer during the early and later years of the study. The Burghead - Culbin area held larger numbers more frequently than the East Sutherland coast or the Riff Bank. Shifts of importance between areas occurred too frequently for any trends to be detected for individual sections.

No trend in numbers was detected for the Moray Firth (r_S = -0.119, ns, n =18) (Figure 3e) and numbers fluctuated considerably from winter to winter. Between 8000 and 12500 were found in most (11 out of 18) winters (Table 10). Much higher numbers (over 20000) were found in 1981/2 and low numbers (fewer than 6000) in 5 out of 18 winters. Between 1984-85 and 1990-91 peak numbers alternated between average (4 winters) and low (3 winters). There was no clear pattern to changes in the peak numbers of Long-tailed Ducks detected each winter. It is possible that between year differences in numbers were influenced by differences in distribution or survey intensity.

Peak winter totals occurred between November and February, with an even spread between months. Individual sections reflected this pattern, although winter peaks at individual sections were also recorded in October, March and April.

Goldeneye *Bucephala clangula*

Prior to 1977-78, large numbers of Goldeneyes were regularly present at sewage and distillery outfalls at Invergordon and Burghead, but these declined after changes were made to the quality of the effluent from these outfalls (Barrett and Barrett 1985a). The Longman outfall at Inverness was the only site in the Moray Firth where large volumes of untreated sewage were regularly discharged up to 1994-95 and this site attracted a large proportion of the Moray Firth population (Table 8).

Over the 18 years numbers of Goldeneyes increased in the Moray Firth (r_S = 0.545, $P<0.05$, n = 18), due to changes in the

Table 8 ***Five season (* = 3 season) means of Goldeneyes at the main sections in the Moray Firth, 1977-78 - 1994-95***

Winter	Cromarty Firth	Inverness Firth	Burghead Maltings	Whole Moray Firth
1977-78 - 1979-80	* 406	* 154	* 219	* 685
1980-81 - 1984-85	256	423	23	662
1985-86 - 1989-90	254	571	30	1002
1990-91 - 1994-95	184	738	38	1103

Inverness Firth (r_S = 0.750, P<0.001, n = 18). Numbers decreased in the Cromarty Firth (r_S = -0.618, P<0.01, n = 18).

Peak numbers occurred in all months between November and March, but mainly in January and February, when freshwater sites were most likely to be frozen

Red-breasted Merganser *Mergus serrator*

The Inverness/Beauly Firth and the Riff Bank were the main sections for Red-breasted Mergansers and large numbers were also found in the Outer Dornoch Firth, in the Cromarty Firth and off Culbin Sands (Table 9),

Survey techniques for Red-breasted Mergansers were believed to have improved during the 1970s (Aspinall and Dennis 1988), so the upward trends for the whole Moray Firth (r_S = 0.637, P<0.01, n = 18) (Figure 3g), Culbin (r_S = 0.601, P<0.01, n = 18) and the Riff Bank (r_S = 0.477, P<0.05, n = 18) might be an artefact of improved coverage. No section showed a trend for the period 1981-82 - 1994-95, when surveys had constant effort.

Peak numbers occurred in all months between October and March, but mainly during December - February (14 out of 18 winters). The Riff Bank, Inverness/Beauly and Cromarty Firths followed this pattern, whereas peak numbers at Culbin and in the Outer Dornoch Firth tended to occur either in October or during February-April.

Goosander *Mergus merganser*

Goosanders were found almost exclusively in the Beauly Firth and accurate count data exist from the mid 1960s onwards (Aspinall and Dennis 1988).

Before 1980-81, peak numbers were generally lower than 1000, but between 1980-81 and 1988-89 numbers peaked at more than 1200 in every winter (Table 10). Thereafter, numbers were much lower, peaking between 200 and 600.

No significant trend was detected for the study period (r_S = -0.426, ns, n=18) (Figure 3h), nor for the 31 year period for which good data exist (r_S=0.151, ns, n = 31). Peak winter counts for the period 1981-82 -1994-95 showed a strongly significant downward trend (r_S = -0.176, P<0.001, n =14).

Peak numbers generally occurred during November-January.

Table 9 ***Five season (* = 3 season) means of Red-breasted Mergansers at the main sections in the Moray Firth, 1977-78 - 1994-95***

Winter	Outer Dornoch Firth	Cromarty Firth	Inv'ness /Beauly Firth	Riff Bank	Culbin Sands	Whole Moray Firth
1977-78 - 1979-80	* 315	* 450	* -	* 123	* 246	* 496
1980-81 - 1984-85	574	341	770	559	47	1431
1985-86 - 1989-90	234	509	964	963	161	2498
1990-91 - 1994-95	192	283	1115	826	326	2242

Table 10 ***Five season (* = 3 season) means of Goosander on the Beauly Firth, 1977-78 - 1994-95***

Winter	Beauly Firth
1977-78 - 1979-80	* 620
1980-81 - 1984-85	1800
1985-86 - 1989-90	1331
1990-91 - 1994-95	415

Discussion

Although many sections within the Moray Firth qualify as nationally important in their own right, the arguments of Campbell *et al* (1986) that the Moray Firth should be treated as a single site because of changes in the relative importance of individual sites between years have been borne out by continued monitoring. Long-tailed Duck and Scaup illustrate this point. Winter numbers of both species in the Moray Firth have remained fairly stable at around 10000 and 350 respectively, but distribution within the firth has changed, gradually in the case of Scaup and more erratically in the case of Long-tailed Duck.

Despite reductions in the numbers of some wintering species, the Moray Firth remains one of the prime seaduck sites in Britain and Ireland, holding around 40% of British wintering Long-tailed Ducks and 30% of British wintering Red-breasted Mergansers (Kirby *et al* 1993). The most dramatic change has been the reduction in peak numbers of Common and Velvet Scoters. There is no apparent reason for this change: similarities in seaduck diet (eg Nilsson 1972) imply that altered food availability should cause changes in numbers of most seaduck species, not one or two.

Scoter numbers fluctuate considerably, at other Scottish sites eg St. Andrews Bay (Milne and Campbell 1973). In the nineteenth century, St. John (1845) wrote of 'considerable numbers' of scoters in the Moray Firth, while 50 years later Harvie-Brown and Buckley (1895) described the status of scoter in the firth as 'not particularly abundant'. More recently, Scottish Bird Reports show that between 1970-71 and 1976-77 peak winter numbers of Common Scoters in the Moray

Table 11 ***Sections of the Moray Firth which hold internationally (**) or nationally (*) important concentrations of individual species.***

	SECTION												
SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	ALL
Red-throated Diver			*				*		*	*		*	*
Black-throated Diver			*							*			*
Slavonian Grebe			*			*	*			*			**
Scaup				*		*	*						*
Eider		*	*							*	*	*	*
Common Scoter			*						*	*		*	*
Velvet Scoter			*						*	*		*	*
Long-tailed Duck		*	*				*	*		*		*	*
Goldeneye						*	*						*
R-b Merganser			*			*		*	*				**
Goosander							*						*

Note: See text for fuller description of distribution of Eider and Long-tailed Duck.

Firth ranged from 6000 to 14000. Such high numbers were not present during the 1960s (RH Dennis, *pers comm*).

Campbell *et al* (1986) found that the Moray Firth held internationally important numbers of Long-tailed Ducks, as well as Common and Velvet Scoter. This is no longer the case for Long-tailed Ducks because of increased winter population estimates for north-west Europe, which raised the qualifying level for international importance from 5000 to 20000 (Laursen 1989).

Numbers of Goosanders on the Beauly Firth declined during the study period. The increase during the 1980s was attributed to the introduction of a fisheries ban (Aspinall and Dennis 1988) whereas the decline during the latter years of the study coincided with reductions in numbers of other fish eating birds, notably Red-breasted Merganser and Cormorant *Phalacrocorax carbo* using the Beauly Firth. Red-breasted Mergansers were apparently able to redistribute to other parts of the Moray Firth, but Goosanders did not. There has been an overall decline in the number of Goosanders recorded winterirg in the UK (Waters and Cranswick 1993). This is of particular concern at a time when there is continuing pressure from fisheries interests in Scotland to shoot more Goosanders under licence (Carss 1994).

Nationally important concentrations of Goldeneyes and Scaup were associated with sewage and distillery outfalls at 3 sites in the Moray Firth; Edderton Bay, the Cromarty Firth off Invergordon and at Inverness. Reductions in Goldeneye numbers at Invergordon and Burghead, which no longer holds nationally important numbers of

Goldeneyes, coincided with changes to the quality of effluent at these sites (Barrett and Barrett 1985a). Similar changes are currently in train at Inverness, with further changes proposed. These are likely to have a further effect on the distribution of Goldeneyes and Scaup within the Moray Firth.

The current study was initiated in order to monitor wintering seaduck populations and to determine whether oil industry developments in the Moray Firth affected them. There were no oil pollution incidents affecting large numbers of seaducks, divers and grebes in the Moray Firth during the study period and the Beatrice Field is now nearing the end of its planned production phase. However, with the difficult process of decommissioning yet to come and with the prospect of further inshore oil exploitation in the Moray Firth following the most recent licensing round, the waterfowl populations of the firth will still be at risk from oil pollution.

Commercial fisheries, including shellfisheries, can affect seaducks and other waterfowl through direct competition for food and disturbance. A commercial mussel fishery already operates in the Dornoch Firth where there was a decline in Eider numbers during the study period. There have also been attempts at commercial cockle dredging at Culbin Sands and in the outer Dornoch Firth, though to date these have largely been confined to intertidal areas little used by seaduck. The provision of artificial reefs for commercial shellfish growing has also been mooted. Clearly, there could be conflicts of interest where commercial shellfisheries and large numbers of shellfish eating birds exist side by side (Galbraith 1992).

Monitoring of waterfowl throughout the Moray Firth should be continued. In the case of seaduck, divers and grebes this requires additional coverage to that provided by the Wetland Bird Survey network.

The Moray Firth is a wetland of international importance and qualifies for Special Protection Area (SPA) and Ramsar status (Pritchard *et al* 1992). Current government guidance is that SPAs and Ramsar should be implemented through the SSSI network, which only allows for the protection of areas above the low water mark. While this is sufficient for some waterfowl, it is not for seaduck, divers and grebes, which are mainly to be found below the low water mark and thus would not be protected by SSSI designation. Provision for designation of Marine Nature Reserves under the Wildlife and Countryside Act 1981 has proved too unwieldy to deliver protection to important seaduck sites in the UK (Kirby *et al* 1993). Areas such as the Moray Firth which are important not only for seaducks but for other forms of marine life clearly require effective protection if the government is to honour its obligations under EC Directives. It is to be hoped that the opportunities for doing so under the EC Species and Habitats Directive are taken up.

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Feeding studies of the Lesser Whitethroat in Strathclyde

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The feeding behaviour of the Lesser Whitethroat was studied in Strathclyde at 2 separate territories, 43 kilometres apart. Invertebrate sampling was also carried out there and at 2 other control sites during May - July 1991 and 1992. Observations on territorial males indicated that a considerable proportion of their time was spent singing and feeding in the upper canopy level. Various feeding strategies of which pecking was the most common were identified and appear to be dependent on prey type and size. Video footage taken at the only accessible nest showed that caterpillars constituted 86% of prey items fed to fledglings. The predominant size range of caterpillars seen on video was between 6-10mm in length and that particular size range was proportionally significant in samples collected around that territory. Although our studies failed to establish a link between climate and Lesser Whitethroat distribution, climate may be an important factor in limiting Lesser Whitethroat distribution in Strathclyde through its effect on habitat.

Introduction

The Lesser Whitethroat *Sylvia curruca* is still a comparatively scarce breeding species in Scotland. In Strathclyde, the breeding population has remained relatively stable at 9-12 pairs since 1986, with no indication of further expansion into new areas. This has been attributed to the lack of suitable breeding habitat and climatic conditions (Byars *et al* 1991). We know of no other feeding studies solely on the Lesser Whitethroat in Britain. It has been suggested by Mason (1976) that range limitations may be related to diet. Because our study sites lie at the north westerly edge of the species' breeding distribution, they provide an opportunity to study Lesser Whitethroat feeding ecology at the edge of its range.

Study areas

The majority of breeding territories which have been discovered in Strathclyde (Byars *et al* 1991) were evenly divided between 2 comparable sites, 43km apart. The Renfrewshire site, which covers a 2km^2 area south east of Paisley, contained 3 territories which were located at Dykebar and Brownside Braes. The Ayrshire site covered a slightly larger area of 2.5km^2 and is located just south of Ayr. Regular breeding territories were established at the Heads of Ayr, Burton Farm and Bracken Bay. All territories were located in areas of dense Hawthorn *Crataegus monogyna* and/or Blackthorn *Prunus spinosa* scrub with a dense mosaic understorey of Bramble *Rubus* sp, Gorse *Ulex europaeus*, Dog Rose *Rosa canina* and Goat Willow *Salix caprea*.

Study sites

Insect sampling and observations of feeding behaviour commenced when territorial males arrived back on site. The criteria for locating suitable breeding habitat and assessing site fidelity have already been discussed (Byars *et al* 1991). The sampling sites for occupied territories were located in 2 Lesser Whitethroat territories, 43km apart. The 2 control sites used for invertebrate sampling were chosen on the basis of their similar habitat characteristics to the 2 breeding territories and were 23km apart. These sites were located in 3 of the 18 climatic zones found in Scotland calculated by Birse & Dry (1971) and are based on measurements of altitude, accumulated temperature and potential water deficits. Territory 1, at Heads of Ayr, was in Zone EE a warm dry lowland region; Territory 2 and Control 2 at Brownside Braes in Renfrewshire were in Zone EM, a warm moist lowland region. Control 1 at Dalry was within Zone ER, a warm rather wet lowland region.

The vegetation profiles at these sites were as follows:
Territory 1, Heads of Ayr: The territory contains large dense patches of Blackthorn scrub (2-3m+) interspersed with mature Hawthorn (3-4m+) and a patchy understorey containing Bramble, Dog Rose and Gorse (0-2m+) This site is situated on a NNE facing slope.
Territory 2, Brownside Braes: The territory is located in a disused limestone quarry which is situated on a north facing slope. The habitat consists of mature Hawthorn scrub (3-4m+) with a dense shrub layer of Bramble, Dog Rose and Gorse (0-2m+).
Control 1, West Brownside Braes: This site contains an area of open mature Hawthorn scrub (3-4m+) with extensive Gorse and Bramble understorey (0-2m+), situated on a north facing slope.
Control 2, Dalry coal bing: A disused coal shale bing cloaked in Hawthorn scrub (2-3m+) with mixed Bramble, Dog Rose and Gorse understorey (0-2m+) on a SE facing slope.

Invertebrate sampling

Insect samples were collected from each of the 4 sites using the beating tray method (Southwood 1 978). Within each territory and control site, 30 white plastic markers were randomly placed on the vegetation at 2 different height levels. Ten markers were placed in the scrub canopy at a 2 metre height level and 20 markers were placed in taller canopy at 4 metres height level. A telescopic metre stick was then used to beat a one metre square quadrat surrounding each marker 6 times in the scrub canopy. Invertebrates which fell were collected in a metre square catching tray. All items were then "pootered" into plastic vials containing 70% ethanol for analysis. Invertebrates were classified into taxonomic orders and all items were individually measured. All invertebrate sampling was carried out on warm sunny days. Samples were collected once a month during May, June and July in 1991 and 1992.

Insect samples were also obtained using the sweep net method (Southwood 1978). A 40cm diameter sweep net was quickly trawled back and forth 6 times over a one metre quadrat, which was randomly located above the scrub canopy. Four 1 metre quadrats per territory were analysed and captured invertebrates were then collected into plastic vials containing 70% ethanol for identification. This method was used to sample flying invertebrates located in mid air above the canopy in both study territories. Sweep sampling took place during 2 warm, but relatively calm days, during May 1991 and May 1992 to maximise capture of *Diptera*.

Observation of feeding birds

Detailed observations on male spatial distribution were conducted over 2 x 10 hour periods on 2 selected dates in May 1991 and 1992 in both study territories. Ten hour periods were from 0700 to 1700 BST and observations were timed immediately after the male was located at the start of each song cycle. Specific activity, vegetation type and duration of time spent at each of the 4 height levels, ie 0-lm, l-2m, 2-3m, 3-4m were noted. Observations stopped when the male disappeared from the vicinity and could not be relocated by song after a 10 minute period. Feeding strategies utilised by the 2 territorial males were observed in May-June 1991-92 on a non quantitative basis within the study territories. Observations of feeding bouts started immediately after the male was located by song and all feeding methods were noted in detail. Adult males are more conspicuous and easy to observe early in the breeding season as they feed quite openly in the scrub canopy. After pair bonding, observing both sexes proved extremely difficult, as Lesser Whitethroats tended to search and feed more furtively within the dense scrub canopy. However, adults appear to give a soft contact *tuc* call when approaching and leaving a nest site, so that established routes can be identified and occasionally followed.

All Lesser Whitethroat territories were mapped using the minimum convex polygon method (Kenward 1987). The enclosed habitat was then systematically searched for any indication of nest building. Once found, nests were kept under daily surveillance and the contents checked periodically. Most food collections that were observed took place within 25 metres of the nest. Only one accessible nest suitable for video footage was located during the study period.

Video monitoring

A tripod mounted VHS video camera was placed approximately 1.2 m away from the nest with magnification set to x8. The video camera was switched on manually and left to record until the battery power pack became drained after 2 hours operation. The equipment was then quickly retrieved with the minimum of disturbance to the nest. The video tape was then replayed back at Paisley University, where feeding visits to the nest could be viewed in detail and freeze framed when required. The majority of prey items were easily identified and, by using adult bill length as a reference, these items could also be individually measured. Video footage was taken on 10 June 1992 at the Heads of Ayr, when the fledglings were approximately 9 days old. To our knowledge, this video technique had never been used on Lesser Whitethroats before.

Results

Invertebrate abundance and seasonal variation *

All 4 sites revealed a uniform trend in insect abundance and most taxa were represented throughout. Statistical analyses calculated from total invertebrate numbers per site showed no significant differences between territories or control sites, although there was a significant difference in mean invertebrate numbers between the 2 years. Out of the 7 taxa groups analysed, only *Diptera* and caterpillars varied significantly between territory and control sites, especially in 1991. There were notably more *Diptera* in territories than in control sites for both years, but there were significantly fewer caterpillars recorded in territories compared to that found in the control sites during 1991. 1992 showed similar

numbers of caterpillars for both territory and control sites. Those 2 groups exhibited distinct fluctuations in populations between the 2 years.

Six different invertebrate taxa groups revealed distinct seasonal patterns of abundance in both territory and control sites. *Lepidoptera* larvae, *Diptera* and *Coleoptera* all showed peaks of abundance during May, followed by a decline in numbers during June and July. *Hemiptera* and *Opiliones* displayed a reverse of this trend, with peaks of abundance occurring during July and *Psocoptera* showed a peak of abundance in June.

Results from the sweep sampling revealed small numbers of slow moving *Diptera,* notably *Bibionidae* and *Stratiomyidae.* It appears that *Bibionidae* are favoured prey items, as male Lesser Whitethroats have been observed picking up large numbers from Goat Willow *Salix caprea* flowers. Densities of 12 *Bibionidae* per m^2 were calculated from 4 random quadrat samples taken from the *Salix* canopy.

Appendices containing details of these results have been lodged in the Waterston Library, 21 Regent Terrace, Edinburgh and may be consulted on request.

Spatial distribution

During the 2x10 hour periods, a total of 418 minutes was observed at the Heads of Ayr and 378 minutes at the Brownside Braes territory. Males appeared to spend a significant proportion of time singing along with feeding; 68% (285/418) and 60% (228/378) were recorded for this particular activity at the 2 sites. The predominant canopy at both sites differed and this was reflected in the results. At the Heads of Ayr, males spent 83% of their time in Blackthorn at the 2-3 metre level (347/418), 16% in Hawthorn at the 3-4 metre level (68/418) and less than 1% in Ash at 5+ metre level (3/418). The utilisation of Ash trees within Lesser Whitethroat territories has been observed before (Hunt 1947). At Brownside Braes, males spent 66%, a substantial amount of time in Hawthorn at the 3-4 metre level (251/378). 23% was spent in Gorse at the 1-2 metre level (87/378) and only 11% in Hawthorn at the 2-3 metre level (40/378).

Foraging behaviour

Lesser Whitethroats can appear like *Phyllocsopus* warblers, especially when they forage in the scrub canopy. This distinctive feeding behaviour has been previously noted before (da Prato 1980). Males regularly patrol their territorial boundaries, singing and feeding as they move through the upper canopy. Lesser Whitethroats obtain their prey in 4 contrasting feeding methods 1.Pecking 2.Chase and snatch 3.Brief hover and 4.Flycatching.

1. Pecking was by far the most common type of feeding activity observed at both sites and accounted for 90% of all feeding observations. Pecking itself can be further split into two types:

A Single peck. This is a pecking action towards individual food items (<5mm) dispersed on vegetation.

B Rapid pecking. This occurs when multiple food items (<5mm) are obtained by rapidly pecking into a productive area of vegetation eg leaf clumps. Lesser Whitethroats appear to use their body weight in shaking leaf clumps when they hop on to adjoining branches. Hidden invertebrates attempt to scatter when disturbed and, are quickly taken by this rapid pecking action.

Food items which had been gleaned off the foliage by pecking were too small to identify visually in the field ie <5mm. Although beat sampling can reveal the diversity of invertebrates located in the canopy, we could not identify what the males were eating.

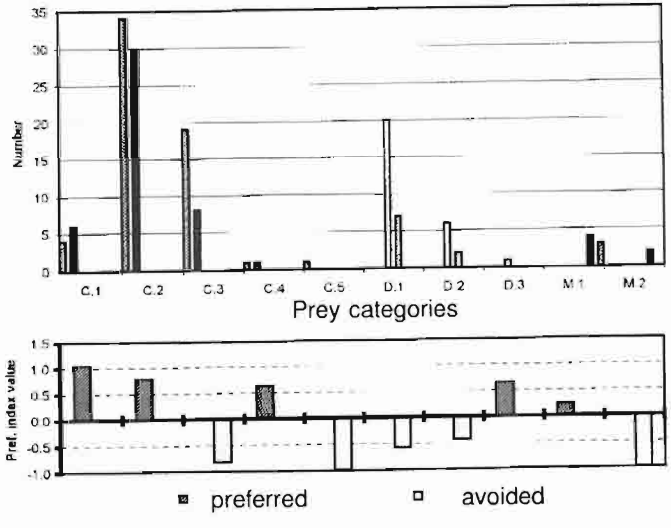
2.Chase and snatch. This strategy always involves a quick chase on moving prey, either by running along a horizontal branch in an attenuated posture, or ascending a trunk using flicked wings. Only 3 chase and snatch observations were made during the study period. The prey items caught were invariably large *Tipulids* (>10mm) which were dispatched by beating on nearby branches.

3.Brief hover. This feeding method is utilised when food items are located away from an available perch. Birds flutter very briefly for up to a second to pick at food items located on thin branch ends or in vertically placed cobwebs. This was observed 3 times during the study period

4.Flycatching. Two types of flycatching have been observed:

A Flight. Seen twice, this involves short (5-8m) one way twisting sallies from the upper canopy.

Figure 1 ***Upper plot shows numbers of prey items availabe (as recorded in beating tray samples during June 1992 at Heads of Ayr) and taken (seen to be eaten in a video recording taken during same sampling date) as left and right bars respectively for various categories C = caterpillars, D = Diptera, M = Moths; 1-5 indicate size categories 0-5mm, 6-10mm, 11-15mm, 16-20mm and 21-25mm respectively. The lower plot uses a preference index where positive values indicate relatively more prey taken than in proportion to their availability, ie preferred, and negative values indicating relative avoidance. This is calculated as (proportion taken/proportion available - 1).***



B Static. This type was observed on 6 occasions. The method comprises short neck lunges from an openly perched position on top of the canopy, often accompanied with an audible bill snap.

Only 114 minutes observation was obtained from one session in the field, during which a total of 47 food carrying visits were made: 31(66%) of such visits were made by the female; while 16 (34%) were made by the male. Fifty two invertebrate items were brought to the nest, 45 (86%) were identified as *Lepidoptera* larvae, 4 (8%) were adult *Tipulids*, and 3 (6%) were adult moths. See (Figure 1). A significant 67% of the caterpillars were in the 6-10mm size category. The female averaged 1.3 caterpillars per visit, while the male averaged 1.0. The female spent a mean of 208 seconds away (31 forays analysed), while the male spent 228 seconds away (16 forays analysed). The male was responsible for the only brooding of the young during the observation period.

Post fledging observations

Fledglings vacate the nest at around 10-11 days after hatching and hide in the dense vegetation layer (0-2m) within the territory, as their flight feathers are still in pin and not fully formed. The adults continue to feed them for a further 2 weeks, foraging in the canopy level. Food items collected by the adults could not be specifically identified during the fledgling period. Once fully fledged, juveniles roam further afield with the adults in a family party. Juveniles appear to loiter around the general vicinity of the territory for approximately 3-4 weeks before completely disappearing. Ringing studies in England have revealed that juvenile Lesser Whitethroats begin to leave their natal area once post juvenile moult has fully commenced at around 30-40 days old (Norman 1992. Boddy 1994).

Discussion

Due to their dense habitat and skulking behaviour, prolonged observations on Lesser Whitethroats are difficult during the breeding season. During early May, however, observations on established males are easier as they patrol their territories. Data collected from timed observations within sampled territories indicate that males appear to spend a considerable amount of time patrolling as they sing and feed in the canopy. This roving behaviour of the territorial males could be territorial defence, mate searching, a response to low prey density, or a combination of these factors. When adults were feeding nestlings, they seemed to largely forage within <25 metres of the nest. As invertebrates and caterpillars in particular are relatively abundant in June, the adults we studied seemed to obtain prey within a small proportion of their territory when foraging to feed their young.

Our study suggests that in Strathclyde male Lesser Whitethroat foraging behaviour depends on habitat structure. At the Heads of Ayr site, where Blackthorn covered approximately 90% of the territorial area, males consistently fed at approximately 2-3m in the Blackthorn canopy. At Brownside Braes, Hawthorn covered 60% of the occupied territory and the male Lesser Whitethroat spent more time feeding in the top (3-4m) canopy than at any other level. This suggests that invertebrate numbers were more abundant in the canopy, but our sampling data found no evidence from any of the 4 sites to confirm this theory. We need to carry out more detailed field work to investigate this. During May, males use various foraging

techniques depending on the prey item concerned. When males are hunting slow moving *Diptera* such as *Bibionidae* the prey items are easily observed and collected. However, the majority of food items taken appeared to be under 5mm in size and were not identified.

Although both sexes hunt in thick cover when foraging for their young, video evidence showed that caterpillars are important prey. If caterpillar populations fluctuate between years - as our results suggest - then fledging success may depend upon caterpillar abundance during the breeding season as caterpillars are large and relatively easy to collect. In 1992, when caterpillar numbers were higher, a brood of 5 successfully fledged at the Heads of Ayr. Clearly more nesting attempts would need to be studied to confirm this link. The timing of the nestling period coinciding with peak caterpillar abundance has been well documented and variations in such timings have been shown to affect the breeding success in insectivorous birds such as tits (Perrins, 1979, 1991) and the Pied Flycatcher *Ficedula hypoleuca* (Lundberg & Alatalo, 1992).

We previously suggested (Byars et al 1991) that the breeding population of Lesser Whitethroats in Strathclyde may be restricted by the climatic effects on prey populations. However, this study found that territories in different climatic zones did not differ in invertebrate diversity and overall numbers to any significant degree. The Brownside Braes control site had the highest total of invertebrate numbers and yet the established breeding territory was located 100 metres away outside the control area. Hawthorn scrub, which was sampled in both territories and control sites, appears to have very high invertebrate numbers and diversity and this is reflected by the variety of other insectivorous bird species which breed within all 4 sites.

Although our studies have failed to establish that climate affects Lesser Whitethroats through invertebrate distribution, it may have an important influence on habitat distribution within Strathclyde. We previously suggested that the distribution of Lesser Whitethroats in the Lothians is linked to the climatic zone defined by Birse & Dry (1971) as Zone EE, which is a warm dry lowland region below 200 metres. What appears to be ideal breeding habitat for Lesser Whitethroats can be found well over 100m in the Lothians *(pers obs)*. Climatic conditions appear to limit the growth and diversity of Hawthorn scrub over 100m in Strathclyde and this seems to restrict the extent of Hawthorn scrub within the region, whereas more favourable climatic conditions in south east Scotland allows for more widespread Hawthorn scrub and therefore a larger breeding population of Lesser Whitethroats.

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Male Lesser Whitethroat at Brownside Braes

Norman Tait

The breeding bird community of upland Juniper scrub in eastern Scotland

S GILLINGS & R J FULLER

During spring 1997 3 sites containing Juniper scrub were censused to describe the breeding bird communities present. A combination of territory mapping and transect counts recorded 18 bird species. The community was dominated by Willow Warbler, Meadow Pipit and Chaffinch but also included locally scarce species such as Ring Ouzel, Whinchat and Black Grouse. The findings are discussed in relation to the likely effects of expansion of Juniper scrub on local avian diversity.

Introduction

It has been suggested that decreases in grazing pressure and reduction of traditional upland management techniques such as burning might promote rapid scrub and woodland regeneration in the Scottish uplands (eg Usher & Thompson 1993). On some estates and reserves in the central and eastern Highlands concerted efforts are now being made to reduce numbers of Red Deer *Cervus elaphus* so it is likely that scrub will develop in several parts of the Highlands in future decades. Where regeneration occurs on open moorland the new habitats will probably support markedly different assemblages of bird species but the exact community likely to develop is not known. The British Trust for Ornithology (BTO) has been undertaking censuses within existing upland scrub of various types in order to describe the range of bird species present and the densities at which they are found. This information will be valuable in understanding the changes that might occur in bird communities with continued scrub expansion. Such knowledge is an important component in developing conservation and management policies as required (Hester 1995).

This paper reports on work undertaken in 1997 aimed at describing the bird communities found in Juniper *Juniperus communis* scrub in the eastern Highlands of Scotland. Juniper scrub is largely restricted to the east central Highlands, particularly in the Cairngorm and Monadhliath ranges where it occurs between 350m and 650m (Rodwell 1991). It may be present as open, short scrub on moorland and also as understorey in birch *Betula* and Scots pine *Pinus sylvestris* woodland. Stands are typically even aged and of low productivity (Hester 1995) hence conservation of Juniper may be an issue itself. Scrub frequently exists as complex mosaics consisting of scrub patches differing in structure interspersed with moorland grass and Hseather *Calluna vulgaris*. Another aim of this study was to assess how this patchiness and structural variation affected bird community composition.

Methods

Study sites and field methods

Juniper is relatively widespread in the Scottish uplands but large tracts suitable for a study such as this are scarce. We selected 3 sites in the eastern Highlands (Table 1) dominated by Juniper but differing in the height, ground cover and shape of bushes. The locations of these sites have been withheld at the request of the landowners. All fieldwork was undertaken in May and June 1997 on dry, clear, relatively calm mornings. Sites 1 and 2 formed discretely definable plots and were censused by territory mapping. Site 3 was extensive and more suited to census by transect counts. On a preliminary visit a hand held global positioning system (GPS) was used to define the plot boundaries of Sites 1 and 2 (accurate to nearest 10m) for drawing plot maps (scale 1:2500). Each of these plots was visited twice during which the locations of all birds were recorded on the plot map using standard territory mapping notation (Marchant *et al* 1990). Site 3 was surveyed using 4 transects (total 4.02km) set out on the first bird recording visit. These crossed extensive tracts of Juniper varying in height and ground cover and followed the hill contours in order to remain at the same altitude. The GPS was used to fix the start, changes of direction and end so that the length of each transect could be derived (to nearest 10m). Each transect was visited 3 times and the direction walked was switched to reduce bias arising from decreasing song activity after dawn. All birds encountered were placed into distance bands (0-50m and 50-100m) on basic transect maps using territory mapping notation.

Basic vegetation descriptions were made at each site. The mapping plot at Site 2 was split into3 sections (A-C, Table 1) on the basis of gross vegetation differences. On Site 3 the transects were split into sections of similar vegetation by fixing the location of major vegetation transitions using the GPS. In this way the length of transect in 4 vegetation types (I-IV, Table 1) was derived. Different grazing animal populations were present at each site and this may partly explain variation in vegetation structure. Rabbits *Oryctolagus cuniculus* and Mountain Hares *Lepus timidus* were present on all 3 sites but at varying densities (see Table 1). Roe Deer *Capreolus capreolus* were seen on Sites 1 and 3 and Red Deer were seen on Site 3. Sheep were recorded only on Site 1. The fact that we did not record one or both deer species or sheep at a particular site should not be taken as an indication of their absence.

Estimation of densities

The number of registrations of each species on each visit was extracted from visit maps for Sites 1 and 2. On Site 3 only birds recorded within the 50m bands were used for density estimation (hence a 100m section is equivalent to 1ha). In all cases if an individual was recorded in more than one section (or inside and outside a plot boundary) the proportion of registrations in each section counted towards the total. Excluding Black Grouse[1], species densities were calculated using the mean number of registrations across visits. This method provides a good approximation to densities derived by territory mapping and Distance Sampling procedures (Gillings *et al* in press). Distance Sampling was not deemed necessary because of the large distances over which individuals were detectable. For male Black Grouse, which were often detected in groups, calculations used the number of males rather than the number of registrations.

Table 1 ***Summary of site details for Juniper plots in the eastern Highlands. Sites 1 and 2 were censused by territory mapping and Site 3 by transect counts. The area covered by transect counts is based on belts of 50m each side of the transect line.***

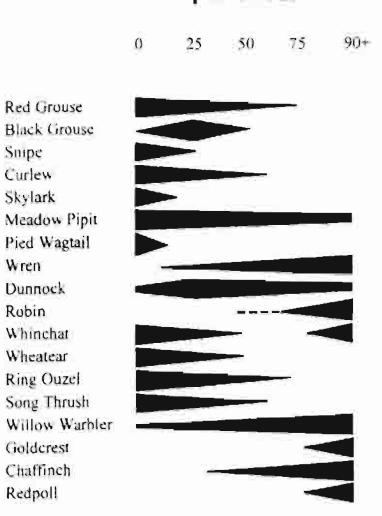
Site	Altitude (m)	Section	Size (ha)	Vegetation description
Site 1	335-366	Whole	19.6	Grass/Heather/Juniper mosaic; Juniper varied from mat like plants <0.5m tall to bushes 1.5m tall, cover in range 5-60%. Mountain Hare particularly common here.
Site 2	396-457	Whole	42.7	Grass/Heather/Juniper mosaic. The site was subdivided into 3 areas:
		A	7.2	Moor Grass; virtually no Juniper (<5% cover).
		B	17.1	Ungrazed grass/Heather; ungrazed bushy Juniper <1m tall, 40-60% cover.
		C	18.4	Short heavily grazed turf-like grass; heavily grazed (Rabbit) Juniper <1m tall, 10-60% cover.
Site 3	518-549	Whole	40.2*	Grass/Heather/Juniper mosaic. Mountain Hare present throughout. The site was subdivided into transect strips of similar habitat:
		I	14.6	Open Moor Grass/Heather; Juniper <10% cover, <0.5m tall.
		II	9.1	Juniper cover 10% - 25%, <0.75m tall (usually 0.5m).
		III	10.0	Juniper cover 26% - 59%, <1m tall.
		IV	11.2	Juniper cover 60% - 90%, <1m tall.

[1]Scientific names of birds are given in Table 2

Results

Eighteen species of bird were recorded across the 3 sites and estimated densities are presented in Table 2. Results are presented for whole sites and for the different habitats (A-B and I-IV). Willow Warbler was the commonest species in virtually all stages of Juniper scrub, followed by Meadow Pipit and Chaffinch There was much vanation in species density between sites and the different vegetation types represented by each section. Our assessment of associations of each species with the extent of Juniper cover are given in Figure 1. Curlew, Snipe and Wheatear were mostly recorded from open moorland areas. At the other extreme, Goldcrest was only recorded where tall (c2m) Juniper bushes existed. Willow Warbler was recorded throughout but increased in density with increasing Juniper cover. Total density (all species combined) increased with increasing Juniper cover and height (Figure 2).

Figure 1. ***Graphical representation of the association of each species with the extent of Juniper cover. Bar width indicates relative habitat association: narrow bars = poor usage, wide bars = regular usage, based on density estimates and field observations.***



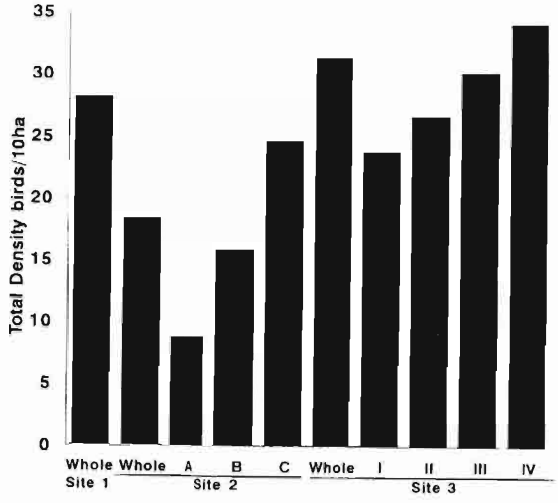
Discussion

The bird assemblage found in Juniper scrub was low in species richness and was dominated by Willow Warbler, Meadow Pipit and Chaffinch. The species recorded, and their densities, were very similar to those found in birch scrub in the eastern Highlands (Gillings *et al* in press). Both in birch and Juniper Willow Warbler densities were in the range 10-15 birds/10ha and comparable with densities in southern England and Scandinavia (Gillings *et al* in press). Meadow Pipit densities in Juniper scrub were less than half previously published densities on open moorland (Thirgood *et al* 1995). Apart from the species mentioned above, there were also notable densities of Dunnock, Song Thrush, Ring Ouzel, Whinchat and Black Grouse. Although densities of Black Grouse appear higher than those reported by Baines (1996), they are probably not representative of larger areas, and are not truly comparable because of methodological differences. Juniper scrub is not homogeneous and plots show wide variation in the extent of cover, growth form and size of bushes. Several factors may causes such variation including genetic differences, local climate (A MacDonald *pers comm*) and different grazing animals. Where abundant, Rabbits may graze the lower foliage. even within the base of the bush, producing stands that are much more open. This combined with the short, turf like

Table 2 ***Densities of breeding birds on 3 Juniper plots in the eastern Highlands. Densities are registrations per 10ha^{-1}, except Black Grouse which is males per 10ha^{-1}. Asterisks indicate species not recorded at a site.***

	Site 1	Site 2				Site 3				
Species	Whole	Whole	A	B	C	Whole	I	II	III	IV
Red Grouse *Lagopus lagopus*	*	*	*	*	*	1.0	1.0	2.2	1.0	1.8
Black Grouse *Tetrao tetrix*	0.5	1.4	0.0	0.0	3.3	1.5	0.0	3.7	0.0	0.0
Snipe *Gallinago gallinago*	1.0	0.2	0.7	0.3	0.0	*	*	*	*	*
Curlew *Numenius arquata*	*	0.8	2.8	0.3	0.5	0.1	0.0	0.3	0.0	0.0
Skylark *Alauda arvensis*	*	*	*	*	*	0.5	1.0	0.0	0.8	0.0
Meadow Pipit *Anthus pratensis*	5.1	3.6	4.2	3.8	3.3	10.6	8.6	7.9	11.8	12.5
Pied Wagtail *Motacilla alba*	*	0.1	0.0	0.0	0.3	*	*	*	*	*
Wren *Troglodytes troglodytes*	*	0.4	0.0	0.3	0.5	0.8	0.2	1.1	0.0	0.9
Dunnock *Prunella modularis*	2.0	1.9	0.0	0.9	3.5	1.0	0.2	1.5	0.2	0.4
Robin *Erithacus rabecula*	0.3	0.1	0.0	0.0	0.3	*	*	*	*	*
Whinchat *Saxicola rubetra*	*	0.1	0.0	0.3	0.0	0.2	0.9	0.0	0.0	0.4
Wheatear *Oenanthe oenanthe*	*	0.2	0.0	0.4	0.1	0.8	0.8	1.6	0.0	0.0
Ring Ouzel *Turdus torquatus*	*	0.9	0.7	0.3	1.6	0.6	0.0	0.7	0.7	0.0
Song Thrush *Turdus philomelos*	1.8	0.7	0.0	0.6	1.1	0.8	0.8	0.9	0.3	0.0
Willow Warbler *Phylloscopus trochilus*	12.5	6.4	0.4	7.8	7.5	12.4	6.5	5.7	13.7	14.7
Goldcrest *Regulus regulus*	1.0	0.1	0.0	0.0	0.3	*	*	*	*	*
Chaffinch *Fringilla coelebs*	3.3	1.4	0.0	0.9	2.5	1.2	0.2	0.0	1.7	2.2
Redpoll *Carduelis flammea*	0.5	*	*	*	*	*	*	*	*	*

Figure 2. ***The total density of all species broken down into sites, sections and habitats.***



grass sward produces a very different habitat from Juniper that is grazed only by Mountain Hares. Such spatial and structural diversity may provide many different niches for birds. Densities produced for gross vegetation types indicated that there were clear preferences by some species for different habitats on a continuum from open moorland to closed canopy Juniper thickets. Without comparable density estimates in open moorland adjacent to our study sites, it is difficult to determine how tolerant of scrub are species typically associated with open moorland. However, it is clear that Snipe, Curlew and Skylark persisted in areas where sparse, prostrate Juniper occurred. Moreover, Meadow Pipit, Ring Ouzel and Red Grouse persisted where Juniper occurred at up to 75% ground cover with some grass. A Ring Ouzel nest and several broods of Red Grouse were found within open canopy Juniper scrub on Site 3.

Section C of Site 2 was Rabbit grazed grass with Juniper bushes and appeared particularly favourable for Ring Ouzels. Two pairs were recorded here, including one feeding a family of 4-5 fledglings on open lawn like turf. At the other extreme, species such as Willow Warbler, Chaffinch and Redpoll preferred more continuous tracts of tall bushes.

When predicting the effects of possible future expansion of Juniper it is clearly important to use the appropriate measure of density. This paper presents several density estimates which are applicable at different spatial scales and to different types of Juniper structure. On a small scale, Juniper scrub may be relatively homogeneous particularly as it often grows in even aged stands (Ward 1973). On a larger scale, however, the densities presented in Table 1 for specific stages will be inappropriate because scrub regeneration is likely to be

patchy and to produce mosaics of Juniper amongst Heather or grass. In these cases, the densities for whole sites might be more useful since they average out high and low density patches. Can these results be generalised to Juniper scrub in other areas of Scotland? The 3 sites used in this study exhibit a range of spatial structure, vegetation form and presence of 5 grazing animals (Rabbit, Mountain Hare, Red Deer, Roe Deer and sheep). Hence they are probably typical of Juniper scrub on moorland in the Scottish uplands but not necessarily in other habitats, for example understorey in birch woodland. The lack of study sites in the western Highlands may reduce the generality of conclusions because local bird species pools may differ, although this is unlikely to have a major effect in these simple habitats. These results suggest that colonisation of open moorland by Juniper scrub would probably cause an increase in local species richness. Scrub regeneration might be at the expense of upland breeding wader populations but there are several reasons why this might not be the case. Firstly, Juniper prefers well drained soils and will only regenerate on bare soil or recently heavily grazed swards (Miles & Kinnaird 1979) where wader populations may typically be low. Furthermore, scrub regeneration is extremely slow or non existent at the high altitudes at which waders such as Golden Plover *Pluvialis apricaria* and Dunlin *Calidris alpina* breed in eastern Scotland (Brown & Stillman 1993). On the positive side, raptor species such as Kestrel *Falco tinnunculus.* Sparrowhawk *Accipiter nisus,* Merlin *Falco columbarius* and Hen Harrier *Circus cyaneus* may benefit from an increase in the local availability of songbirds. We encountered Kestrels and Hen Harriers on or around our study areas but cannot provide any information on their use of the scrub. Also, mosaics of Juniper scrub and grass adjacent to heather moorland may be particularly beneficial to Black Grouse populations. Males from a large lek at Site 3 were often seen within the scrub during fieldwork and this habitat probably provides important daytime cover and food resources (D Baines *pers comm*).

In summary, we have found moderate to high densities of several species typical of open moorland and scrub breeding in Juniper scrub. Further expansion of Juniper scrub could be beneficial for many species, including some that are vulnerable, but possibly at the expense of strictly open moorland species More work is needed to identify the areas most likely to be colonised by Juniper and to describe the breeding bird population there so that any necessary areas of action can be identified. Future research could also focus on wide ranging species such as raptors to assess how they utilise scrub habitats.

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Willow Warbler *Sidney Clarke*

Seasonal differences in pellet remains from Golden Eagles in the Isle of Harris

A C POUT

An analysis of prey remains in pellets collected from 4 pairs of Golden Eagles in the Isle of Harris revealed that 'live prey' remains were more frequently found in pellets from the prebreeding period than from later in the season, and in pellets collected from an active nest site than from other sites within the same range during the fledging period. It is argued that these differences arise from the feeding preferences of the adult Golden Eagles. Possible reasons for such a preference and the implications are discussed.

Introduction

Golden Eagle diet in Scotland can be usefully thought of as consisting of 2 distinct components: the small and medium sized mammals and birds that Watson *et al* (1992) termed 'live prey'; and the remains of sheep and Red Deer *Cervus elaphus* that eagles scavenge as carrion. Live prey is, in the vast majority of cases, likely to have been killed by the eagles, will thus be fresh at the time of consumption, and is generally of a size that enables it to be transported by an adult Golden Eagle.

In contrast, carrion is scavenged and not killed, therefore need not be fresh when it is consumed. Due to the size of the carcasses it is not readily transportable by the eagles themselves and consequently the vast majority of the feeding occurs at the site where the animal died.

Watson *et al* (1992), in a study encompassing 9 geographic areas across Scotland, found a positive correlation between the availability of live prey and Golden Eagle breeding success, and between the availability of carrion and Golden Eagle nesting density. A suggested explanation for the relationship between live prey and breeding success (Watson & Langslow 1989) was that, as carrion was not readily transported, the feeding of the young on the nest was dependent on the availability of live prey.

In much of Scotland, and particularly the west, a substantial number of pairs of Golden Eagles is consistently recorded as being present within home ranges for which no evidence of breeding is subsequently found (Murray 1992-1996). While this may in part be due to observer effort, it also suggests that failure to lay eggs may be as important a factor as fledging success to overall breeding productivity. This study is based on pellets from Golden Eagles in South Harris, from which Red Deer are absent and where sheep are the only source of carrion, to examine seasonal changes in the live prey and carrion components of Golden Eagle diet.

Methods

Cast pellets were collected from the perches, roosts and the nest sites of 4 adjacent pairs

of Golden Eagles in the Isle of Harris, Western Isles, during 3 periods in 1996: 25 March-11 April; 26 May-2 June; and 26 August-2 September. Collections were made from the same sites during each period and, therefore, the time interval within which pellets were cast could be determined, allowing pellet contents to be related to particular periods in the breeding season of the adult Golden Eagles. The pellets collected in March-April would have been cast in the period prior to egg laying, those collected in May-June will have been cast during the incubation period and the early fledging period, and those collected in August-September will have been cast during the late fledging period and the first 4 weeks of the post fledging period. In addition, pellets cast by a young eaglet were collected from a successful nest of one of these pairs during June and August, enabling a comparison between the remains of food consumed by the young on the nest and those from food eaten by the adults of that pair away from the nest over the same time period. Prey seen on the nest was also recorded, though was not used in the analysis.

Maximum length and width of pellets was recorded and hair and feather remains were examined under x 47, x 100 and x 400 magnifications and identified with reference to Day (1966), Brunner and Corman (1974), Brom (1986) and Teerink (1991), and also by comparison with a reference collection gathered in Harris. Skeletal remains recovered from the pellets were identified from skins in the Department of Zoology, University of Aberdeen and, in one instance, from Yalden (1977).

Remains were recorded by their occurrence within a pellet, the presence or absence of live prey remains being compared. No attempt was made to relate the frequency of occurrence of remains in pellets to the frequency of occurrence of individual animals as food except when the presence of skeletal material enabled a minimum number of individuals to be inferred. Statistical tests followed Fowler & Cohen (1990).

Results

Remains of live prey were found to be present in 31 of the 51 pellets from the prebreeding period, 8 of the 23 pellets from the second collection period and 3 of the 10 pellets from the third collection period, the remaining pellets consisting entirely of carrion remains. The greater frequency of live prey remains in pellets collected during the prebreeding period in comparision with pellets from later in the season is statistically significant (X^2= 6.12, d.f.=2, $p< 0.05$). There was no evidence that the size of pellets changed over the period (Kruskal-Wallis test: K=4.12,d.f.= 2,n.s.), nor that the pellets became any more or less heterogeneous in the number of discernible prey remains a single pellet contained (X^2= 0.73, d.f.=2, n.s.).

The live prey remains recorded in pellets included 49 bird and 29 mammal items (Table 1). Of the birds, Red Grouse *Lagopus lagopus* was the most common species with 24 occurrences. Passeriform remains were found in 11 pellets; of those that were identifiable to family, 2 were corvids and one was a thrush *Turdus sp.* Three passerines were identifiable from skeletal remains as being small, ie under 40g, but were not identifiable to family. Three pellets contained the remains of diver *Gavia sp* and a Woodcock *Scolopax rusticola* was identifiable as one of the Scolopacidea recorded. A single pellet contained Grey Heron *Ardea cinerea* feathers and another contained feather remains that were unidentifiable due to lack of downy barbules.

Of the mammalian live prey, Rabbit *Oryctolagus cuniculus* was the most common single item, remains being found in 8 pellets. The remains of small mammals, such as Wood Mouse *Apodemus sylvaticus* and Pygmy Shrew *Sorex minutus*, were found in 6 pellets and a single pellet contained the fur of a cat *Felis sp.*

The 12 pellets recovered from the nest differed from 20 pellets collected from the adults of that pair over the same period in that nest pellets contained no sheep remains (X^2= 12.85, d.f.=1,p< 0.01). Red Grouse was present in 11 of the pellets and Mink *Mustela vison* fur was present in 6 pellets. A total of 27 Mink claws were recovered from these pellets indicating that at least 2 Mink must have been consumed. Prey items actually observed at the nest site included 4 Red Grouse, 1 Golden Plover *Pluvialis apricaria* chick, 1 Snipe *Gallinago gallinago*, 2 Rabbits, 2 lambs and a Wood Mouse. The surviving eaglet also consumed its sibling which died at between 2 and 3 weeks of age.

Discussion

Live prey predominated in the pellets from the young eaglet on the nest at a time when the pellets from the adult Golden Eagles of that pair contained a substantial proportion of sheep carrion. This suggests that the adult eagles are either constrained in, or discriminating between, the types of food they consume themselves and that which

Table 1 ***Frequency of indigestible remains recovered from Golden Eagle pellets, Isle of Harris in 1996.***

	25/3 to 11/4	26/5 to 2/6	26/8 to 2/9	Nest	Total
Gavia	3				3
Ardea			1		1
Lagopus	7	4	2	11	24
Charadridae	3				3
Scolopacidae	5			1	6
Passeriform	5	3		3	11
Unidentified	1				1
Sorex	1				1
Mustela				6	6
Felis		1			1
Sheep	33	18	9		60
Apodemus	3	2			5
Oryctolagus	5	2	1		8
Total occurrences	66	30	14	21	131
Total pellets	51	23	10	12	96

they use to provision their young. It also suggests that studies that do not distinguish between pellets from adults, ie those cast away from the nest site, and pellets from the young are likely to misrepresent Golden Eagle diet. The frequency of live prey remains in pellets from adult eagles during the prebreeding period also runs counter to the seasonal abundance of the live prey species present in Harris. While this may in part be explained by adult eagles feeding their young on the live prey they catch in the fledging period rather than eating it themselves, it nevertheless suggests that live prey is favoured over carrion by the adult eagles during the prebreeding period. Indeed, based on the stocking levels, reported mortality rates and the numbers of carcasses found within the ranges (own data, unpublished BSc honours project, University of Aberdeen), the availability of sheep carrion in South Harris is such that it would be feasible for Golden Eagles to feed on nothing else for the majority of the year if it were their favoured food. That so, one explanation for favouring live prey might be that there is a need for female Golden Eagles to gain body condition prior to egg production and incubation, a requirement demonstrated in Sparrowhawks *Accipiter nisus* (Newton *et al*, 1983) and argued (Ferrer, 1994) for the Spanish Imperial Eagle *Aquila adalberti*, and that the carrion that is available is nutritionally inferior to live prey in this respect. Again, were it not so then, as Brown (1969) pointed out, one would expect breeding failure to be manifest as death of the young during the fledging period due to lack of live prey delivered to the nest and not as high levels of nonbreeding. Consideration of the circumstances under which sheep die on moorland grazings suggests that many of the carcasses available to scavenging birds, at least in Harris, will be those of sheep in poor condition. Carrion is also likely to be much more variable in quality than live prey in a situation where consistency of diet over a prolonged period may be important. Barton and Houston (1993) have shown that sheep carrion has lower fat content and energy yield than Rabbit or Pheasant *Phasianus colchicus*.

Carrion abundance correlates with high Golden Eagle nesting density (Watson *et al* 1992) hence smaller relative range sizes and, everything else being equal, fewer live prey per pair. In addition, heavily grazed areas support fewer live prey than, for example, areas with good heather cover. If there is a relationship between the availability of live prey and egg production then one might expect that areas with high carrion availability and high Golden Eagle nesting density would be characterised by the widespread incidence of nonbreeding by established pairs of Golden Eagles that are able to subsist on the ample carrion that is available. This appears to be the case in South Harris where Golden Eagle density is approaching 40 pairs per 1000 km^2 of suitable habitat (Green 1996), sheep carrion is abundant for the majority of the year and, of 3 pairs of Golden Eagles monitored over an 8 year period, 2 have consistently failed to lay eggs despite regular occupancy and with no evident signs of disturbance.

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Golden Eagle *Steven Brown*

SHORT NOTES

Inland Common Gull colonies in north east Scotland

Tasker *et al* (*Scottish Birds* 16: 106-112) reported very big gull colonies on north east Scotland moorland. Here I give past data that may throw some light on this. In 1943-48 fairly big Common Gull *Larus canus* colonies (> 100 pairs) were on Monaughty near Pluscarden, Wishach Hill (also >100 pairs of Lesser Black-backed Gulls *Larus fuscus*), Aultmore, Ordiequhish, Hill of Towie, The Balloch (>1000 pairs), and Fetteresso, and small ones south of Cuminestown on Greenness Hill (20 pairs in 1945) and Waggle Hill. At Waggle's south end in 1945, 14 pairs nested and a pair of Great Black-backed Gulls *Larus major*. At its north end, hundreds of Black-headed Gulls *Larus ridibundus* nested, many Common and Lesser Black-backed and a few Great Black-backed. The Balloch held thousands, mostly Common Gulls but many Lesser Black-backed and some Herring Gulls. Ordiequish had a few Great Black-backed pairs also.

These sites lay on heather moorland that was later destroyed by tree planting on Forestry Commission land or on private land using FC methods. Since 1970 this happened to much of the Corrennie and Suie colonies and all the Cairn Mon Earn and Spyhill ones. Birds moving from these to the increasingly few moors near the main farmland tracts may have contributed to the current big colonies.

At The Balloch, Edward Bruce (*pers comm*) said Common Gulls deserted the area within a few years of planting, but Lesser Black-backed and Herring Gulls continued to nest until tree branches met above the nests. Small areas remained unplanted at The Balloch and Hill of Towie, but gulls deserted them once the surrounding trees were >1m high. At a Mulben peat bog with stunted pines he found several Common Gulls nesting on top of the dense tree foliage. James Allan (*pers comm*) saw such a nest at Kellas moor by Elgin.

Foxes *Vulpes vulpes* were absent in the 1940s in Buchan, lower Deveron and lower Don and colonised low farmland in Banff, Aberdeen and Kincardine counties only in the 1950s (Nethersole-Thompson & Watson 1974, *The Cairngorms*). This applied also to low Moray including Pluscarden. Small gull colonies are probably more vulnerable to Foxes than big ones.

In 1945 crofters marked nests at Waggle with small cairns. They said the moor was 'moving with gulls' in the 1930s but wartime shortages led to high egg prices and the colony declined. They took each new egg about every 3 days and fresh eggs were laid into July.

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Hunting associations between Merlins and Hen Harriers

All the reported cases of hunting associations between Merlins *Falco columbarius* and Hen Harriers *Circus cyaneus* in winter have usually involved single birds of either species (Dickson 1993 *Scottish Birds* 17:58-59).

On 6 January 1996 at 1430 GMT on farmland in west Galloway, I watched a female or juvenile Merlin hunting 500+ Skylarks *Alauda arvensis* and 1000+ Linnets *Carduelis cannabina* without success. A ringtail Hen Harrier then hunted these same flocks but the Merlin did not take part. Thirty minutes later the harrier returned and again hunted the passerine flocks. This time the Merlin took part and, at the same time, another, smaller brown Merlin appeared. Both Merlins then attacked the passerines which were flushed by the harrier, swooping and stooping on them together in a quite spectacular manner for the next 4 minutes. The harrier landed and the Merlins began chasing each other and both flew out of sight, the larger Merlin leading. Eight minutes later the harrier resumed its hunting alone.

On only 1.4% of hunts I have watched in Galloway have 2 Merlins hunted together (Dickson 1995, *Scottish Birds* 18:165-169). The occasion where 2 Merlins hunted together in association with a hunting harrier has not been recorded before.

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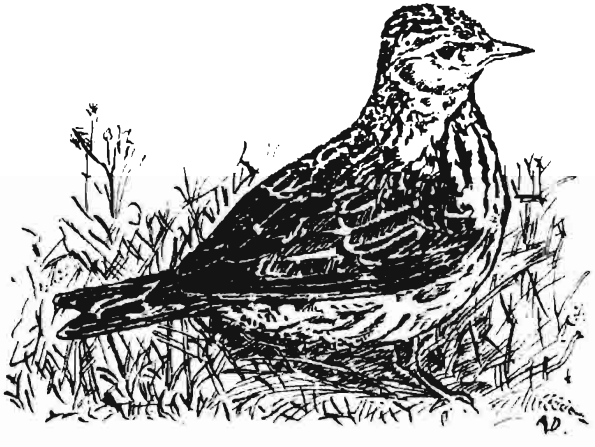

Skylark *Andy Dowell*

Double brooding by Lapwings

In 1997 a pair of Lapwings *Vanellus vanellus* nested on an island in a freshwater pool at a nature reserve in East Kilbride, South Lanarkshire. At least 3 chicks hatched on 3 May. Between 11 and 14 May one of the chicks disappeared and by 21 May only one chick remained; however, this bird fledged successfully and was seen flying on 6 June.

In late May and early June the male of the pair had been noted sitting in the same area of the original nest, but was not thought to be incubating a second clutch of eggs. However, on 13 June 4 chicks less than 24 hours old were observed. Of this second brood, only a single chick remained on 24 June, with no Lapwings at all present on 28 June - the adults either moved away with the chick, or abandoned the site following its death. *BWP* (vol 3) states the Lapwing is single brooded but replacement clutches can be laid after egg loss and that field experiments on the species have revealed that up to 4 replacement clutches can be laid following egg removal. Given a mean incubation period of 21+/- 1.77 days (n= 96) from clutch completion in a Hampshire study (mean of 28.1 days (24.7 - 34.0), n= 41, including the egg-laying period, from a Scottish study) and clutch completion in 5 days - most females lay daily (*BWP* vol. 3), then the second clutch was almost certainly started between 17 and 20 May, when there was at least one chick still present from the first breeding event. In the Lapwing, laying of replacement clutches occurs 5-12 days after the loss of a previous clutch, but it can also be triggered by loss of chicks, at least early in the season (*BWP* vol. 3).

The Lapwing nest site was approximately 30m from a frequently used public path, and the site was carefully monitored at least twice a week. No other adult Lapwings were observed anywhere in the area from 9 March to 28 July.

The East Kilbride Lapwings are of interest, therefore, in that a second breeding attempt followed a successful first one when there was no complete loss of clutch or brood, and did not involve a replacement clutch, but rather a genuine second clutch.

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Lapwing *Barry Larking*

Cormorant calls at a winter roost

Cormorants *Phalacrocorax carbo* on nesting territories are well known to show a loud and complex vocal repertoire (BWP Vol 1), yet away from this situation authorities consider that this species is usually silent. My experience is that this is certainly true of birds, singly or in groups, commuting to feeding grounds or actually fishing, but they can be very noisy at roost.

For some years I have studied a large roost in the upper Forth estuary just above Alloa, the site being 20 pairs of piers of a dismantled railway bridge. Most of these piers consist of round brick pillars, about 10m high, and the birds mainly roost (a) on the flat tops of the pillars plus top connecting struts, (b) the middle horizontal struts plus the narrow ledges formed by metal bands around the brick pillars connected to these struts. My observations refer to watches made just before sunset in autumn and winter, when up to 200 birds assemble with 15 to 20 on the more favoured central piers.

I cannnot recall a single watch which has not been enlivened by a number of loud outbursts of calling. These are usually stimulated by an incoming bird flying onto a site already occupied by 5 or more birds, but occasionally when a squabble breaks out among some that are already settled. Often a bird, either an incomer or a 'resident', is displaced in such encounters and it then flies round to make an attempt to resettle, either immediately or after resting on the water. The disturbance is thus often intensified. Two main types of call can be distinguished, though many intermediates occur. The first is a short series of low pitched, hoarse bellows or roars, describable as ' gok-gok-gok', that I would equate with the threat call described by van Tets and mentioned in BWP. The second is a more rapid series of higher pitched barks, best rendered as 'ag-ag-ag-ag-ag'; this could be similar (as a sound) to any of 4 of the intra pair calls in BWP, but I cannot see a clear relation. The roost encounters are also characterised by bill lunging and fencing (typical of territorial aggression at nest sites) (BWP) and also by the gaping display (bill up and tail up) figured in BWP and taken as a breeding season greeting ceremony that is accompanied by a loud call (not described in detail). There is no reason to suppose any greeting between the sexes when the gaping display occurs in winter roosts. In my observations the birds are some hundred of metres distant; this and the close grouping at a roost preclude a detailed study of any association between particular calls, displays and contexts. M Martin and E D Cameron have watched 2 inland roosts in trees in Perthshire, each sometimes holding 50 birds, and tell me that they have also heard loud calling in broadly similar situations during both daytime assembly (MM) and morning departure (EDC).

Loud calling is a constant feature of aggressive interactions at the Alloa roost. However, the occasional midday roosts occurring on mud banks lower down the river are quite silent even though birds are often close together. The most likely explanation is that roosting for the night involves some aspect of territoriality. There may well be some individual preferences for particular roost sites but, without marked birds, my only evidence comes from a very distinctive juvenile (with pure white underparts and a blackish cap) that was seen twice and occupied the same site on 24 January and 14 February 1997.

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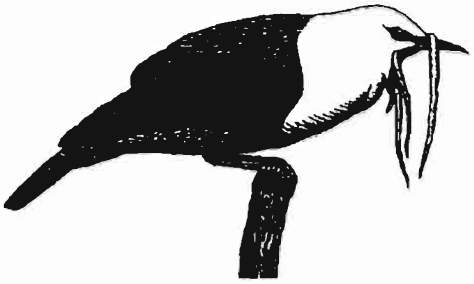
Advice to contributors

Authors should bear in mind that only a small proportion of the *Scottish Birds* readership are scientists, and should aim to present their material concisely, interestingly and clearly. Unfamiliar technical terms and symbols should be avoided wherever possible and, if deemed essential, should be explained. Supporting statistics should be kept to a minimum. All papers and short notes are accepted on the understanding that they have not been offered for publication elsewhere and that they will be subject to editing. Papers will be acknowledged on receipt and will be reviewed by at least 2 members of the editorial panel and, in most cases, also by an independent referee. They will normally be published in order of acceptance of fully revised manuscripts. The editor will be happy to advise authors on the preparation of papers.

Reference should be made to the most recent issues of ***Scottish Birds*** for guidance on style of presentation, use of capitals, form of references, etc. **Papers should be typed on one side of the paper only, double spaced and with wide margins and of good quality; 2 copies are required and the author should also retain one.** We are happy to accept papers on computer discs, however please state the type of word processing programme used. Contact Sylvia Laing on 0131 556 6042 if you wish further information on this. Headings should not be underlined, nor typed entirely in capitals. Scientific names in italics should normally follow the first text reference to each species unless all can be incorporated into a table. Names of birds should follow the official Scottish list (*Scottish Birds* Vol 17:146-159). Only single quotation marks should be used throughout. Numbers should be written as numerals except for one and the start of sentences. Avoid hyphens except where essential eg in bird names. Dates should be written:...on 5 August 1991.....but not on the 5th (if the name of the month does not follow). Please do not use headers, footers and page numbers. Please note that papers shorter than c700 words will be treated as short notes, where all references should be incorporated into the text, and not listed at the end, as in full papers.

Tables, maps and diagrams should be designed to fit either a single column or the full page width. Tables should be self explanatory and headings should be kept as simple as possible, with footnotes used to provide extra details where necessary. Each table should be on a separate sheet. Maps and diagrams should be either good quality computer print outs in black and white (please do not use greyscale shading) or in black ink and be camera ready, but drawn so as to permit reduction from their original size.



NEOTROPICAL BIRD CLUB

Neotropical bird club launched

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

For further details and membership forms, please contact:
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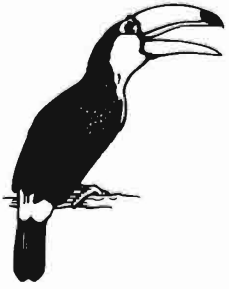

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