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Research Progress Report

D.B.A. THOMPSON AND D.P. WHITFIELD

Research on mountain birds and their habitats

This report summarises some of the progress to date on SNH-funded research on montane (high mountain) ecology, notably on the population ecology and conservation of Dotterel *Charadrius morinellus*.

Montane habitat in the UK

Whilst Ratcliffe (1977) provides a good working definition of the two major upland zones in the UK – montane (above the former tree-line) and sub-montane (below the tree-line down to the upper limits of enclosed farmland) – Ratcliffe & Thompson (1988) first described their international significance. The montane zone characteristically begins at 700m, but at as low as 300-400m in north-west Scotland. It is marked by the dwarf-shrub heaths, notably heather *Calluna vulgaris*, becoming prostrate with exposure, and by increasing prevalence of small herbs, mosses and lichens (Thompson & Brown 1992). The sub-montane areas were predominantly tree-clad until perhaps only 200-400 years ago in some regions but the montane zone has not held trees for at least seven thousand years and so is much more natural. The distinction between these two zones is important. Whereas the complex montane ecological inter-relationships are in many respects natural, fragile and sensitive to environmental change, those in the more recently created sub-montane zone are founded on semi-natural, arrested successional habitats.

Thompson *et al.* (1987) and Thompson & Brown (1992) described the extent of the montane zone as comprising just over 3% of the GB land surface (12% of Scotland). Thompson & Brown (1992) quantified the habitat variability and plant community diversity throughout montane Britain. One of their findings was that the most extensive

montane plant community, the *Racomitrium lanuginosum* – *Carex bigelowii* mossy dominated heath, is the single most extensive near-natural community on land in the whole of UK.

The assemblage of birds

Twenty-seven bird species use the montane zone in the UK, but only four are confined to it (Snow Bunting *Plectrophenax nivalis*, Ptarmigan *Lagopus mutus*, Dotterel *Charadrius morinellus* and the rare Purple Sandpiper *Calidris maritima*). Nineteen of these species breed in the arctic, and only those with arctic strongholds are restricted in the UK to the mountains (Galbraith *et al.* in press a; Ratcliffe 1990). This assemblage is internationally distinctive not least because the same combination of species is not found elsewhere. Two species have their highest recorded breeding densities in the Scottish Highlands: Dotterel (Galbraith *et al.* in press b, Thompson and Whitfield, in press), and Ptarmigan (Watson 1965). There have been a few breeding records of other arctic birds in Scotland, such as Lapland Bunting *Calcarius lapponicus*, Shorelark *Eremophila alpestris* and Snowy Owl *Nyctea scandiaca*, but recently such records have been scarce.

Our work on the montane birds forms part of a wider study of montane ecology and aims to examine the reasons underlying differences between mountain tops in the composition of bird communities, and differences in their diet and habitat use.

Habitat preferences

Montane plant communities are complex, and the variables of altitude, exposure, wetness and snowlie contribute substantially to habitat mosaics that vary within mountains as well as between mountain

systems in the UK (eg. Ratcliffe 1977; Thompson & Brown 1992; Brown *et al.* in press), and Table 1 provides a coarse breakdown of the principal habitats used by breeding birds on three central Highland areas studied in detail. Some general rules emerge applying to the breeding birds: a) herbivorous birds prefer dwarf-shrub communities and montane bogs (with variable amounts of *Empetrum* spp.); b) springs, flushes, boulder fields and the exposed *Juncus trifidus* heaths are least preferred, particularly as nesting habitat, by most birds; c) the higher-altitude *Empetrum-Vaccinium* heaths are preferred slightly over the stunted *Calluna* heaths; d) the mossy summit heaths, *Empetrum - Vaccinium* heaths, and the boggy expanses

are most preferred, and e) the springs and flushes have high value as brood rearing habitat for some species.

Such information is important for two reasons. First, if particular parts of mountains are at risk of development or change we need to know their importance for the birds, and the importance of their constituent habitats and communities, for the birds. Second, information on habitat-nesting/feeding bird relationships for individuals provides a springboard for a much more detailed assessment of species requirements. Little comparable quantitative information is available on habitat use for the majority of birds breeding in the British uplands (eg. Ratcliffe 1990; Haworth & Thompson 1990).

TABLE 1. Summary of habitat-use by the more regular breeding montane birds in the central Scottish Highlands. The species are ranked roughly in descending order of breeding density.

	Dwarf <i>Calluna</i> heaths	<i>Vaccinium- Empetrum</i> heaths	Mossy (<i>Raco- mitrium</i>) heaths	Exposed <i>Juncus trifidus</i> heaths	<i>Nardus</i> snowbed grass- lands	Montane bogs	Springs and flushes	Boulder fields
Ptarmigan (H)	(B)	B++	(B)	—	—	B+	—+	B
Dotterel (I)	(B)	(B)+	B+	B+	—	—	—	—
Meadow Pipit (I)	B	B+	(B)	—	(B)+	B	—	—
Golden Plover (I)	—	(B)+	B+	—	—	B+	—	—
Dunlin (I)	—	—	—+	—	B+	B+	—	—
Wheatear (I)	(B)	B+	(B)+	B+	—	—	—+	—
Skylark (I)	(B)	B+	(B)+	—	(B)+	B	—	—
Red Grouse (H)	B++	B+	—	—	—	(B)+	—	—
Snow Bunting (I)	—	—	—	—+	—	—	—+	B

Notes (H) = mainly herbivorous; (I) = feeds mainly on invertebrates

B = main breeding habitat where available, (B) less preferred breeding habitat, — not often used by breeding birds for nesting;
++ = major feeding habitat, + feeding habitat. NB Many birds feed in mosaics of these vegetation classes.

Source: Galbraith *et al.* (in press, a, c); Ratcliffe (1990); Watson (1965, 1979); Nethersole-Thompson & Nethersole-Thompson (1986); Thompson & Brown (1992); SNH (unpublished).

Population ecology and dynamics of Dotterel

We studied the Dotterel in close detail because, unlike the other regular montane specialists, it is listed on the *EC Directive on the Conservation of Wild Birds* (Directive 79/409/EEC). This obliges the UK government to protect the habitat needed to sustain UK (and therefore EC) populations of Dotterel (and other birds listed in the annexes of the Directive).

There were other reasons for our work, however. The Dotterel is one of the more widespread of the montane specialists and may be an important indicator of the 'health' of mountain environments. It is also one of only two regularly polyandrous species in the UK (female pairs and mates with more than one male), the other being the Dunnock *Prunellus modularis*. We were keen, therefore, to find out what affected

the breeding success of each sex under such an unusual mating system. Prior to our project there were only clues as to what influenced breeding success, and there was virtually no information on movements by adults and chicks between mountain tops. There was even less on age of breeding, mate/site fidelity, estimated lifespan, or causes of death and dispersal (notably rates of immigration and emigration). We need to understand all of these factors in order to understand how Dotterel respond to the vagaries of their environment, including changes at the hand of man. Previous work on the species had yielded some important results but had been limited by insufficient time to make prolonged intensive observations as well as low numbers of individually marked birds (Nethersole-Thompson 1973; Nethersole-Thompson and

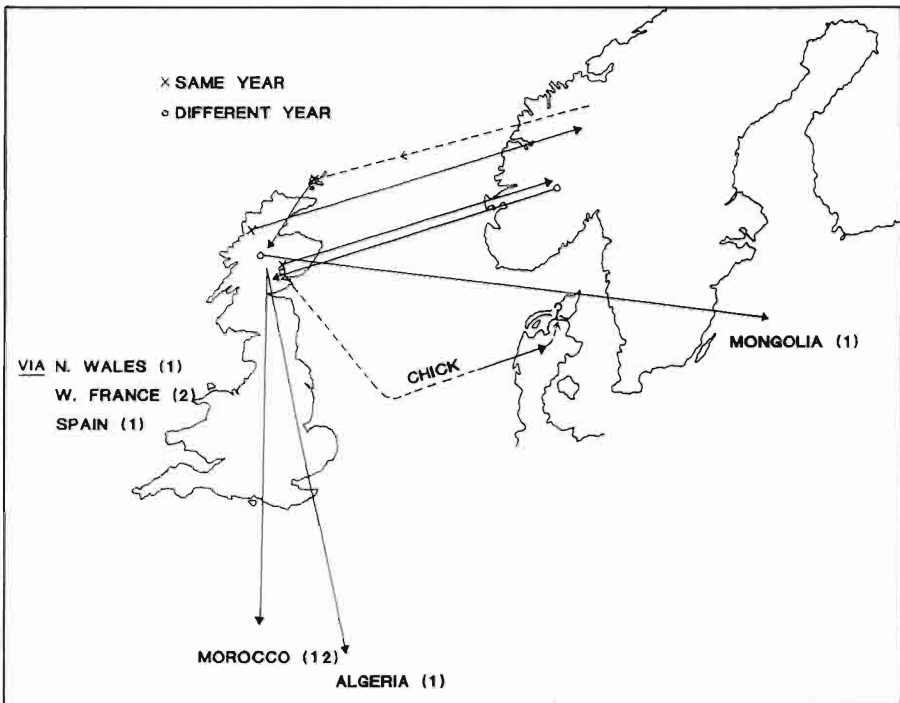


FIGURE 1. Examples of international movements by Dotterel ringed in Scotland.

Nethersole Thompson 1986; Watson 1988, 1989).

We established three intensive study areas, supplemented recently by two more, and several others which we visited less frequently (size range = 2-8km²). By the early 1990s we had developed working methods. From early May to late August we plotted the arrival, habitat use, nesting distributions, individual fate of nests and broods, and movements of Dotterel (eg. Thomas *et al.* 1989; Galbraith *et al.* in press b, c). Most nesting males were individually colour-ringed, and the chicks were also ringed. We then searched the mountains for colour-ringed birds to build up a picture of movements.

The results show that some adults repeatedly return to the same hill to breed in different years whilst others move large distances between breeding attempts. As Fig. 1 shows, some individuals breed in both Norway and Scotland in different years as well as in the *same* year. There are also highly marked differences in productivity between mountain areas, with some being capable of exporting young birds to other hills as potential breeders whilst others appearing to act as 'sinks' for breeding birds (Fig. 2). On one hill, very few chicks return to breed whereas on others several chicks return, sometimes nesting within 50m of their fathers.

Males alone usually care for the eggs and chicks, and once the first males are incubating, the activities of the females are uncertain. Few females seem to remain on hills where they have laid their eggs and do not seem to return to their wintering grounds in Morocco earlier than the males. Do they fly on farther north-east, to Scandinavia, to breed with males that nest there later? This does seem possible because most observers in Scandinavia comment on the relatively high numbers of females (whilst males are on eggs or caring for chicks). Some females, however, remain to seek out males that have either lost their nests, deserted or arrived late.

PRODUCTIVITY - MAIN STUDY SITES

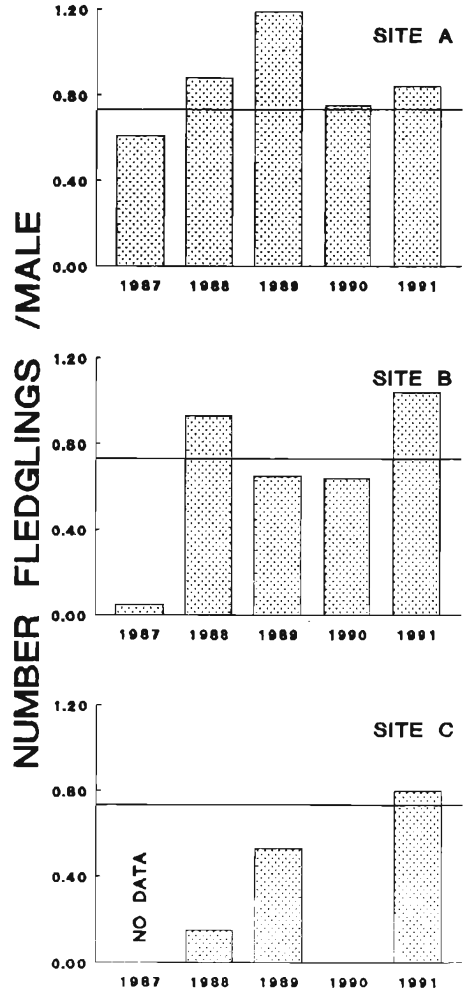


FIGURE 2. Differences in Dotterel productivity (fledged young: adult male ratio) between study areas. The horizontal line gives the productivity required to keep the population stable (calculated across all years).

Breeding success in Scotland has been affected primarily by weather and predation and, on some hills, by trampling of nests by sheep and red deer. At one site significant numbers of crows and gulls were attracted to the plateau. This site has a ski development and it is debateable to what extent the presence of many more people, brought to the tops by a chairlift, attracted birds. By taking Dotterel eggs, these predators have reduced the production of fledglings by almost 20%. At other sites, 20-25% of clutches have been trampled by sheep and/or deer. It was predominantly the later, less productive clutches that were trampled, however, so that there has been only some 10% reduction in the production of fledglings through trampling. Even so, if numbers of predators, sheep and deer were lower, then many more young Dotterel would be produced by the Scottish population.

A three-part paper in preparation by Whitfield *et al.* provides a story of ecological differences between mountains, years, seasons and individual birds (see also Owens 1991). We are also reviewing similarities and contrasts between the Scottish, Norwegian and Finnish situations, and also the links between the breeding birds and their North African wintering grounds.

A major challenge is to model both the dynamics of population change between different mountains and the key factors accounting for variation in productivity and dispersal. The resulting models should help predict future changes in status and distribution. For example, one of the main prey of Dotterel, the crane-fly *Tipula montana*, exhibits a bi-annual pattern of emergence so that some plateaux have peaks in the early summer—swarms of crane-flies every other year, but nearby plateaux may show peaks in different years. Their life-cycle seems to be tracked by migratory Dotterel, with flocks settling to exploit the large pre-emergence larvae that precede the hatch of adult crane-flies every other year. With knowledge of the crane-fly life-cycle we

can predict which hills will be important each season.

Dotterel population size in the UK

We estimate that the UK population of Dotterel is at least 860 breeding 'pairs', with the vast majority in Scotland where there are about 1.7 pairs km² (Galbraith *et al.* in press b; Thompson and Whitfield, in press; Whitfield *et al.* 1991). This is considerably higher than previous estimates (e.g. 100-150 pairs by Nethersole-Thompson & Nethersole-Thompson 1986), but not so different from Watson & Rae's (1987) more accurate assessment of at least 600 pairs. Has the population increased? We believe that in some areas it has, perhaps with more birds destined for Norway stopping off to breed in Scotland *en route* from North Africa. More precipitation in Norway than previously has resulted in greater snowlie there (H.J.B. Birks pers. comm.), perhaps leading to more birds breeding in Scotland. But much more detailed research is needed on climate change and the Scotland-Scandinavia connection. In some areas, more intensive survey effort has simply resulted in more birds being seen.

The last national survey of Dotterel was in 1987-1988 covering just over 55% of all suitable habitat in GB. We plan to repeat this in a later year and to look, in particular, for colour-ringed birds. We need a much more complete picture of movements before the breeding season, and of the use made by roving birds of more than one mountain system both here and abroad.

Environmental changes and impacts

Whilst numbers of Dotterel are higher now than recorded at anytime this century, there is a big difference between the Scottish Highlands and the rest of montane UK. Way back in the mid-19th Century, records suggest a population of at least 50 pairs in north England and Wales (Ratcliffe 1990); now, there are fewer than ten pairs! Work on habitat composition suggests that the moss-dominated heaths preferred by

breeding Dotterel are becoming more grassy, especially in areas south of the Highlands (Thompson *et al.* 1987; Thompson & Baddeley 1991; Thompson & Brown 1992).

This may be due to increasingly severe grazing pressures from sheep, producing habitat conditions that gradually encourage grasses at the expense of mosses, and to rising acidic (notably nitrate) deposition close to industrial centres which may also benefit the grasses and raise soil acidification (see also Baddeley *et al.* in press). These changes will not benefit the food availability and nesting requirements of Dotterel, and may explain low densities in the south of the species' UK range. Pre-breeding flocks pass through north Wales, north England and south Scotland in late spring, but very few settle to breed there.

We are presently developing a new method for monitoring habitat change in montane areas. This method will contrast climate and human-induced changes throughout montane areas in the UK.

Conservation

The study has provided baseline information for three montane Special Protection Areas being proposed under the EC Birds Directive, and a further seven candidate sites are under consideration. A new National Planning Guideline on Skiing has been issued, and this has benefitted from what we have learned about Dotterel and their habitats. We have made numerous representations to the Cairngorms Working Party, which reports to the Secretary of State for Scotland in February 1993. We are pressing hard for reductions in grazing pressures from sheep and deer on the mountains where there have been serious losses of natural habitat diversity over the past 30 years. We also need to have a better understanding of why predators (crows, gulls and foxes) are more active on some hills than on others.

At the strategic level, we need a clear policy for these high mountain areas. This

has to be sensitive to the highly individual nature of each mountain, but has to address land-use and management issues lower down the hill which impinge on the higher tops. The Countryside Commission for Scotland (1991) report marked an important start in this new policy making process.

The future

We have also studied Ptarmigan, Snow Bunting and montane invertebrate communities. We are establishing new study sites in the western and northern Highlands and want to see much more research in the montane areas of the southern uplands, north England and north Wales. This new work will focus more on Ptarmigan, and build on the studies of Dotterel and Snow Buntings. Rik Smith and Neil Metcalfe are studying the winter behavioural ecology of Snow Buntings and have found surprising differences between the small stock of birds destined to breed in the Cairngorms and the great majority of birds that breed in more northern countries (e.g. Smith in press).

Much more effort is being devoted to studying pressures from grazing and to the role of grazers, people and predators in affecting the invertebrate biota and breeding success of montane birds. Our work has left us unconvinced that the mounting numbers of hill walkers are having an adverse impact on montane wildlife, but this needs to be monitored. We need to contrast past and contemporary impacts of pollution and climate change on plant species and communities in order to assess what the future holds. Some of the communities are bound to respond rapidly to changes in growing season, snowlie and grazing pressures, not least because of the knife-edge ecological niches occupied. We already see smaller snowbeds and signs of more wind-related erosion. How will the birds and invertebrates react to this?

Over the next five years our success will be marked by how accurately we can predict responses in the montane habitat and its wildlife to environmental change, and the

priority attached by government to these special places.

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Research Progress Report

G.S. RIDDLE

A 20 year study of Kestrels in Ayrshire

In the early 1970s, enthusiasts were becoming organised into a group to monitor and protect the population of the Peregrine Falcon, *Falco peregrinus*, in the south-west of Scotland. The Peregrine, along with other raptors, had declined alarmingly in the previous two decades due to the now well documented effects of organochlorine pesticides. As well as taking part in the work on the Peregrine, I decided to study that neglected species, the Kestrel, *Falco tinnunculus*, and over the past 20 years have carried out fieldwork on it every year.

The initial aims were basic: to assess the impact of the pesticide problem on the Kestrel in Ayrshire, confirm its status as common, map its distribution within the county and document current breeding performance. A system of annual monitoring evolved from the early work, sample plots of territories were targeted annually, a ringing programme set up and field techniques developed. The obvious fluctuation in annual output that was found led to an investigation into factors affecting the breeding performance of Kestrels in the area.

The first steps taken were to undertake a comprehensive review of historical literature, launch an appeal for information and contact local naturalists to build up a picture of the previous 20 years. The response exceeded all expectations. Although the data were very mixed in quality, over 50 territories were reported and sufficient data obtained to confirm that, while there had been instances of adult deaths because of chemical poisoning, there was no evidence of clutch depletion or brood size reductions. In fact the Kestrel maintained a high level of production and was confirmed as breeding in all ten kilometre squares in the County.

One of the main benefits of the trawl was the number of productive contacts which were made and the number of traditional territories which were identified. Some of the responses were bizarre, including one from an "oologist of ill repute" as he signed himself, who willingly gave me a number of clutch sizes, apologising profusely that the information did not go beyond the egg stage!

Three main study areas were chosen, each with a distinct habitat type. The Carrick Forest, managed by the Forestry Commission, is a good example of upland hill pasture converted to commercial afforestation. Responding to the increase in vole numbers in the newly planted ground, the Kestrel population increased from 3-4 pairs in the mid 1960s to 15 pairs by the end of that decade, but rapidly returned to the former numbers when the canopy closed. Harvesting is now in progress and the restocked areas are once again providing feeding grounds for Kestrels. A nest box scheme begun in 1992 has already attracted nesting Kestrels and numbers should increase in the next ten years. As the forest cycle stabilises and landscaping improves the quality of the habitat, open areas within the forest will become a permanent feature and Kestrels should be ever present.

The Waterhead area is typical upland sheep grazing ground characterised by its open nature and the regular spacing of conifer shelter belts which provided the Kestrels with nesting territories. It is a very stable area compared to the dynamic forest environment. A 45 kilometre section of coastline from Ballantrae to Ayr was chosen as the lowland study area and this was supplemented by individual territories inland which were of interest due to long term occupation. Data from outside the

study areas were always welcomed for comparison and since 1972 information on 440 nesting territories has accumulated.

One of the main thrusts of the work was to monitor the same 40 sample territories annually to achieve full information on breeding from each one. The following six pieces of information were obtained: occupancy, nest site location and time of laying the first egg, clutch size, hatching details, brood survival and fledging details. To obtain these required anything from four to 15 visits per season to each territory depending upon the outcome of the cycle. It is imperative to get into territories in early March in order to make sure that pairs which fail at the pre-laying stage are recorded. Knowing the date on which the first egg is laid is critical from a time management point of view as the rest of the visits can then be planned and disturbance minimised.

From the data collected it was obvious that, although there was annual variation in breeding output (see Fig. 1), no matter which measure is used, over the 20 years the production rate was very high. From 1979 to 1992, during which period the monitoring had reached a very consistent level, the figures were: 4.7 average clutch size; 73% of eggs laid hatched; number of young reared per successful breeding attempt averaged 3.4, with average for all attempts 2.5; brood survival in the nest 87% with 75% of nesting attempts resulting in at least one young reared. This fits in well with the general pattern for middle-sized falcons in which there is a quick turnover of population.

Clutch sizes ranged from 3-8 in size but the majority were 4-6. One interesting finding is that clutch sizes have increased over the past two decades. In the period 1971-80, the average clutch size was 4.55

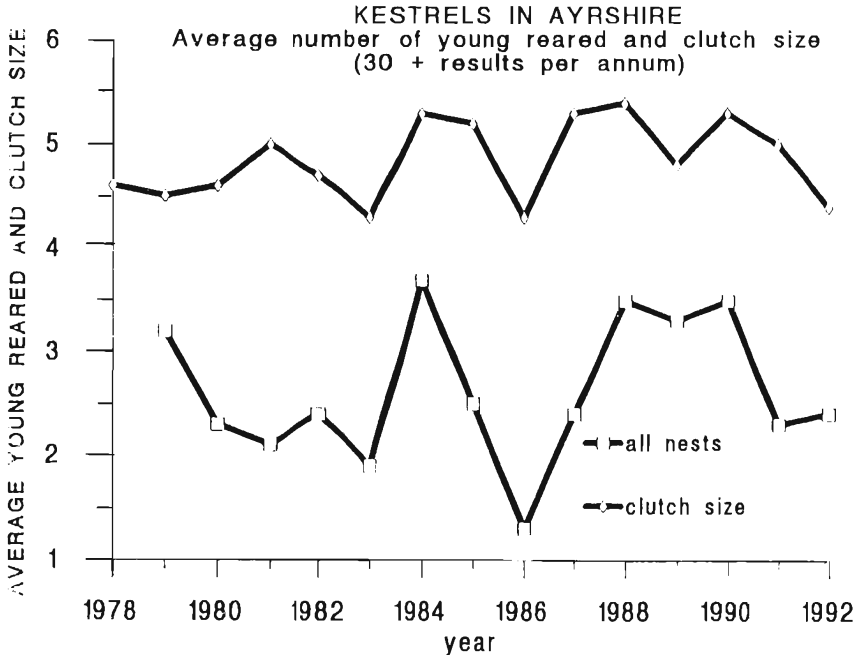


FIGURE 1.

and this had increased to 5.00 for the period 1981-1990. This trend has also been identified by the British Trust for Ornithology from nest record card analysis.

In general, pairs of Kestrels which breed early lay larger clutches and fledge more young per breeding attempt than pairs which start their cycle later. Clutch sizes in Ayrshire averaged 5.3 eggs for hens laying in April as against 4.3 for May. Similarly the number of young reared per breeding attempt was 3.9 for early cycles compared to 2.5 for later cycles. The advantages of having young out of the nest early in the summer are that they will have more time to gain hunting experience and build up resources before the severe winter weather makes survival difficult. Work in Holland by Cavé has also shown that progeny from early breeding pairs have higher survival rates through the first winter.

Nearly 90% of breeding failures take place during the pre-laying or clutch stage of the cycle in Ayrshire (failed attempts: pre-laying 26%, clutch 63%, brood 11%). Analysis of failed breeding attempts shows a variety of reasons, ranging from accidents to deliberate human interference. Accidents and the effects of adverse weather conditions, such as washed out sites or desertion due to food shortages, account for nearly a quarter of failed breeding attempts. 29% of failed attempts could definitely be attributed to man's activities whether intentional, such as egg collecting, or unintentional, such as the felling of a nesting tree or maintenance activity in a building. The number of nests robbed by egg collectors or would-be falconers has decreased in the last ten years.

Very few nests were predated (6%) but competition for nest sites with other raptors such as Tawny Owls *Strix aluco*, Barn Owls *Tyto alba*, and Long-Eared Owls *Asio otus* accounted for 14% of failures. Ironically, the recovery of the Peregrine Falcon and their re-colonisation of previously vacated territories caused Kestrels to desert cliff sites into which they had moved as the Peregrines

declined. In some cases the adult Kestrels were killed but in one instance the Peregrine pair, which had their nest washed out at the clutch stage, took over a Kestrel brood and reared the two young.

The monitoring data are submitted to the co-ordinator of the South Strathclyde Raptor Study Group each year, then collated with the rest of the raptor work by the RSPB and published in *Scottish Birds News* by the SOC. Any major change in the breeding population of Kestrels would be identified quickly.

Variations in clutch size and in the number of young produced by breeding pairs did occur as a matter of course annually (see Fig. 1). The pattern for clutch size was very regular, with lows in 1979-80, 1983, 1986, 1989 and 1992. However, the number of young reared per breeding pair was much more irregular and made interpretation more difficult. A close examination of possible factors ruled out nest site availability as having great influence. Although there was some competition from other raptors as already mentioned, the number of nest sites available in each territory was high, mainly due to the number of abandoned Carrion Crow *Corvus corone* nests. Most territories had 3-8 potential nest sites available annually. The food supply and consistent spells of good or bad weather were found to be the most important factors in fledging success.

No monitoring of the vole population was carried out but figures from Geoff Shaw's Barn Owl work within the adjacent Galloway Forest Park was used. Interestingly, the poor vole years identified in his area coincided with the years of lowest Kestrel clutch size. The difference was that, whereas the Barn Owl breeding output crashed in those years, the Kestrels merely produced slightly fewer young per breeding pair than normal. Kestrels are not wholly dependent upon field voles and take a considerable number of young passerines (Starlings *Sturnus vulgaris*, Meadow Pipits



A rare instance of a cock Kestrel brooding newly hatched chicks.

Anthus pratensis, and Skylarks *Alauda arvensis*) in June and July and are thus able to switch to other food sources if their primary prey is scarce.

Consistent spells of bad weather in early spring can have a profound effect upon the timing of the cycles and on breeding success. A look at one five year period 1982-86 illustrates the point well.

1982 – a typical season, mixed weather throughout.

Clutch size 4.7: hatching rate 67% and 2.4 young reared per breeding attempt.

1983 – a cold and wet spring

Clutch size 4.3: hatching rate 70% and 1.9 young reared per breeding attempt.

1984 – warm and dry from beginning to end

Clutch size 5.2: hatching rate 94% and 3.8 young reared per breeding attempt.

1985 – a dry early spring: all pairs started breeding in April: followed by cold wet late spring and early summer.

Clutch size 5.2: 93% hatching rate but only 2.5 young reared per breeding attempt.

1986 – a complete disaster – cold and wet throughout: only 58% of territories occupied and, coincidentally, a poor vole year.

Clutch size 4.3: hatching rate 50% and 1.3 young reared per breeding attempt.

When a poor vole year coincides with a consistent inclement spell of weather in the spring, as in 1986, then the breeding output is badly affected. However, the 1987-88 production rates were well up to normal and recovery from a bad year was swift.

The ringing programme has been a key

part of the study and has shed some light on migration and mortality. Over 1100 young Kestrels have been ringed from the targetted territories since 1975. A recovery rate of 7% has shown a random dispersal of juvenile Kestrels in the late summer in all directions followed by a predominantly south south-easterly migration, birds reaching the south of England and Northern Europe by October. One first year bird reached Northern Spain by 22 December, a flight of 1880 kilometres, but three quarters of recoveries were within 400 kilometres of the natal site. Some birds overwintered in Ireland.

First year birds were most likely to move, only 30% being recovered in Ayrshire compared to 50% for birds aged two years or more. Intriguingly some of the older birds continued to travel abroad or even stayed there: a fourth winter hen was killed in France, a bird in its third breeding season died in Holland and another was killed in its first breeding season in Norway.

Sixty percent of birds recovered had died during their first year, by far the majority between November-March, due mainly to accidents or exhaustion. 18%

were second year birds, 12% third year, 6% fourth year and 4% in subsequent years. One bird reached the commendable age of 11 years.

Trapping of adults has also shown a rapid turnover of adults at breeding territories. For example, six different hens nested in one territory over a 13 year period, six in seven years in another and eight in eleven years in a third. There is some evidence of movement of hens within a local area, one bird nesting in three different adjacent territories in a three year period.

In any work on raptors, long term monitoring is important and the continuity of work on the Kestrel in Ayrshire will be maintained for as long as possible.

On a personal note, it is great therapy having such close contact with a fine bird like the Kestrel.

References

- A comprehensive list of references relating to this work can be found in the publications.
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The status of the Pintail in the Orkney Islands

E.R. MEEK

A survey of all the likely breeding sites of Pintails in Orkney in 1991 revealed a potential breeding population of 22-26 pairs. This is believed to represent over 50% of the British population. Habitat features characterising breeding waters are described. Factors controlling the species' choice of breeding water are discussed as are options for the conservation of these sites.

Introduction

The Pintail *Anas acuta* is a very scarce breeding species in Britain and it is listed as a Red Data Bird by Batten *et al.* (1990). Estimates of the breeding population since the 1960s have suggested a population of about 50 pairs with fluctuations up to 100 but in the years 1974-88 the maximum total was only 32 pairs (Batten *et al.* 1990). For 1989 the Rare Breeding Birds Panel gave a range of 11-39 pairs (Spencer 1991).

The Pintail, like several other duck species, is a relatively recent colonist, first proved to breed in Scotland, in Inverness-shire, in 1869 and in England, in Kent, in 1910. In Orkney, they probably first nested on Sanday, in 1907 or 1908 (Noble 1908; Hale & Aldworth 1910). By the late 1930s Pintails were breeding more or less consistently in Orkney, Shetland, and the Moray, Dee and Forth basins with Loch Leven (Kinross) being the main centre (Berry 1939). Elsewhere in Scotland, as well as in northern England, East Anglia and Kent, nesting was only irregular. By the time of the 'Atlas' survey of 1968-72 (Sharrock 1976), East Anglia and Kent were accounting for about one-third of all breeding occurrences; breeding was no longer annual in any of the north Scottish mainland counties, had apparently become less regular in Orkney and had ceased in Shetland.

More recently, however, Orkney has become the foremost area in Britain for

breeding Pintail. In 1989, for example, 17 of the maximum total of 39 pairs in the country were recorded from the islands (Spencer 1991) while in 1990 14 pairs were found (Booth *et al.* 1991).

The present study reports results from a comprehensive survey of Orkney conducted in 1991. It describes the habitats associated with Pintail breeding waters and discusses methods for their effective conservation.

Methods

The accurate censusing of breeding ducks is notoriously difficult, the only entirely reliable method being rigorous nest searching which has the major disadvantage of increasing desertion rates. Such a method would be unacceptable with a species as scarce as the Pintail. It is, however, possible to assess the populations of some species by counting the numbers of males in spring at the start of the nesting season (Bibby *et al.* 1992). In spring 1991 the opportunity arose, during the course of other work, to check all breeding waters throughout Orkney for Pintails in the pre-laying period. This had never been systematically done in previous years, records being dependent on the checking of previously known sites. All waters, other than very acidic moorland lochs which were considered unsuitable and on which Pintail are not known to occur, were checked between late March and early

May. The moorland lochs were checked later in the summer. In Orkney the Pintail is almost solely a summer visitor to its breeding lochs so that confusion with wintering birds was not an important factor. It is just possible that some records may refer to birds on passage, although in the majority of cases the behaviour and length of stay of the birds concerned made this unlikely. The range of numbers given for the population allows for the uncertainty of some of the records.

- Data on the occurrence of Pintail in 1991 and characteristics of Orkney lochs from a survey carried out for the then Nature Conservancy Council in 1986 (Charter & van Houten 1989) were assembled for as many lochs as possible. The loch characteristics considered were:
- trophic (nutrient) status, classified into 10 types as shown in Table 3.
 - area of surface
 - altitude above mean sea level

d) conductivity measured at one or two places

e) pH measured at one or two places.

Where two estimates of conductivity or pH were available, the mean was used in the analysis. For the purposes of analysis, the only lochs considered were those which had been surveyed for Pintail and for which all five of the variables listed above had been measured. This provided a total of 88 lochs of which 12 were recorded as holding Pintail in 1991.

Results

The 1991 survey found a total of 22-26 potential breeding pairs (Table 1). Birds were recorded from 15 sites on seven different islands. The physical characteristics of those lochs on which Pintail were recorded are shown in Table 2 while the occurrence of Pintail in relation to the trophic status of all lochs for which data were available is shown in Table 3.

TABLE 1. Potentially breeding Pintail in Orkney, Spring 1991.

Island	Site	Details
A	1	First noted 27.03 (4m. + 3f.); copulation seen 20.04; peak count 4 prs plus 1-2 males 27.04; only young seen was late brood of 2 on 12.08.
	2	First noted 20.03; peak count (2m + 1f.) on 28.03; display 08.05; f. + b/5 (large) 03.07.
	3	Pair present 17.04 and subsequently with f. only 28.04.
	4	Pair present on 04 & 08.05.
	5	First noted 30.03; 2 males and 2 alert females possibly with ducklings on 10.05.
B	1	Pair present on 29.04.
	2	Male & 2 females 29.04, female on 30.04.
	3	Male on 29.04 with pair plus a male 30.04.
	4	2 males and 1 female on 30.04.
	5	Pair on 30.04; female possibly nest searching.
C	1	Pair on 29.04 (flew to this site from unsuitable site on island B).
D	1	4 pairs present on 11.04.
E	1	A single female present on 11.05.
F	1	A pair present on two dates in April.
G	1	First noted 27.03; 2 pairs present in late April; single females in late May/early June; single male 07.06.

TABLE 2. Characteristics of Pintail breeding waters in Orkney.

Island/Site	Loch Type	Size	Altitude	Conductivity (μ mhos)	pH
A1	4	5.7	20	548*	8.05*
A2	4	19.6	12	530*	8.06*
A3	4	96.8	30	458*	8.34*
A4			No data		
A5	8	0.2	<5	720	7.12
B1	6	1.8	<5	5590	9.03
B2	6	7.5	<5	14850	10.30*
B3	7A	19.9	12	510*	10.00*
B4	7A	27.8	<5	720*	9.83*
B5	7A	0.6	40	566*	8.78*
C1	7A	6.0	<5	759	7.06
D1			No data		
E1	6	4.6	<5	21600	8.65
F1	7A	17.3	<5	530	8.53
G1	7A	0.9	<5		No data

Source: Charter and van Houten, 1989.

* = Mean of two readings

TABLE 3. Occurrence of Pintail in relation to trophic status of lochs.

Loch Type	Number of Lochs		Total
	Without Pintail	With Pintail	
1. Dystrophic	7	0	7
2. Oligotrophic (peat substrate)	1	0	1
3a. Oligotrophic (stone substrate)	3	0	3
3b. Oligotrophic (other)	8	0	8
4. Oligotrophic with eutrophic influence	10	3	13
5. Mesotrophic	1	0	1
6. Brackish	5	3	8
7a. Eutrophic	37	4	41
7b. Eutrophic (species poor)	4	1	5
8. Eutrophic (enriched by livestock)	0	1	1
Totals	76	12	88

Ten loch types were identified during the NCC survey but these were grouped into six main categories for further analysis. Type 1 lochs were dystrophic (lacking in nutrients), Types 2 and 3 were oligotrophic (lacking in nutrients but rich in oxygen), Type 5 were mesotrophic (providing moderate amounts of nutrients), Type 6 were brackish and Types 7-10 were eutrophic (over-rich in nutrients); Type 4 lochs showed signs of both oligotrophy and eutrophy.

The sizes of the lochs occupied by Pintails ranged from 0.2-19.92 ha. with the exception of one of 96.8 ha. where the Pintails always used a particular restricted inlet. The altitudes of the lochs ranged from <5-40m., but only two were above 20m. The conductivity of their waters showed a wide range of values from 458-21600 μ mhos (a measure of the speed at which electricity passes through a unit length of water at 25°C.). However, nine were in the range 458-759 μ mhos, the much higher figures being from the three waters subject to inundation at high tides. pH values varied from 7.06-10.30.

Lochs with Pintail were of higher pH than lochs without Pintail but there were no other significant differences (Table 4). To check for the possibility that Pintail occurrence might be affected by a combination of two variables, logistic regression models (Aitken *et al.* 1989) were fitted to the data, with the presence or absence of Pintail being the dependent

variable and the effect of all pairwise combinations of pH, conductivity, area and altitude being tested. It was found that, although pH had a statistically significant effect on Pintail incidence, there was no significant additional effect of any of the other variables.

It is difficult to assess differences between loch types in the incidence of Pintail because there are many loch types (8) compared with the number of lochs (12). None of the 19 lochs which were dystrophic, oligotrophic or mesotrophic held Pintails but the loch types on which Pintails did occur were disparate and included oligotrophic with eutrophic influence, brackish and eutrophic. The effect of pH on the incidence of Pintail was found to remain statistically significant in a logistic regression model in which the effect of loch type was also included (chi-squared (1) = 4.41, $p < 0.05$). However, on the slim evidence available it is not clear whether Pintail incidence on Orkney lochs is more strongly related to pH, trophic status or possibly other unmeasured factors.

Discussion

The 1991 survey has further emphasised the importance of Orkney for breeding Pintail in a British context. 1991 figures for the rest of the country are not yet to hand but it would appear that the 22-26 pairs breeding in the islands probably represents more than 50% of the national population.

TABLE 4. Medians and ranges of characteristics of lochs with and without Pintail. Values of U from Mann-Whitney tests and associated P values are also given.

Variable	Without Pintail		With Pintail		U (12,76)	P
	Median	Range	Median	Range		
Area (ha)	3.5	0.2-227.0	6.8	0.2-96.8	374.5	0.32
Altitude (m)	10	<5-280	<5	<5-40	346	0.16
Conductivity (μ mhos)	527	100-22200	643	458-21600	320.5	0.10
pH	7.92	3.58-10.19	8.59	7.06-10.30	296	0.05

TABLE 5. Conservation status of Pintail breeding lochs in Orkney.

Island/Site	Conservation Status
A1	RSPB Reserve; SSSI; Proposed SPA
A2	SSSI
A3	Part RSPB Reserve; part SSSI
A4	Unprotected
A5	Receiving Environmental Management Payments
B1	Unprotected
B2	Receiving Environmental Management Payments
B3	Receiving Environmental Management Payments
B4	Unprotected
B5	Unprotected
C1	Unprotected
D1	Proposed SPA but currently unprotected
E1	SSSI
F1	Unprotected
G1	Unprotected

Islands A and B have held the great majority of Orkney's breeding Pintail for the last 20 years. In 1991 birds were found on all the lochs previously recorded as breeding sites on these two islands while some new sites were also found. Island D has only recently been colonised but has a growing population at the one site. Islands C, E, F and G have not been regularly used in recent years and breeding was not actually proven on them in 1991.

The preference of Orkney Pintails for more eutrophic waters with a high pH is notable. It has been shown that, in more northerly latitudes, eutrophic waters support a more abundant phytoplankton and zoobenthos than do other water bodies (references in Fox *et al.* 1989). Further, Fox & Bell (in press) have shown that in northern Scottish wetlands the most important environmental parameters in determining species richness are pH and conductivity. In some areas, and particularly in spring and summer, animal food, in the form of invertebrates, is known to form a major part of

the diet of the Pintail (Cramp & Simmons 1977). Such food is also known to be important to ducklings in the pre-fledging period. A statistical relationship could not be found between Pintail distribution in Orkney and conductivity but the relationship between distribution and trophic status and distribution and pH, might possibly be explained in terms of the richness of the invertebrate fauna in such waters.

What is not explained, however, is the absence of Pintails from numerous other Orkney waters with apparently suitable water characteristics. The NCC survey identified a further 76 waters in the eutrophic categories (together with 12 classed as brackish and 21 as eutrophic/oligotrophic), none of which held breeding Pintails. Other factors must also be controlling site choice, a major one probably being suitable surrounding vegetation for nesting.

Batten *et al.* (1990) discuss the possible threats to the survival of the Pintail as a

breeding bird in Britain. They conclude that there are few threats other than possibly climatic factors and the species' nomadic or opportunistic behaviour. However, in the Orkney context, site safeguard may play an important role in the future. All of the sites holding breeding Pintail in Orkney could potentially be damaged by agricultural drainage. Of the 15 sites listed in Table 1, only one and part of another are RSPB reserves and only they and two others are Sites of Special Scientific Interest (SSSIs). The other 11 sites have no formal protection although four of them are, either wholly or in part, the subject of Environmental Management Payments under the Agricultural Development Programme for Scottish Islands. This Programme ceases to operate in spring 1993, after which payments that have helped to conserve these sites will no longer be made. Attempts are being made to ensure the continuation of such conservation payments under some alternative scheme, designation of the islands as an Environmentally Sensitive Area (ESA) being currently the best option. Although several new Scottish ESAs were announced in spring 1992, Orkney was not amongst them. While further reserve acquisition and SSSI designation is a possibility, an Orkney ESA seems essential for the conservation of the numerous small wetlands on which the Pintail, together with other wildfowl and waders, depends.

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A Survey of Black Grouse leks in Perthshire

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This paper describes a survey of Black Grouse leks in seven 10km grid squares in highland Perthshire in 1990-92. Counts in April and May 1992 at 79 leks produced 697 cocks. An additional 25 cocks were found displaying singly. Leks were generally evenly distributed 1,500m apart within the altitudinal band 230-470m ASL. Densities of displaying cocks in Perthshire were compared with density estimates from other British and European studies.

Introduction

This paper presents results of a survey of Black Grouse *Tetrao tetrix* leks carried out in 1990-92 by the Perthshire Black Grouse Study Group. The group comprised amateur bird-watchers, including members of the Tayside Raptor Study Group, and staff of the RSPB, The Game Conservancy and Forest Enterprise.

Batten *et al.* (1990) list Black Grouse as a species of special concern owing to the recent decline and range retraction in its European populations during the present century, brought about largely by habitat deterioration (reviewed in Cramp & Simmons 1980). Locally, nonetheless, there have been increases due to the colonisation of recently afforested areas in parts of Wales and Scotland (Grove *et al.* 1988; Thom 1986). However, once new forests grow up into the closed canopy post-thicket stage, declines are to be expected, even where there were initial benefits (Cayford 1990).

Highland Perthshire and the Angus glens are a stronghold of the Black Grouse in Britain (Tapper 1992), but land-use changes have recently been far-reaching: the area of commercial forestry in Perth and Kinross District increased by 30% to 73,300ha between 1980 and 1990 (J. Crawford, Tayside Region Planning Dept., pers. comm.). This may affect the

distribution and abundance of Black Grouse, and it was to monitor such possible changes that the present study was started.

The study area

This comprised seven 10km grid squares forming a single block in highland Perthshire mainly across the area where the Rivers Garry, Tummel and Tay meet. To the east, it includes the watershed between the Rivers Tummel and Ardlie (Fig. 1). This block was chosen as we were already recording other bird species there.

The interface between wooded valley and open hill is particularly well represented in most of the area. Typically the valleys and stream sides have blocks of birch *Betula* spp. wood emerging on to open moorland between 200-300m. This pattern is not followed however where plantations of larch *Larix* spp., spruce *Picea* spp. or Scots Pine *Pinus sylvestris* have been planted along the valley sides. Many of these have been established within the last ten years, although some in the Blair Atholl and Tummel areas are considerably older.

The heather *Calluna* dominant moorland is largely traditional grouse moor managed through rotational burning. Blanket bog covers a comparatively small

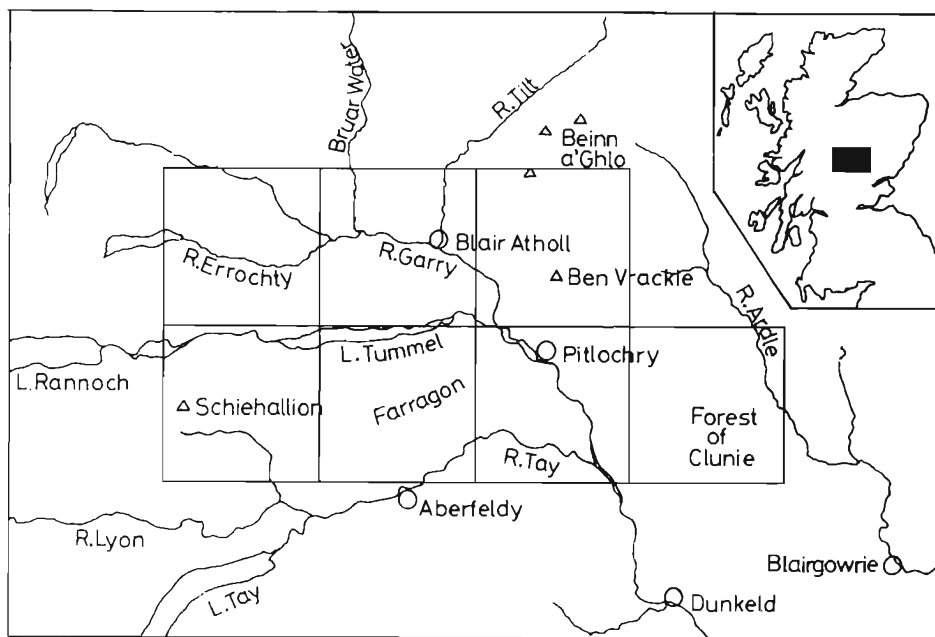


FIGURE 1. The survey area in highland Perthshire.

part of the moorland area, but small flushes and mires are frequent. Grassland communities form mosaics with the heather, especially along stream sides and around lochs. Areas of improved grassland in some places form continuous belts or isolated fields below the moorland edge. The extent of the principal habitats within the study area were roughly estimated from 1:25,000 Ordnance Survey maps and personal knowledge of the area (Table 1).

Methods

Leks are generally considered to be communal displays by the same group of males on a traditional site. To qualify as a lek in this study, two or more males had to be seen displaying at the same place on two or more occasions, thus discounting bouts of display on only one day away from leks and cocks displaying alone. Single displaying cocks were counted separately

and added to the total number displaying communally at leks to give an overall number of cocks within each grid square. However, 26 sites were not found until 1992 and were then only counted once. Of these, 17 had two or more displaying birds and were considered to be true leks.

TABLE 1. Estimate of the percentage of the study area covered by the main habitats.

Habitat	% area covered
Unenclosed heather dominant moorland	50%
Conifer plantation (pre-thicket)	10%
Conifer plantation (post-thicket)	15%
Birch woodland	5%
Valley bottoms, inbye fields, towns	18%
Lochs	2%

In Wales, Cayford & Walker (1991) found that peak numbers of cocks occurred at up to 1.5 hours after dawn from mid-April to mid-May. The remoteness of some of the leks and the need to visit several sites on one morning precluded the possibility of visiting all leks during this period. However, 76% of the 208 recording visits were made between 15 April and 15 May, 16% between 5-14 April and 8% between 16-29 May.

The first two years, 1990 and 1991, were spent locating all leks in preparation for a full survey in 1992. The whole of each square, apart from some montane ground, were searched for leks. Leks tended to be

conspicuous, with displaying cocks heard from up to 1km away. The location of each lek was recorded using a six-figure grid reference and the date and time of the visit and the number of cocks present noted. Hens were recorded when seen, but as they tended to visit leks in small groups, typically of 2-3, counts at leks gave no reliable estimate of total hen numbers.

In 1992, observers visited 57% of the leks once, 23% twice, 8% three times and the remaining 12% anything up to nine times. When more than one count was made at a lek, the highest number of cocks seen was used. In the case of two leks not visited

TABLE 2. Numbers and density of displaying Blackcock in 1992.

Grid Square No.	No. leks	No. single cocks	Total cocks counted
NN76	12	7	104
NN86	7	3	63
NN96	8	2	85
NN75	11	8	68
NN85	13	1	100
NN95	9	0	85
NO05	19	4	192
Total	79	25	697

TABLE 3. Blackcock population changes at 31 leks counted between 1990-1992.

Grid Square No.	No. leks	No. of cocks counted (% change between years)			
		1990	1991	1992	
NN76	5	68	68 (0)	68	(0)
NN86	5	36	29 (-19)	33	(+14)
NN96	3	29	25 (-14)	23	(-8)
NN75	9	44	45 (+2)	34	(-24)
NN85	2	13	14 (+8)	17	(+21)
NN95	1	9	12 (+33)	8	(-33)
NO05	6	86	94 (+9)	73	(-22)
Total	31	285	287 (+1)	256	(-11)

in 1992, the 1991 count was used. Variations in numbers of cocks between years were assessed from 31 leks counted in all three years.

Results

In 1992, a total of 672 cocks was recorded at 79 leks (Table 2), with numbers of cocks at a lek ranging from 2-30 (median and mode seven cocks). Only 13% of leks had 15 or more cocks (Fig. 2). In addition, 25 single displaying cocks, comprising 4% of the total cock population, were found, giving an overall total of 697 displaying cocks. Numbers of cocks differed three-fold within grid squares, with a maximum of 192 and a minimum of 63 cocks. Data from 31 leks counted in all three years indicated that numbers of cocks attending leks showed

virtually no mean change between 1990 and 1991 but declined by 11% between 1991 and 1992 (Table 3). However, changes in some of the squares between 1990 and 1991 were larger than the overall changes between 1991 and 1992.

Displaying cocks were found within a distinct altitudinal band, at 230-470m. (mean 350 + 5 s.e.) in 1990-92 (Fig. 3). The area of land in each square between these altitudes was measured from Ordnance Survey maps. Densities ranged from 0.8-2.3 cocks per km² between different squares giving a mean density for the study area of 1.6 cocks per km² (Table 4). The seven squares varied considerably in the proportion of land within this altitudinal band, but although there was a weak positive correlation between the area of

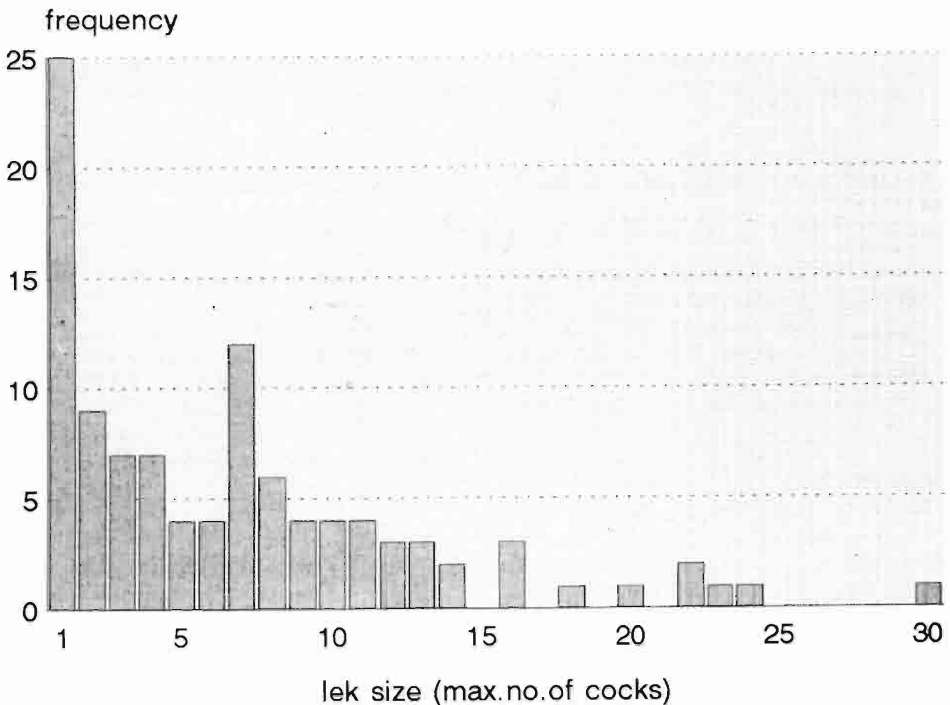


FIGURE 2. Frequency distribution of lek size (max. no. cocks present) from 79 leks and 25 single displaying cocks.

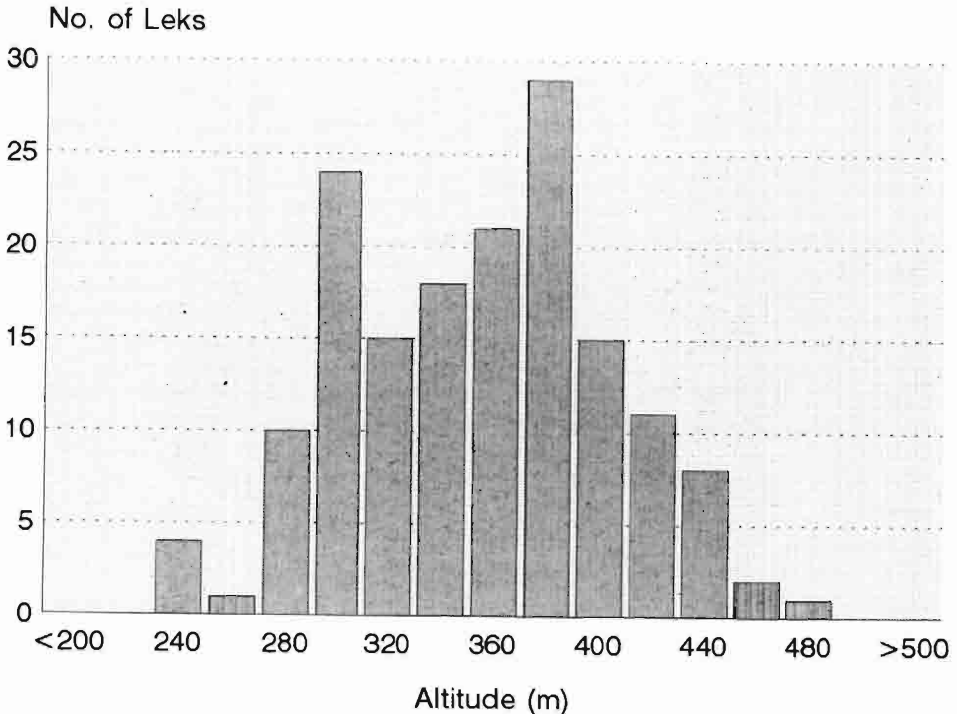


FIGURE 3. Altitudinal distribution of 160 Blackcock display sites including single cocks between 1990 and 1992.

ground between 230-470m and Blackcock numbers, this correlation was not statistically significant ($r_s = 0.53$). The mean distance between leks varied two-fold between squares from 1110-2220m. The mean for the whole survey area was 1460m.

Discussion

The mean density of 1.6 cocks per km² found by this study is similar to estimates from other British studies, and is within the range of densities found by Baines (1992) but is slightly higher than that found by Picozzi (unpublished) for parts of Deeside (Table 5). Higher densities have been reported by studies in Sweden, the Alps and Estonia, but these studies have either used smaller areas within which birds may be

concentrated, or only favourable habitats have been searched.

Black Grouse favour a mosaic of habitats that are transitional in their nature (Cramp & Simmons 1980) or maintained by burning or grazing. In this study, all leks were found at 230-470m which corresponded to a transitional zone between the upper edge of the valley woodland and inbye grasslands and much of the unenclosed moorland. Numbers of cocks varied three-fold between grid squares, but these differences could not be explained solely by variations in the amount of ground lying within the favoured altitudinal zone. Instead, it is possible that differences in the availability and quality of preferred habitat patches within this zone are more important than the absolute amount of ground

available. Such data were not collected during this study, but will form the focus for further analyses.

In our study, only 4% of cocks displayed on their own. This value is low compared to that found in Wales by Grove *et al.* (1988), where 45% of 91 leks were of single birds. Although we do not describe such observations of single birds as leks, there was clearly a higher proportion of singly displaying cocks in the Welsh study.

The difference may be due to the Welsh population being scattered and declining whereas there was no evidence that this was the case in Perthshire.

The proportion of single displaying cocks is thought to vary between years in relation to breeding success in the previous year (Angelstam 1983). However we found no evidence of changes in the proportion of single displaying cocks in this study despite between-year differences in breeding

TABLE 4. Densities of Blackcocks and mean inter-lek distances.

Grid Square No.	Area at 230-470m (km ²)	Density (cocks/km ²)	Inter-lek dist. (m)	
			n	mean + se
NN76	85.9	1.2	9	1460 + 175
NN86	74.2	0.9	5	2220 + 365
NN96	48.9	1.7	5	2000 + 310
NN75	52.9	1.3	10	1110 + 90
NN85	52.6	1.9	8	1525 + 300
NN95	44.0	1.9	5	1385 + 340
NO05	84.2	2.3	13	1210 + 150
Total	442.7	1.6 ± 0.2 s.e.	55	1460 + 90

TABLE 5. Densities of displaying Blackcocks in spring in this and other European studies. * densities expressed as number of cocks within the altitudinal band.

Study Area	Area (km ²)	Density (Cocks/km ²)	Author
Perthshire	443 (* 230-470m)	0.9-2.3	This study
N. Britain	306 (* 250-500m)	1.2-2.3	Baines (1992)
Deeside	34	0.8-1.2	Picozzi (unpubl)
Grimso (Sweden)	90	1.3	Angelstam (1983)
Boda (Sweden)	32	3.7	Angelstam (1983)
Halsen (Sweden)	14	7.2	Angelstam (1983)
French Alps	8	1.5-3.7	Ellison <i>et al.</i> (1988)
Tessin, Switzerland	Favoured habitat only	4.3-6.5	Zbinden (1985)
Estonia	Favoured habitat only	3.9	Viht (1974)

success. Instead, Baines (unpublished) recorded low breeding success in 1990 and 1991, which was correlated with reductions in numbers of cocks attending leks in 1992.

In the next few years, counts will be repeated and changes in Blackcock numbers will be compared with current land use patterns and subsequent changes. For example, new forests under the Native Pinewoods Grant Scheme are being planted in the study area. These developments and their impact on Black Grouse populations will form a focal point for the study group in future years. The Black Grouse has apparently declined in relation to land-use changes and it is hoped that, as understanding of its habitat requirements increases, appropriate management guidelines can be developed and implemented.

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Productivity of waterfowl breeding at Airthrey Loch, Stirling

M.V. BELL

Airthrey Loch is a small (9ha) eutrophic lowland loch in central Scotland. The productivity of breeding waterfowl was studied over five summers (1987-1991). The loch supported a large population of common species for its size with between 66-91 pairs of waterfowl breeding annually at a density of 7.3-10.1 pairs/ha or 25-35 pairs/km of shoreline, comprising five pairs of Little Grebe, one pair of Mute Swan, 21-29 pairs of Mallard, 7-8 pairs of Tufted Duck, 20-26 pairs of Coot and 9-18 pairs of Moorhen. Productivity was variable for all species and apparently independent of weather conditions. Predation by mink depressed breeding output by Coot and Moorhen in three seasons and algal blooms were coincident with mortality of downy Tufted Duck and Coot in two summers. The numbers of juveniles observed suggested that the loch produced a surplus of Little Grebe, Mute Swan, Coot and Moorhen.

Introduction

Airthrey Loch is situated in the grounds of the former Airthrey estate on the campus of Stirling University. The loch has a surprisingly large breeding population of common waterfowl which showed marked differences in breeding success between 1987 and 1991. Most of these birds, especially Mute Swan *Cygnus olor*, Mallard *Anas platyrhynchos* and Coot *Fulica atra*, are very tolerant of humans and sometimes aggressive in defence of territories or young. Even though many nests of Coot and Moorhen *Gallinula chloropus* were within two metres of the path round the loch and extremely obvious early in the season, there were very few losses attributed to humans. There is some fly-fishing for trout from boats and from the shore that sometimes led to the loss of lines and hooks on the lochside trees which then presented a hazard to the birds. There was also occasional dinghy sailing on the west bay and canoeing as far as the marker (see Fig. 1). The area round

the island is designated as a sanctuary area, though this is not always respected by canoeists and dingy sailors.

Airthrey Loch was formed in the early 19th century by constructing an embankment across a small burn at the west end and diverting the flow to a new exit stream at the south-east corner. The 9ha loch has an unusual shape (Fig. 1) and a correspondingly long shoreline of 2.62km; of this the small loch is 0.28km and the island an additional 0.18km. An access road and embankment divides the small loch from the main loch, these being connected by a submerged pipe. The loch has a mean depth of 1.5m with a maximum depth of 4.2m in the west bay. Water levels are controlled by a sluice but can still rise by up to 30cm after heavy rain. The loch is eutrophic with a low water turnover, especially in summer when dense algal blooms occur. There is emergent vegetation, mainly yellow iris *Iris pseudacorus* and

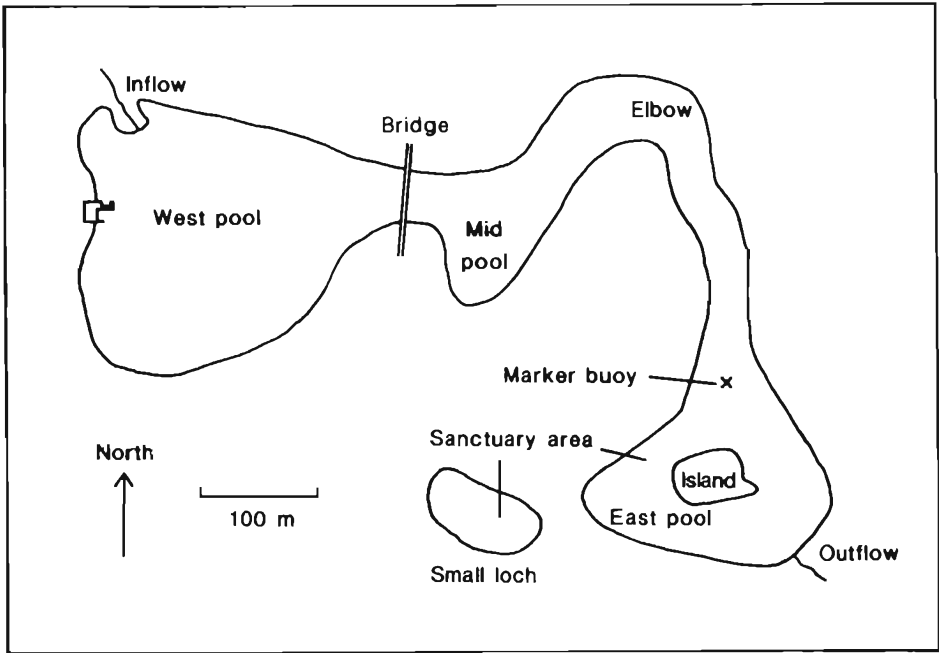


FIGURE 1. Map of Airthrey Loch.

bulrush *Typha latifolia*, along much of the shore east of the bridge which provided nesting cover for Little Grebes *Tachybaptus ruficollis*, Coot and Moorhen while many over-hanging willows *Salix sp.* around the entire shoreline also provided nest sites for Coot. Mature trees with cavities in the surrounding parkland provided some nest sites for Mallard.

Methods

In the first four summers of this study the loch was visited 2-4 times a week from early April to late August with less frequent visits before and after this period. In 1991 the loch was visited only weekly. It was most convenient to walk round the loch between 0615 and 0730 hrs GMT as the loch was least disturbed at that time. However, on cold mornings downy young were often brooded and therefore not visible; this was

particularly a problem in late April and May. In these circumstances the loch was checked between 1145 and 1300 hrs also, and very occasionally between 1615 and 1730 hrs but the birds were found to be rather inactive and therefore not very visible in late afternoon and evening. Visits every few days allowed newly hatched broods to be followed from hatching to fledging. Nests and territories of Little Grebe, Moorhen and Coot were marked on a map of the site; Coot territories were a useful reference point for broods of ducklings. No attempt was made to find nests not visible from the perimeter path. The island was not visited.

Individual territory sizes were not determined in this study. Average territory sizes were obtained by dividing the water area by the number of pairs of the particular species. Each year some birds appeared not to nest. Non-breeding pairs were identified

by the following criteria: for Coot and Moorhen, territorial pairs seen regularly (i.e. both adults) through part or all of the nesting season with no signs of egg-laying or incubation of a clutch. Some pairs built rudimentary nests. Pairs of Tufted Duck which were regularly seen on the water (i.e. female not incubating) throughout the summer were taken to be non-breeders. It is possible that some of these pairs may have failed within a few days of starting to nest.

Results

Nesting territories of Little Grebe, Coot and Moorhen were easily located. Almost all Coot nests and most nests of Little Grebe were visible from the shore. Sometimes newly hatched chicks were the first indication of nesting by Moorhens. Providing losses were low, it was possible to follow the success of individual broods of Mallard and Tufted Duck. In 1991, with less frequent visits, this was not possible and there may have been total losses of broods within the first few days which were not noted. Laying and hatching dates were also less accurately known.

Little Grebe

Five pairs of Little Grebe nested each year (Table 1). Most nested east of the bridge (Fig. 1) with single pairs in the west bay in 1988, 1989, 1990 and 1991. The maximum

density was 1.1 pair/ha when all five pairs were on the east part of the loch. From late May onwards it was usually impossible to see nests among bulrush, but later nests in floating beds of amphibious bistort *Polygonum amphibium* and yellow water lily *Nuphar lutea* were very obvious and sometimes as much as 10m from the shore. In spite of appearing vulnerable to predators and wind, only two out of twelve such nests were lost; adults usually remained incubating as the wash from canoes rocked their nests.

Newly hatched young often remained hidden in cover and occasionally were not seen until about two weeks old; the number of young hatched was therefore not known. Post-hatching losses appeared to be low with some young fledged from every clutch: only 11 young were lost from 79 hatched in 32 broods. One brood of five was recorded. Broods usually remained within the nesting territory until dispersing about four weeks after fledging but in 1990, a pair moved their newly hatched brood some 200-300m from the mid pool to the west pool from where the young fledged. In 1987, most of the young from the first broods left the loch several weeks after dispersing. The mean size of successful broods was 2.0 (8 of 1, 16 of 2, 5 of 3, 2 of 4 and 1 of 5) over the five summers, and the average productivity varied from 2.0 to 4.0 young/pair.

TABLE 1. Little Grebes breeding at Airthrey Loch 1987-1991.

	1987	1988	1989	1990	1991
no. of pairs	5	5	5	5	5
median hatch date (first clutches)	28 May	21 May	5 Jun	2 Jul	18 Jul
broods hatched	9	6	6	5	6
single broods	2	4	4	3	2
double broods	2	1	1	1	2
triple broods	1	0	0	0	0
young fledged	20	11	12	10	15
young fledged/pair	4.0	2.2	2.4	2.0	3.0

In 1987, there were three pairs at the start of the summer with a fourth arriving in the last week of June and a fifth in the last week of July. This then became the most successful of the five years, with two pairs double-brooded and a third triple-brooded (Table 1). This latter pair fledged two, two and four young from clutches which hatched on approximately 20 May, 13 July and 30 August. Two other pairs also fledged two and three young from late nests which hatched on 20 and 29 August. In 1988, 1989 and 1990 only one pair was double-brooded, with two pairs in 1991. In 1990 and 1991, single pairs failed to rear any young. 1990 was the least successful season. Although all five pairs were present by early May they made no attempt to nest for 4-5 weeks and every nest was then built in amphibious bistort and yellow water lilies well out from the shore. Laying was also delayed until late May or early June in 1991. In 1988, 1989 and 1990 single non-territorial adults were present all summer.

Mute Swan

A pair of Mute Swans nested successfully on the island each year. Eight, seven, seven, seven and nine cygnets were hatched on 7 May, 1 June, 28 May, 27 May and 28 May in 1987-1991 respectively and of these seven, five, four, five and seven fledged. (In 1986, all nine young fledged at Airthrey). In 1988

and 1990, single young were lost soon after hatching while in 1989, all three losses occurred at or just after fledging. In 1988, a fledged juvenile died of ingested lead poisoning.

Mallard

Over twenty broods of Mallard were seen each summer but counts of drakes in April and May underestimated the breeding population by a large margin in every spring except 1991 (Table 2). Numbers of Mallard increased in June, as birds arrived from elsewhere to moult, and large numbers were present in late summer each year with 609 in August 1990.

Mallard nested in the lochside vegetation and in the campus shrubberies up to at least 400m from the water. Four nests were found 3-4m above ground in holes in lochside oaks, and in 1990 one such site was occupied consecutively by different females, both of which hatched their clutches.

Broods appeared from the second week of April to the first week of July, with most appearing in the last week of April and the first two weeks of May, median hatch dates were between 2-18 May in 1987-1990 (Table 2). Fledging success varied between 29-70% of those ducklings first seen: 1987 was the best season with the largest number fledged (110) and the highest number of young fledged/brood (5.0) (Table 2). Four

TABLE 2. Mallard breeding at Airthrey Loch 1987-1991.

	1987	1988	1989	1990	1991
av. no. of drakes April-May	9	9	12	14	21
no. of broods	22	21	23	28	34 ^a
median hatch date	15 May	18 May	2 May	6 May	29 May
no. of ducklings first seen	158	127	158	202 ^b	210
ducklings fledged (6 weeks)	110	41	54	79	60
total brood failures	4	7	11	7	20
young fledged/brood seen	5.0	2.0	2.3	3.3	1.8

^a five broods were probably replacements.

^b four broods totalling 32 ducklings left the site within a few days of hatching.

aberrant pale females fledged from one brood in 1988 and these ducks could be identified individually over the following three summers. In 1990, one of these ducks was double-brooded. She abandoned three ducklings of c.20 days old in the first week of May and ten days later these had joined a brood of seven ducklings of similar age also with a pale duck; all ten ducklings subsequently fledged. On 20 June (45 days later), she appeared with nine newly hatched ducklings of which five fledged. In 1987 and to a lesser extent in 1990, broods older than about three weeks wandered extensively from the loch to feed (up to at least 400m) and several ducks and young were killed on the adjacent roads. In 1990, four broods were thought to have left the loch shortly after hatching, possibly for the river.

Tufted Duck

Between 7-12 pairs of Tufted Duck *Aythya fuligula* were present each summer. Several pairs remained on the water throughout the period and did not appear to attempt to breed. The number of broods seen varied between 2-8 (Table 3). Four nests were found during the study and all were in rank grass on the banks of the loch within 1m of the water. Most broods started to break up after four weeks though some remained cohesive for up to six weeks.

Fledging success was very variable in the four years (Table 3). In 1987, the best year, 43 ducklings out of 57 fledged from seven broods, discounting one brood abandoned at hatching. The duck was found sick and all the ducklings disappeared within two days, most being taken by Carrion Crows *Corvus corone*. In 1988, there was a synchronous failure in good weather with six ducks appearing without broods on 24 June; the first two broods to hatch were very successful, fledging 16 out of 17. In 1990, all but one brood were abandoned between a few days and two weeks after hatching; these broods then fragmented making it very difficult to follow broods and ducklings. Many ducklings grew very slowly, taking up to two weeks longer to fledge than usual. This also occurred in 1991 with the first brood which hatched in the last week of June, fledging all nine ducklings and the subsequent seven broods hatching from mid-July showing brood desertion, slow growth and large losses.

Coot

Between 20-26 pairs of Coot nested each year with up to five additional territorial pairs present (Table 4). The smallest average territory size was 0.22 ha/pair for the two pairs on the small loch in 1991, but the 11

TABLE 3. Tufted Duck breeding at Airthrey Loch 1987-1991.

	1987	1988	1989	1990	1991
no. of pairs	9	8-10	7-11	10-12	8-14
no. of broods	8	2	5	8	8
median hatch date	11 Jul	17 Jun	7 Jul	15 Jul	18 Jul
ducklings first seen (four weeks)	64	17	37	53	54
ducklings fledged	43	16	21	17	19
total failures	1	0	1	2	?
broods abandoned	1	0	1*	7	7
young fledged/pair	4.8	2.0	3.0	1.7	1.7

* duck died

TABLE 4. Coot breeding at Airthrey Loch 1987-1991.

	1987	1988	1989	1990	1991
territorial pairs	20	27	29	25	25
pairs laying	20	26	24	23	24
clutches laid	23	35	39	31(+)	28
replacement clutches	3	7	11	8	4
second clutches	0	2	4	0	1
median hatch date (first clutches)	15 May	14 May	11 May	10 May	1 May
no. of clutches hatched	22	29	26	18	22
no. from which young fledged	17	24	17	9	19
no. of young fledged	42	61	36	19	49
pairs double-brooded	0	1	2	0	1
young fledged/pair	2.1	2.3	1.5	0.8	2.0

pairs on the east loch in 1991 only averaged 0.26 ha/pair. The overall density varied between 2.2 and 2.8 ha/pair in the five summers. The average length of shoreline available varied from 101 to 131 m/pair with the smallest average of 78 m/pair in the west bay in 1989. The boundaries of Coot territories were indicated by frequent territorial interactions. Territory size changed during the season depending on the stage and fortunes of neighbouring pairs, thus pairs with young frequently took over parts of the territories of adjacent pairs that had failed.

First clutches became progressively earlier during this study with egg laying from mid-March in 1990. The median hatch date of first clutches was very constant between 10-15 May in the first four summers but was almost a fortnight earlier (1 May) in 1991 (Table 4). High spring water levels may have prevented even earlier nesting in each of the years. Annual productivity varied between 0.8 and 2.3 young fledged/nesting pair over the five summers.

Nests were rarely unattended and no attempts were made to determine clutch size but opportunist observations of 11 first clutches or replacement clutches gave an average of 6.9 eggs (4 of 5, 1 of 6, 2 of 7,

1 of 8, 2 of 9 and 1 of 10). The four largest clutches may have contained dumped eggs since 11 eggs were left unhatched in these four nests. More detailed observation of nests would have been necessary to determine the extent of egg dumping for both Coot and Moorhen. Newly hatched young were often brooded and not visible for several days post-hatching, but where the brood size was known, 26 first broods averaged 6.0 chicks (1 of 2, 4 of 5, 13 of 6, 7 of 7 & 1 of 8) and seven replacement broods averaged 4.4 chicks (1 of 3, 3 of 5, 2 of 5, 1 of 6). On only one occasion were eggs noted in the water at the edge of the nest but it is likely that other eggs were knocked out of the nest by the adults during skirmishes with rival pairs of Coot or Moorhen. Most losses occurred at the stage of newly hatched young, with brood reduction occurring during the first week, probably due to starvation of the weakest chicks following neglect by the adults. Three instances of predation by Lesser Black-backed Gulls *Larus fuscus* were seen, on chicks about seven, nine and ten days old. Over the five years, of the successful pairs, 21 fledged one young, 24 pairs two young, 17 pairs three young, 16 pairs four young, 4 pairs five young and 1 pair six young

(from two broods of three). There were seven attempts at second broods over the four seasons and only four were successful. In 1988, a very late attempt at a second brood (hatching on 9 September), following a replacement first brood, failed when the last chick which had grown very slowly disappeared between 29 September and 3 October. Small territories caused frequent disputes between adults but young were allowed to cross territorial boundaries. In 1988, young from two adjacent pairs frequently interchanged, while another pair lost control of a brood of five 15-day old chicks which were adopted by a pair with two young 11 days older. All seven fledged.

There was very little interference with nests by humans, though in 1990 it was thought that the failure of three adjacent and obvious nests over the same weekend was caused by human disturbance. In 1988, three pairs failed on 2 May just before or at hatching, following heavy rain and strong easterly winds. Two of these pairs quickly relaid in the same nests. In the summer of 1989, a mink *Mustela vison* was seen at the east end of the loch on two occasions and the agitated behaviour of some birds indicated its presence on several other dates. There was a marked difference in the success of pairs at the east and west ends of the lochs (Table 5). A mink was also present on the same part of the loch in 1990 and 1991.

Most of these nests failed at or shortly after hatching and the mink was probably attracted by the calls of the chicks. In 1989, one pair failed four times from clutches started before 12 April, on 28 April, 2 May and 20 June, the last hatching but the young disappearing within a week. In 1990, breeding success was poor round the whole loch though it was still poorer at the east end. Several nests here failed early in incubation after a dilatory start to the season and the birds did not relay. At the west end, five broods were abandoned between 16 days and five weeks after hatching, and the young eventually died though two chicks from different broods, abandoned at 17 days and five weeks, eventually fledged. Other chicks were very slow to grow, taking 2-3 weeks longer to fledge than normal; one died after ten weeks when it was much smaller than normal (c. 3-4 weeks retarded). In 1991, all the first broods of Coot had fledged before the algal bloom occurred.

Moorhen

The number of pairs of Moorhen increased steadily over the five years (Table 6), mainly at the west end of the loch (Table 5). Average Moorhen territory size varied from 0.52 to 1.03ha water area/pair over the five years with the three pairs on the small loch in 1990 and 1991 having only 0.15 ha/pair.

TABLE 5. Breeding success of Coots and Moorhens at the east and west* ends of the loch.

	Coot (nesting pairs)				Moorhen (territorial pairs)			
	West end		East end		West end		East end	
	prs	young	prs	young	prs	young	prs	young
1987	12	22	8	20	4	12	5	18
1988	16	38	10	23	8	12	4	9
1989	16	39	8	1	9	21	5	6
1990	15	15	8	4	13	45	5	6
1991	13	35	11	14	12	47	7	5

* The west end includes the small loch.

TABLE 6. Moorhens breeding at Airthrey Loch 1987-1991.

	1987	1988	1989	1990	1991
territorial pairs	9	12	14	17	19
no. of pairs nesting	9	11	12	15	18
no. of double broods	4	1	1	4	8
no. of triple broods	0	0	0	1	0
median hatch date (first clutches)	12 May	13 May	24 May	14 May	10 May
no. of broods hatched	17	12	15	24	27
no. from which young fledged	12	10	10	18	22
no. of young fledged (5 weeks)	30	21	27	49	52
young fledged/nesting pair	3.3	1.9	2.3	3.3	2.9

Length of shoreline, which may be a more important factor for Moorhen, varied from an average of 175-291 m/pair, with extremes of 390 m/pair in the west bay in 1987 and 93 m/pair on the small loch in 1990 and 1991.

Over the five summers, a total of 65 pairs of Moorhens nested. There was a minimum of 111 nesting attempts of which at least 15 failed before hatching, and a further 24 failed to fledge any young. Of the 65 pairs, 12 fledged no young, 8 pairs one young, 13 pairs two young, 11 pairs three young, 8 pairs four young, 5 pairs five young, 3 pairs six young, 3 pairs seven young and 2 pairs eight young.

There were very frequent disputes between Moorhens and Coots, especially early in the season when little cover was available to hide Moorhens. Every Moorhen territory overlapped with at least one Coot territory, and on one occasion an early Moorhen nest was taken over by Coots. Early nests were often in the base of willows up to a metre above the water since there was little other cover available at this time. A Norway spruce *Picea excelsa* with branches at this height overhanging the water was also used in three seasons. Such sites were not accessible to Coots but could not be used as brood nests, since chicks were unable to climb back to them. In 1989, a

brood of five newly hatched young from such a nest were thought to have been killed by Coots, whose nest was only five metres away.

As with Coot, first hatching dates became progressively earlier during the study though the median hatch date of first clutches was little changed (Table 6). The best years were 1987, 1990 and 1991 with about three young fledged/territorial pair. In 1987 and 1990 four pairs were double-brooded, and in 1991 there were eight double-broods. All three pairs on the small loch in 1991 were double-brooded, fledging seven, eight and eight young; the two pairs of Coot fledged three and five young so this site was extremely productive that year. In 1990 there was also a triple-brooded pair which fledged one, two & two young from clutches hatching on about 8 April, 28 May and 17 July. Breeding was less successful at the east end of the loch than at the west end in 1989, 1990 and 1991 (Table 5), especially in the last two years. This was thought to be because of disturbance and/or predation from mink. Moorhen nests were vulnerable to predation by Grey Squirrel *Sciurus carolinensis*, Carrion Crow and Magpie *Pica pica*, while chicks were also vulnerable to cats which were known to have taken several juveniles. Adults from territories adjacent to roads were vulnerable to traffic and in

1987 three of the 18 breeding adults were killed on the roads during the summer.

In 1990, a pair incubated an infertile clutch from at least 28 May to 14 August (79 days), leaving two eggs on eventual desertion. Another territory in 1990 held three birds. After an early failure a bird was incubating a new clutch on 11 April. On 25 April two adults were incubating side by side (head to head) with a third in close attendance. The following day, they were both incubating again and the nest was inspected to reveal at least nine eggs, one of which was chipping. One adult was extremely aggressive, leaving the nest only when the observer was less than a metre away. On the following three days, one bird was incubating/brooding with the other two adults in attendance. On 7 May, the nest had been interfered with by humans and the adults and an indeterminate number of young were hidden in a bed of iris. The full family of three adults and seven young was not seen until 23 May, when three young were clearly larger than the other four and were estimated to be about a week older. All seven fledged. It was thought that a second clutch was attempted by one bird but that this failed before hatching.

Discussion

There have been many studies of the breeding biology of waterfowl but rather few of these have examined breeding productivity. Fledging success is frequently difficult to determine because of the wariness of waterfowl and the extensive cover at breeding sites. The population of waterfowl at Airthrey Loch was particularly amenable to study because the birds were conditioned to the presence of humans and all parts of the loch were easily visible.

The average fledging success of Little Grebe varied between 2.0-4.0 young/pair over the five seasons. A Danish study found clutches of 4-6 usual with a mean brood size of 4.6 at hatching and 1.8 on fledging (Ahlen 1966; cited in Cramp 1977) with two

broods normal and possibly three occasionally. During this study there were 15 single broods, seven double broods and one triple brood. In 1987, the most successful year, two pairs were double brooded and one triple brooded, with extreme hatching dates of 18 May and 2 September. This was the first recorded pair of triple-brooded Little Grebe in Britain. Another was recorded at Aylesbury sewage works in 1988 (Glue 1990).

Over 20 broods of Mallard were seen each summer but counts of drakes in April-May consistently underestimated the population of breeding females by 40-60%. Breeding success varied between 2.0-5.0 young fledged/♀ or 2.9-6.1 young/successful ♀. The annual productivity varied from 1.9-5.5 young fledged/pair at a gravel pit in Kent over ten summers (Harrison 1972). Other studies reported 3.5 young/successful ♀ (Iceland), 4.7 (SW England), 5.0-7.5 (Denmark) and 7.0 (Finland) (in Cramp 1977) so the productivity at Airthrey Loch was comparable.

At Loch Leven, the most important site in Britain for breeding duck, c.1150 pairs of duck, mainly Mallard and Tufted Duck, nested each year between 1966-1971. Hatching success averaged 55% and 57% respectively for these two species over the six summers but productivity was poor with estimates of only about one young fledged/pair for Mallard and probably better for Tufted Duck (Newton & Campbell 1975), many ducklings being taken by gulls. The breeding duck were re-surveyed here in 1980-1984, when the population was found to be slightly larger at c.1200 pairs. Though relatively few broods were again noted, the number of ducklings per brood surviving beyond two weeks of age was 4.3 for Mallard and 3.6 for Tufted Duck (Wright 1986).

A study of Tufted Duck in Finland found 78% hatching success but only 11.4% fledged with a survival of 0.5, 1.0 and 2.2 young/pair in different years (Hilden 1964).

At Lake Myvatn, Iceland, 1.9-3.3 full-grown young/♀ were produced over six summers (Bengtson 1972). At Airthrey hatching success and fledging success were broadly similar to those found in these studies.

An earlier study of Coot at Airthrey Loch was carried out in 1971, when 16 territories were present (Downie 1972). There were fewer waterside willows available to provide nest sites in 1971 than during this study, and recent mild winters may also have elevated the populations of Coot (and Moorhen). Territory size varied between 0.14-1.06ha but measurements of territory quality were so variable that the results did not allow any conclusion. No attempts were made in this study to relate productivity of Coots or Moorhens to territory quality. In 1971, egg laying occurred between 20 April and 6 June, mean clutch size was 5.6 (range 3-8), but only 40.6% of eggs hatched and only 19 young fledged (Downie 1972). Individual territory sizes were not determined in the present study but some pairs were much closer than the average values given in the results, e.g. three pairs in the mid pool in 1988, four pairs at the 'elbow' of the loch in 1988, 1989 & 1990, with three on the outer curve and one on the apex, and three nests within 40m at the southern end of the loch in 1991. One of these nests probably failed because of fighting but the middle territory supported the only double-brooded pair in 1991. In St. James Park, London, Coot territories varied between 0.12-0.44ha, mean 0.36ha (Cramp 1947). Studies in Holland have shown that the size and quality of a Coot territory is related to the age of the male tenant and its neighbours, older males having bigger and better territories (Cave *et al.* 1989).

The nesting season was much more protracted at Airthrey during this study than in 1971, and limited observations also suggested that the clutch size was larger. Hatching success in 1987 and 1988 was also much better than in the earlier study

(Downie 1972), but fell in 1989, 1990 and 1991 because of predation by mink. However, there were large losses of chicks in the first two weeks post-hatching in most broods and overall fledging success was similar to that found by Downie (1972). In the earlier study, several Coots used nest boxes that attracted interference from humans which depressed hatching success. A study of brood reduction and brood division in Coots in Oxfordshire found that all chicks surviving the first week subsequently fledged and that the earlier hatched chicks within broods had better survival (Horsfall 1984a,b). Brood reduction is a means of matching the number of young to the food supply through the establishment of a feeding hierarchy, leading to the starvation of the smallest and weakest later hatching chicks. Occasionally, chicks are killed by the parents (Horsfall 1984b).

Violent bouts of 'tousling' of chicks by the parents were noted during the present study but it is not known whether these resulted directly in the death of the chick. At Airthrey, brood reduction occurred over a longer period. In 1987 and 1988, from 48 clutches hatched where the disappearance of chicks was accurately known, 58 disappeared in week one post-hatch, 20 in week two, 11 in week three, four in week four, two in week five and one in week six. Although some of these larger chicks may have been predated, in most cases the circumstances (visibly slow growth, neglect by parents) suggested starvation, poor condition or disease. The small size of some territories at Airthrey and thus food shortage may have accounted for the number of total brood failures or broods from which only one chick fledged. In 1987 and 1988, from 48 nesting attempts which hatched, nine failed to raise any young and eight fledged one young. Only four out of 117 pairs of Coot were double-brooded in 1987-1991. This was surprising, since there seemed to be sufficient time for second broods given the early start to nesting; in

1991, 17 pairs had young which were independent by the end of June, yet only one pair attempted a second clutch (and was successful). A study in Somerset (Alley & Boyd 1947) also recorded poor hatching success but better fledging success than the current study at Airthrey. Alley & Boyd (1947) observed Coots killing chicks from neighbouring pairs which wandered into their territory. Although there were frequent territorial disputes at Airthrey, such aggression was never seen directed towards chicks. On the contrary, in one instance in 1988 young of similar age from broods of four and five wandered between adjacent territories at will and were possibly fed by the other pair. In another case a pair with two young drove off the parents of an adjacent brood and adopted their chicks. It is possible that in these instances of unusual behaviour the adults were related. Lesser Black-backed Gulls were seen cruising over the loch frequently in late May and June and may have been major predators of small Coot chicks. Three successful attacks were witnessed during this study, and three by Downie (1972), who also observed a Lesser Black-backed Gull attack a Coot nest.

Downie (1972) found 11 territorial pairs of Moorhen at Airthrey in 1971. Hatching success was only 43.5% with humans the main cause of failure. Hatching success was not determined in the present study but is thought to have been better, even though most nests were not found, but fledging success was also low with 1.9-3.3 young fledged/pair even though most pairs attempted two broods.

Over the five seasons, 65 pairs of Moorhens nested and 18 of these were double-brooded with only one triple brood. This is in accord with the study of Wood (1974), who found double broods unusual, while Relton (1972) found more than a third of her pairs double-brooded. However, a study in Aberdeenshire under semi-artificial conditions with an abundant food supply and few predators found three broods to be normal with experienced adults (Anderson

1965). In the Avon valley, Hampshire, 1.6 and 2.6 young fledged/pair in two different years (Wood 1974). Hatching success was poor (13.6% and 25.8%) with only 11 out of 53 nests hatching but fledging success was then very good (Wood 1974). This was not the case at Airthrey where hatching success was much better but fledging success poor. The high density of Moorhens encouraged juveniles to remain on the natal territory, and juveniles from first broods often helped feed the chicks of second broods. A study in Cambridgeshire found that pairs of Moorhen with helpers reared more chicks per nesting attempt than pairs rearing chicks at the same time without helpers (Gibbons 1987), but insufficient data were available in this study to show whether this was true at Airthrey.

Mink was believed to be the major cause of failure of Coots and Moorhens in 1989, 1990 and 1991. Signs of mink were seen only at the east end of the loch, where the lacustrine vegetation was most dense, and this coincided with the failure of most pairs nesting in this area. Mink take a wide range of prey items in proportion to their availability (Akande 1972). They are therefore particularly damaging to birds which nest at high density such as gulls and terns on offshore islands (Craik 1990; Lloyd *et al.* 1991) and localised concentrations of wildfowl which may be found along rivers, streams and loch margins. Lesser Black-backed Gulls may also have been significant predators of young Coot which, being unable to dive, are very vulnerable to attack when out of cover. The other potential predators, Carrion Crows, Magpies and Grey Squirrels, spent most of the time scavenging and largely ignored nests and chicks. In June and July 1990, a bloom of toxic algae appeared to kill many young Tufted Duck and Coot. Adults lost interest in and abandoned chicks, which grew very slowly with many dying. Mallard and Moorhen which mainly fed out of the water had a good season. In 1991, the first brood of Tufted Duck fledged all nine ducklings

but the remaining seven broods, which hatched three to four weeks later during a bad algal bloom, fledged only ten out of 45 ducklings.

Despite its relatively small size, Airthrey Loch is the most important freshwater site in Central Region at the present time for breeding waterfowl in terms of density and number of pairs. The numbers of young fledged were likely to exceed adult mortality, certainly for Little Grebe, Mute Swan, Coot and Moorhen. Survival of full-grown Little Grebe, Mute Swan, Coot and Moorhen was good, and most young Coot and Moorhen appeared to remain on site through the winter, with numbers falling only from February onwards as territories were established. Many Coot remained on territory throughout the year. On only one occasion in five winters was there snow cover and the loch frozen at the same time, forcing most birds to leave. The 1985/86 winter was more severe at Airthrey than any of the subsequent five, and the steady increase in the population of Moorhen suggests they were recovering from a low point. The population of the other five species remained stable during this period.

Breeding productivity was variable for all species over the five seasons, but different species were more or less successful in different years. Success appeared to be independent of temperature and precipitation. A ranking of breeding success for each species with mean temperature, monthly precipitation and the number of days with over 5mm rain measured at the University weather station in each month from April to July showed no relationship. However, these are particularly crude measures and a factor which integrates precipitation and wind chill over time would be much more meaningful since it is well established that a combination of rain, wind and low temperatures is particularly damaging to small downy young. The detailed study at Lake Myvatn found that the weather in the week after hatching was

the main factor determining duckling survival (Bergtson 1972), and Harrison (1972) also found cold, wet weather to be very damaging to ducklings of Mallard and Tufted Duck. At Airthrey, the birds fared better in the poor summers of 1987 and 1990 than in the good summers of 1988 and 1989. The reasons for this are unclear but at a neighbouring site in south-west Perthshire, duck bred very well in 1988 and 1989 and badly in 1987, 1990 and 1991 (pers. obs.). At Airthrey, the very short grass around much of the loch may have allowed young Mallard, Coot and Moorhen to feed without becoming soaked and chilled during wet weather. A relatively asynchronous and prolonged breeding season may also have meant that some cold wet periods in June of 1987, 1990 and 1991 were not as damaging as would have been the case in a more synchronous population. Therefore, bad weather may not have had as much effect as expected at Airthrey. It is less clear why success was relatively poor in the two good summers. The loch shore is much more disturbed by walkers and sunbathers in good weather but this disturbance only occurs for a few hours, mainly around mid-day. Food shortage may have been a factor though there was no direct evidence to support this.

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Breeding numbers and breeding success of the Peregrine in Shetland, 1961-1991

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The British Trust for Ornithology (BTO) Peregrine Enquiry in 1962 was the first attempt to survey breeding Peregrines in Shetland (Ratcliffe 1963). Of the 19 known traditional nesting sites visited, 11 were occupied and at least three pairs nested. By 1991, the number of occupied sites had fallen to five with no breeding pairs located, making Shetland the only Scottish county without breeding Peregrines. Available data on breeding Peregrines in Shetland between 1961 and 1991 are presented and compared to the situation in Orkney. Possible reasons why Shetland's Peregrine population remains so small are discussed.

Historical background

The Peregrine *Falco peregrinus* has a long history in Shetland, with bones found in excavations of ninth and tenth century Viking dwellings at Jarlshof (Venables & Venables 1955). Dunn (1837) considered it to be "pretty numerous" and Saxby (1874) stated that "within the last five years the number has increased". Evans and Buckley (1899) noted about 14 occupied sites. In 1951-52, P.W. Sandeman reported ten pairs nesting in Shetland (D.A. Ratcliffe in litt.) and Venables & Venables (1955) stated that Shetland "is, and apparently always has been, one of the strongholds in Britain for this species".

Methods

In national enquiries, organised by the BTO in 1961, 1971, 1981 and 1991 and also in 1986, an attempt was made to visit all known nesting sites at least once in April or early May. In the intervening years, from 1978 to 1991, all known nesting sites which had been occupied since 1974 were checked for signs of occupation at least once in April and May. Sites with one or more birds

present and active nests were visited subsequently to record breeding success. All prey items found during visits were recorded and removed. A nesting area was considered to be occupied if a nest was located or if one or more Peregrines were seen in suitable habitat. The high sea cliffs made it difficult to locate the kills and in no cases were definite Peregrine kills found without one or more Peregrines also being seen. Since 1984, visits to most sites each year included both searching from the top of the cliff and searching from a boat. The high cliff nesting habitat, together with the large numbers of Fulmars *Fulmarus glacialis* which inhabit it, increased the difficulty of detecting Peregrines, particularly non-breeding birds which, when an observer approaches, may fly directly away from a cliff without calling and without returning (pers. obs.).

Results

Site descriptions

All known sites and all sites occupied since 1978 were on sea cliffs 50-140m high. All nests located since 1984 were on cliff ledges,

except for one which was in the old nest of a Raven *Corvus corax* and another nest which was in the centre of the flat grassy top of a sea stack.

Population size

Table 1 shows the results of each of the five surveys of known Peregrine breeding sites in Shetland. Over the years, a small number of previously unrecorded sites have been discovered. The rate of occupation of the sites visited declined from 58% in 1962 to 13% in 1991, when only five single birds occupied sites. Since 1962, when eight pairs were located, only a small number of pairs were recorded, with one in 1971, five in 1981, four in 1986 and naught in 1991. Breeding attempts were only recorded in 1962, 1981 and 1986, when respectively at least three pairs, four pairs (80% of pairs holding territory) and three pairs (75%) nested. Not all sites were visited each year, and data gathered during intervening years were incomplete, but the maximum number of occupied sites found in any year since

1961 was 14 in 1985, of which only half were apparently occupied by pairs (tables 2-5). By 1991, the number of occupied sites had fallen to only five, and all occupied by single birds. The number of known breeding pairs in any one year since 1961 has never exceeded four.

Breeding success and productivity

In 30 years since 1961, the largest number of successful nests recorded in any year was three, and in total only about 69 young are known to have been produced (an average of only about 2.2 young fledging per year). During the years when all sites were visited, the proportion of pairs breeding successfully varied between 25% in 1981 and 67% in 1986, with no known nesting attempts in 1991. Although up to four pairs nested in individual years, only one or two were successful, although overall 11 out of 15 (73%) were successful. Only in 1987 did all known pairs nest. Usually three to five pairs were located and about half (56%) of these nested. We did not climb to nests until the

TABLE 1. Peregrine breeding data for the BTO National Peregrine Enquiry years and 1986, when all known sites in Shetland were visited.

	1962	1971	1981	1986	1991
Sites checked	19	25	35	36	38
(%) of known sites	(68)	(89)	(100)	(100)	(100)
Sites occupied	11	5	11	8	5
(%) of sites checked	(58)	(20)	(31)	(22)	(13)
Sites occupied by single birds	3	4	6	4	5
Sites occupied by pairs	8	1	5	4	0
Nesting pairs	3+	0	4	3	0
Successful pairs	3+	0	1	2	0
Young fledged	5+	0	3	6	0
Young fledged per nest	?	0	0.75	2.0	0
Young fledged per successful nest	?	0	3	3	0
Productivity (young fledged per pair)	?	0	0.6	1.5	0

In 1962, it was not known whether three of the pairs nested.
Data for 1962 and 1971 from D.A. Ratcliffe (in litt.).

TABLE 2. Data for Peregrines breeding in Shetland in 1961-1970.

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Sites checked	8	19	11	18	9	10	2	12	5	4
(%) of known sites	(22)	(68)	(31)	(50)	(25)	(28)	(6)	(33)	(14)	(11)
Sites occupied	6	11	8	6	2	3	1	9	5	4
Sites occupied by single birds	1	3	1	2	0	2	0	2	2	1
Sites occupied by pairs	5	8	7	4	2	1	1	7	3	3
Nesting pairs	4+	3+	2+	4	1	1	1	1	2	2
Successful pairs	2+	3+	2+	4	0	0	1	1	2	0-1
Young fledged	3+	5+	3+	7	0	0	2	1	4	?

Data from D.A. Ratcliffe (in Litt.) and Fair Isle Bird Observatory Trust (FIBOT).

TABLE 3. Data for Peregrine breeding in Shetland in 1971-1977.

	1971	1972	1973	1974	1975	1976	1977
Sites checked	25	?	?	?	?	7	10
(%) of known sites	(89)	(?)	(?)	(?)	(?)	(19)	(28)
Sites occupied	5	4	4	6	8	9	?
Sites occupied by single birds	4	0	0	1	0	?	?
Sites occupied by pairs	1	4	2	5	8	?	?
Nesting pairs	0	2	0	4	2+	?	?
Successful pairs	0	2	0	2+	2+	1	0
Young fledged	0	4	0	2+	2+	1+	0
Young fledged per nest	0	2	0	0.25+	1+	?	0
Young fledged per successful nest	0	2	0	1+	1+	?	0
Productivity (young fledged per pair)	0	1	0	0.4+	0.25+	?	0

Data from D.A. Ratcliffe (in litt.) (1971), *Shetland Bird Reports* 1972-1977, Shetland Bird Club, Lerwick, and FIBOT.

TABLE 4. Data for Peregrines breeding in Shetland in 1978-1983.

	1978	1979	1980	1981	1982	1983
Sites checked	21	21	19	36	28	27
(%)	(58)	(58)	(53)	(100)	(78)	(75)
Sites occupied	7	6	6	11	5	4
(%) of sites checked	(33)	(29)	(32)	(31)	(18)	(15)
Sites occupied by single birds	4	3	2	6	1	1
Sites occupied by pairs	3	3	4	5	4	3
Nesting pairs	2	2	4	4	0	2
Successful pairs	0	0	2	1	0	2
Young fledged	0	0	2	3	0	3
Young fledged per nest	0	0	0.5	0.75	0	1.5
Young fledged per successful nest	0	0	1.0	3	0	1.5
Productivity (young fledged per pair)	0	0	0.5	0.6	0	1.0

Data from J.D. Okill and FIBOT.

TABLE 5. Data for Peregrines breeding in Shetland in 1984-1991.

	1984	1985	1986	1987	1988	1989	1990	1991
Sites checked	25	30	36	27	28	31	29	38
(% of known sites)	(69)	(83)	(100)	(75)	(78)	(86)	(81)	(100)
Sites occupied	7	14	9	8	5	4	6	5
(%) of sites checked	(28)	(47)	(25)	(30)	(18)	(14)	(21)	(13)
Sites occupied by single birds	2	7	5	5	1	2	4	5
Sites occupied by pairs	5	7	4	3	4	2	2	0
Nesting pairs	3	2	3	3	2	1	1	0
Successful pairs	2	2	2	1	2	1	1	0
Young fledged	4	6	6	3	4	1	3	0
Young fledged per nest	1.3	3.0	2.0	1.0	2.0	1.0	3.0	0
Young fledged per successful nest	2	3	3	3	2	1	3	0
Productivity (young fledged per pair)	0.8	0.9	1.5	1.0	1.0	0.5	1.5	0

Data from P.M. Ellis, J.D. Okill and FIBOT.

young were at least 10 days old so there are only three records of clutch size between 1984 and 1991. Brood size at fledging varied from 1-3 with a mean of 2.5 from a total of 11 fledged broods. The maximum number of young fledged in Shetland in any year since 1984 was six in 1986 and in 1987, and a total of only 27 young were known to have fledged between 1984-1991, averaging only 3.25 young fledging in the islands each year. Since 1984, productivity has varied from 0-1.5 young fledged per pair with a mean over the eight years of 0.9. Of the four nests known to have failed since 1984, one clutch was addled, one clutch being incubated by a female heavily contaminated with Fulmar *Fulmarus glacialis* oil disappeared (what was presumed to be the same female was later found not far from the nest site unable to fly), one nest failed with small chicks and another at the egg stage, both for unknown reasons. Despite the incompleteness of the data, it is clear that since 1969 few Peregrines have nested in Shetland and very few young have been reared.

Organochlorine, PCB and mercury contamination

Between 1981 and 1991, unhatched eggs from three clutches were analysed at the Institute of Terrestrial Ecology's Experimental Station at Monks Wood (Table 6). The egg with the thinnest shell, collected in 1986, had been incubated for considerably longer than the normal incubation period, and so may have lost more calcium carbonate than eggs which had not been incubated for so long (Ratcliffe 1980). The sample was small, but the levels of DDE (the main metabolic breakdown product of DDT) and HEOD (the main metabolic breakdown product of aldrin and dieldrin) are unremarkable for British Peregrines (Newton, Bogan & Haas 1989). In contrast, the level of PCB in a 1988 egg of 1218.18 ppm in lipid (64.33 ppm wet wt.) and the level of mercury in a 1986 egg of 4.62 ppm dry wt. are high.

Prey taken during the breeding season

Saxby (1874) mentions that the Kittiwake *Rissa tridactyla* was a favourite prey on

TABLE 6. Eggshell indices, organochlorine and mercury levels in unhatched (addled) Peregrine eggs, Shetland 1981-88.

	Nest successful = s failed = f	Eggshell index	% shell thinning	HEOD	DDE	PCB	Mercury
1981	f	1.65	9	—	47 (2.9)	280 (17.0)	—
	f	1.52	16	—	—	—	—
1986	f	1.44	21	5.38 (0.28)	67.74 (3.48)	238.44 (12.24)	4.62
1988	s	1.48	19	—	—	1218.18 (64.33)	2.45

HEOD, DDE and PCB units are parts per million (ppm) in lipid (fats), with ppm wet weight values in brackets below. Mercury units are ppm dry weight.

% shell thinning is calculated using pre DDT mean shell index of 1.82. — indicates not analysed.

Eggshell index is calculated by dividing the dry weight of a blown eggshell by its volume.

Unst and in addition mentions 13 species of wild birds, domestic chicken *Gallus gallus* and rabbit *Oryctolagus cuniculus* as prey species taken during the breeding season. In 1962, one pair appeared to be living almost entirely on Fulmars (Ratcliffe 1963).

Table 7 gives details of the 141 prey items recorded in Shetland during 1984-1991. By both number and weight, about half the prey were seabirds, mainly terns and Puffins *Fratercula arctica*. Waders (mostly Redshanks *Tringa totanus* were also

TABLE 7. Prey recorded as taken by Peregrines during the breeding season in Shetland 1984-1991.

Species	Total	% by number	% by weight
Storm Petrel <i>Hydrobates pelagicus</i>	1	0.7	0.1
Red Grouse <i>Lagopus lagopus</i>	1	0.7	2.6
Oystercatcher <i>Haematopus ostralegus</i>	4	2.8	8.5
Ringed Plover <i>Charadrius hiaticula</i>	2	1.4	0.7
Golden Plover <i>Pluvialis apricaria</i>	5	3.5	3.9
Lapwing <i>Vanellus vanellus</i>	3	2.1	2.6
Dunlin <i>Calidris alpina</i>	1	0.7	0.2
Snipe <i>Gallinago gallinago</i>	2	1.4	0.9
Curlew <i>Numenius arquata</i>	1	0.7	2.9
Redshank <i>Tringa totanus</i>	7	5.0	4.3
Turnstone <i>Arenaria interpres</i>	3	2.1	1.2
Common Tern <i>Sterna hirundo</i>	3	2.1	1.5
Arctic Tern <i>Sterna paradisaea</i>	35	24.8	17.4
Commic Tern <i>Sterna spp.</i>	8	5.7	4.0
Black Guillemot <i>Cepphus grylle</i>	1	0.7	1.6
Puffin <i>Fratercula arctica</i>	21	14.9	32.1
Rock Dove/Feral Pigeon <i>Columba livia</i>	4	2.8	5.9
Collared Dove <i>Streptopelia decaocto</i>	1	0.7	0.8
Skylark <i>Alauda arvensis</i>	7	5.0	1.1
Meadow Pipit <i>Anthus pratensis</i>	2	1.4	0.2
Rock Pipit <i>Anthus petrosus</i>	4	2.8	0.4
Wheatear <i>Oenanthe oenanthe</i>	1	0.7	0.1
Blackbird <i>Turdus merula</i>	2	1.4	0.7
Starling <i>Sturnus vulgaris</i>	19	13.5	6.0
Chaffinch <i>Fringilla coelebs</i>	1	0.7	0.1
Common Crossbill <i>Loxia curvirostra</i>	1	0.7	0.1
Field Mouse <i>Apodemus sylvaticus</i>	1	0.7	0.1
Total number items	141		

Commic Terns are Arctic or Common Terns which could not be specifically identified.

Bird weights from Ratcliffe (1980).

Field Mouse weight from Berry & Johnston (1980).

taken frequently, as were Starlings *Sturnus vulgaris*.

Contamination by Fulmar oil

Fulmars have a very effective anti-predator defence mechanism. If they are approached by a potential predator, both adults and larger chicks spit oil at the intruder. In 1976, two fledged juvenile Peregrines were found alive but unable to fly properly and covered in Fulmar oil. Another heavily oiled (by Fulmars) juvenile Peregrine was found dead in 1983. In 1987, an adult female was found alive, but unable to fly, not far from a recently failed nest site where the incubating female had been seen to be coated with Fulmar oil. In the same year a contaminated juvenile bird was seen in flight.

Movements

At least some adult Peregrines appear to be resident because some are seen at Shetland breeding sites during the winter (pers. obs.). Although only 29 nestling Peregrines have been ringed in Shetland, a total of six have been recovered. Five were recovered within Shetland, two in their second calendar year in March and April, one in its third calendar year in June, one in its fifth calendar year in October and one in its tenth calendar year in February. One chick was recovered in Orkney 190km from its natal site in its second calendar year in January. No Peregrines ringed outside Shetland have ever been recovered within the islands.

Discussion

Population and breeding success

Ratcliffe (1963) stated that, "the status of the Shetland Peregrine population was not clear, but it may have experienced the same slow decline since 1925 as populations in the Western Highlands of Scotland". The data presented here show that the population has declined further since then, with only five single birds recorded in 1991. The decline of the Shetland Peregrine population may not have been entirely due to contamination

by organochlorines as occurred elsewhere (Ratcliffe 1963). By 1971, the BTO Peregrine Enquiry showed that a marked recovery in numbers had taken place throughout most of Britain (Ratcliffe 1972). The 1981 enquiry found that, although numbers were continuing to increase in many inland areas, Peregrines were not recolonising many coastal districts, particularly in the south-east of England and north and west of Scotland (Ratcliffe 1984), and this has been particularly the case in Shetland, the only Scottish county in which Peregrines did not breed in 1991 (T.D. Dick pers. comm.).

The production of young in Shetland has also been low since at least 1962, and the remnant population is distant from the expanding Peregrine population of the Scottish mainland. There is thus little opportunity for the Shetland population to increase through immigration or local production. Several factors including poor weather, persistent pollutants, poor food supplies and contamination with Fulmar oil might be responsible for poor breeding success. Possible causes include the following:

i) Weather

Peregrine breeding success in southern Scotland was depressed by wet, cold weather during hatching (Mearns & Newton 1988). Meteorological records from Lerwick Observatory suggest that weather conditions during the breeding seasons 1976-1991 (particularly rainfall and temperature in April and May) were unexceptional and are unlikely to have directly reduced breeding success in that period.

ii) Organochlorine, PCB and mercury contamination

Only four addled eggs from three clutches have been analysed since 1981, but an effect of chemical residues in depressing breeding success cannot be ruled out, and the chemical analysis of further eggs would be worthwhile. Seabirds and waders, which

together constitute 68% by number and 82% by weight of the breeding season prey found since 1984, are known to carry heavy burdens of PCBs and mercury (Newton *et al.* 1989). The pattern of breeding season data in Shetland with a high proportion of unoccupied territories, unpaired adults, non-breeding pairs and nest failures but with a few pairs rearing young, is similar to that found in populations elsewhere in Britain which were depressed by the effects of organochlorine pesticides during the 1950s and 1960s but which have now recovered (Ratcliffe 1980). It seems likely that Peregrines in Shetland are contaminated with these chemicals via their breeding season prey.

iii) Poor food supply

Although breeding season prey populations, particularly seabirds, have fluctuated in Shetland since 1969 (Lloyd *et al.* 1991), there is no evidence that prey availability during the breeding season is limiting breeding success or adult survival. At least some adult Peregrines are probably at their Shetland breeding sites during the winter but their prey (and its availability) outside the breeding season remains unknown.

iv) Contamination by Fulmar oil

Mearns (1983) showed that of four oiled Peregrines caught at the nest in south-west Scotland, none was retrapped in subsequent years. In his study, one third of trapped females were oiled in an area with relatively few Fulmars compared with Shetland. Fulmars first nested in Shetland in 1878, and their numbers increased rapidly to c.236,000 pairs by 1985-87 (41% of the British and Irish population) (Lloyd *et al.* 1991). All the traditional Peregrine nest sites in Shetland hold large numbers of breeding Fulmars and at times Fulmars try to nest on ledges used by Peregrines (pers. obs.). Contamination by Fulmar oil has claimed a small number of Peregrines in Shetland, but with such a small Peregrine population this could be critical.

Reasons for the low population level of the Peregrine in Shetland

The Shetland Peregrine population may have been declining since 1925, but was probably further reduced as a result of organochlorine contamination after 1955, when Peregrine numbers plummeted in most parts of Britain (Ratcliffe 1963). Peregrines in Shetland, as in many coastal areas, have not recovered to the same degree as those at inland localities (Ratcliffe 1980). The few added eggs from Shetland which have been analysed are contaminated with levels of PCBs and mercury that could be sufficient to depress breeding success. In addition, a small number of Peregrines have been found debilitated by Fulmar oil contamination. This could reduce the survival of both fledged juveniles and adults and in an extremely small population this could be critical.

A comparison with the situation in Orkney

All Orkney data are from E.R. Meek (pers. comm.). The Orkney Islands hold approximately 35 known sites, a similar number to Shetland. The Peregrine population in these islands has also had poor breeding success since at least the 1960s. However, the population in 1991 was larger than in Shetland with 25 occupied sites, 16 occupied by pairs of which 6-11 nested. However, in 1991 breeding success was poor with only 3-9 pairs rearing young.

Of a total of 327 prey items examined in Orkney in the breeding season between 1981 and 1992, seabirds and waders made up 40% by number and 53% by weight, as opposed to 68% by number and 82% by weight in Shetland. However, Rock Doves *Columba livia* and Feral Pigeons were considerably more important in Orkney (20% by number and 26% by weight), compared to only 3% by number and 6% by weight in Shetland in this study. Waders and seabirds are more heavily contaminated

with organochlorines and heavy metals than are Rock Doves and Feral Pigeons (Newton *et al.* 1989). A higher proportion of seabirds and waders in the diet of Shetland Peregrines could be one of the main reasons why the Shetland Peregrine population has declined more than that of Orkney. But there are no data on prey taken in Orkney outside the breeding season.

In addition, the Orkney Peregrine population may have experienced a higher degree of immigration than is the case in Shetland. Some evidence for this comes from three recoveries of Peregrines on Mainland Orkney where the birds were ringed as nestlings elsewhere in Scotland.

A further contributory factor could be that Orkney has less than half the number of Fulmars found in Shetland (82,000 pairs in 1985-87) (Lloyd *et al.* 1991), and as the Peregrine population there has never reached such a low level as in Shetland it may be less affected if a few Peregrines become oiled.

Conclusion

Probably more than one factor is involved in preventing the recovery of the Shetland Peregrine population. More information is needed before the most important factors can be determined. There are indications that chemical contamination caused the main decline and may be the most important factor preventing the population from recovering in numbers.

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Spring Passage of Pomarine Skuas off Shetland in May 1992

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Between 8-17 May 1992 an unprecedented passage of 2709 Pomarine Skuas were recorded off the west coast of mainland Shetland, 2093 of which passed Watsness on 9 May alone, representing the highest known count of this species past one location in Western Europe. The passage and associated weather, their behaviour, suggested theory of arrival and their displaced movement along the west coast of mainland Shetland are discussed.

Introduction

During May 1992, an unprecedented northerly passage of Pomarine Skuas *Stercorarius pomarinus* was recorded from the west coast of mainland Shetland. Observations from Watsness and Eshaness between 7-17 May recorded a total of at least 2709 birds, including 2563 off Watsness on 8 and 9 May. Watsness was manned on five days (see Table 1) and Eshaness on three days during the above period when weather conditions were thought suitable for observing passage.

Spring occurrence in Britain and Ireland

Passage of Pomarine Skuas in spring generally occurs from late April until early June, usually peaking during the first three weeks of May (Davenport 1992). Skua passage is perhaps best known to occur off the Western Isles (e.g. Davenport 1979, 1984, 1987, 1991), but annual movements off the western and southern coasts of Britain and Ireland, most notably off Slyne Head (County Galway), Carnsore Point (County Wexford) and smaller numbers in the English Channel at Beachy Head (East Sussex) and Dungeness (Kent) (Davenport 1981). Since the mid-1980s, irregular spring seawatching off Watsness and Eshaness

have recorded small numbers, the most notable year being 1991, when 105 birds were recorded between 14-25 May (*Shetland Bird Report* 1991).

May 1992 records off Shetland

Pomarine Skuas were recorded on all days that Watsness was visited and the results are outlined in Table 1. Observations from Eshaness and other localities are discussed later (see below).

Passage and associated weather

On 7 May, weak frontal systems moving south-eastwards across the British Isles, introduced north-westerly force 6-7 winds with intermittent rain showers to Shetland (see Fig. 1). These conditions prompted a two hour seawatch off Eshaness, during which two Long-tailed Skuas *S. longicaudus* were seen. On 8 May, the trough of low pressure was still tracking south-eastwards over the British Isles continuing the north-westerly airflow over Shetland, with the wind decreasing to force 3-4, gusting five during more frequent showers (see Fig. 2). Another two-hour seawatch off Eshaness between 1100-1300 hrs BST recorded just

TABLE 1. Pomarine Skua passage off Watsness, 8-17 May 1992.

Date	Time (BST)	Wind	Total	Range (flock size)	Mean (flock size)	Birds/hour
08/5	1030-1430 & 1900-2100	NW3-4	470	1-123	24.7 (n = 19)	78.3
09/5	0600-2100	NNW5-7	2093	1-300	37.4 (n = 56)	161.0
10/5	0800-1230	NW4-5	58	1-20	7.3 (n = 8)	12.9
16/5	0900-1200	W4	86	—	not recorded	28.7
17/5	0815-1100	WSW3	2	—	—	0.73

n = number of flocks.

two Arctic Skuas *S. parasiticus*, whilst a total of six hours seawatching off Watsness produced a single flock of 44 Long-tailed Skuas and 470 Pomarines, 359 between 1030-1230 hrs. On 9 May, a deepening low pressure system reached south-west Ireland and had moved across central Britain by early evening; the northern flank of the low gave Shetland a north-north-westerly airstream of force 4-5, gusting 6-7 during the frequent showers of rain, snow and hail (see Fig. 3). A multi-observer seawatch off Watsness from 0600-1700 and 1800-2100 hrs recorded a total of 2093 Pomarine and three Long-tailed Skuas. Passage started at 0645 hrs and continued throughout the day, with the majority of flocks seen soon after showers. There were two pronounced waves of passage: between 0900-1100 hrs and 1445-1700 hrs, with totals of 472 and 1350 Pomarines respectively. Both waves coincided with periods of frequent showers, which presumably drove the birds close inshore. On the same day, 147 Pomarines were recorded off Eshaness between 1015-1145 hrs, exactly the same number recorded off Watsness between the same times suggesting that some flocks were coasting north. Although weather conditions in Shetland were similar on 10 May (see Fig. 4), only 58 birds were recorded off Watsness between 0800-1230 hrs. Off Watsness on 16 May, a west-north-

west wind force four produced 86 Pomarines between 0900-1200 hrs with two recorded there the following day between 0815-1100 hrs, the wind having backed to the west-south-west and decreased to force three.

Other west coast localities in Shetland, namely Fair Isle, Garth's Ness, Fora Ness and Belmont were watched to a lesser extent on 9 and 10-May, but failed to produce any Pomarine or Long-tailed Skuas.

Behaviour

The majority of flocks of Pomarine Skuas observed flew low over the sea, and comprised a nucleus of approximately two-thirds bunched at the front, with the remainder following in single file. In advance of approaching showers all but one flock ceased moving and rested on the sea until conditions improved, the exception being a flock of 72 which, on sighting a shower, rose up from sea level and proceeded to climb at a 70° angle until they flew over the shower. Once the showers had passed over the flock, a nucleus of birds would start to climb high and circle until the stragglers or another smaller flock following behind had caught up with them, after which the flock descended to sea level again and continued in a northerly direction. This behaviour was noted also in fine weather

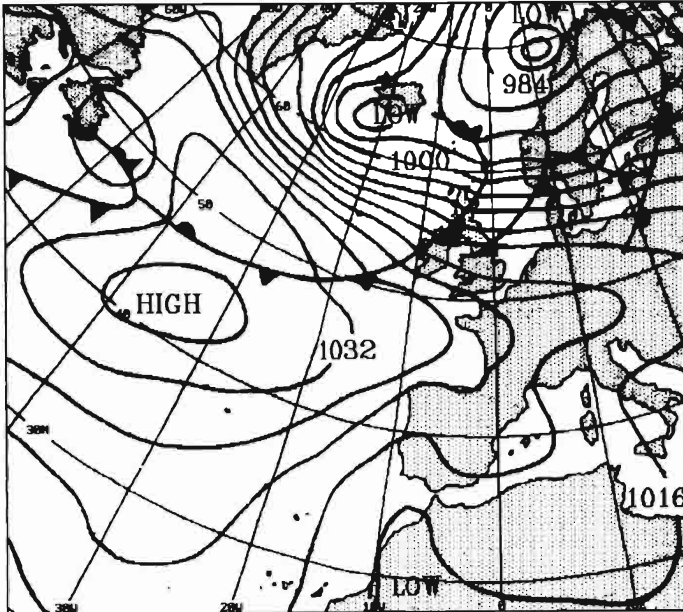


FIGURE 1. 1200 GMT 7 May 1992

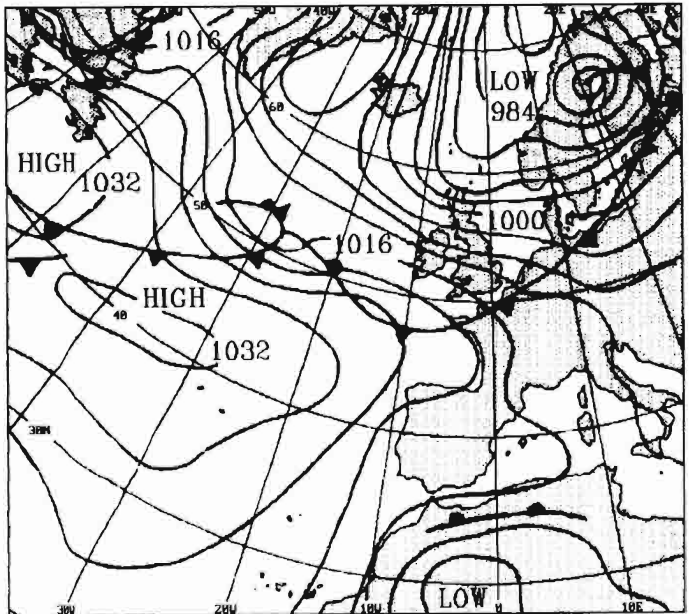


FIGURE 2. 1200 GMT 8 May 1992

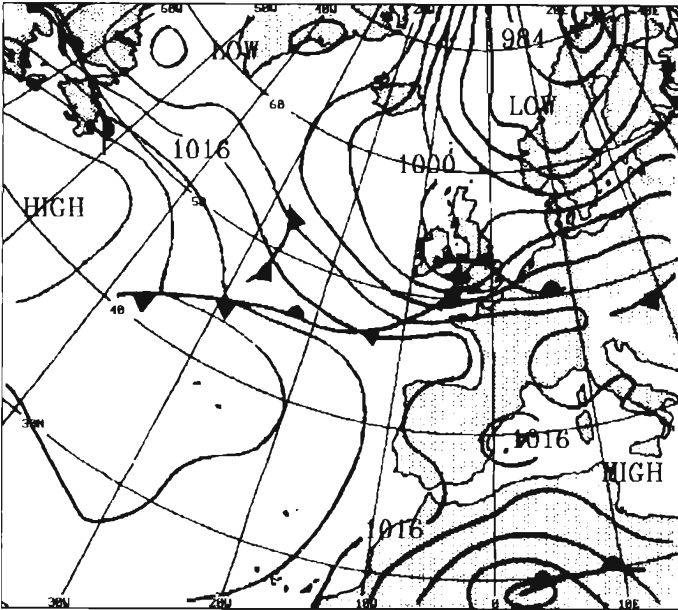


FIGURE 3. 1200 GMT 9 May 1992

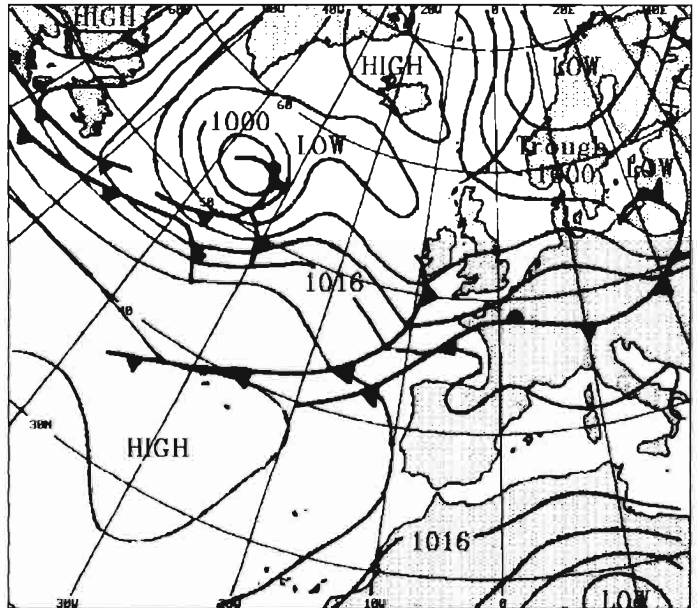


FIGURE 4. 1200 GMT 10 May 1992

with occasional 'coasting' flocks. A likely explanation for this behaviour is that the nucleus of the flock were sighting their continuing route past Watsness.

Discussion

Passage off Shetland seems to occur after several days of strong to gale force west to north-westerly winds, therefore displacing those birds which are thought to follow the continental shelf on northward spring migration (Furness 1987). This assumption is reinforced by the fact that skua passage off the west coast of mainland Shetland has been recorded only after the conditions outlined above. These certainly applied in May 1992, with strong to gale force west to north-westerly winds over the Northern Isles from 4-7 May resulting in large scale northerly movements on 8 and 9 May. However, it must be stressed that those conditions found suitable for observing skua passage off the Western Isles (Davenport 1992) have not, to date, been sufficiently investigated off the west coast of Shetland.

Although no accurate recording of colour phase or age was undertaken during periods of seawatching, a conservative estimation of dark phase birds and sub-adult birds on 9 May, resulted in figures of 5-8% and 15-20% respectively.

Observations at other sites in 1992

Pomarine Skuas were generally noted earlier than usual in spring 1992. In April, birds were recorded from several western localities from 18 April onwards, peak counts being 290 off Bowness-on-Solway (Cumbria) between 19-30 April and 22 off Carnsore Point (County Wexford) on 25 April (Anon. 1992a). In May, records from the Western Isles, predominantly off Balranald and Ardivachar Point included 1289 Pomarines and 835 Long-taileds between 1-16 May. Unfortunately, there was no coverage at Balranald on 7-8 May (to correspond with the coverage at Watsness on 8-9 May) and

by 9 May the weather there was unsuitable for skua passage, with light variable winds (D. Davenport pers. comms.). Off Bowness-on-Solway, another 303 Pomarines were recorded between 1-15 May. Many other records came from the west, but good numbers were also recorded from English Channel and North Sea coasts (Anon. 1992b; D. Davenport in litt.).

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Short Notes

Kestrels feeding on road casualties

Recently we saw Kestrels *Falco tinnunculus* feeding on rabbit road casualties on a relatively quiet moorland road in west Galloway. On 16 December 1991, 7 February 1992, 2 April 1992 and 11 February 1993 we saw a male Kestrel feed on rabbit carrion (twice in the early morning and twice in the late evening) and on 22 October 1992, we disturbed in our car a female or juvenile Kestrel feeding on the old remains of a rabbit carcass at dusk. All five records occurred in the same area within a 400-600m stretch of road. On 15 February 1993, we saw a male Kestrel feed on the remains of a cock Pheasant *Phasianus colchicus* on another road nearby.

Such behaviour may be unusual because Village (1990. *The Kestrel*. London) states that Kestrels are predominantly

predators of small mammals. Carrion is probably not commonly eaten, but Cramp & Simmons (1980. *The Birds of the Western Palearctic*. Oxford. Vol.2.) state that Kestrels may scavenge at carrion. Village's only record of a Kestrel eating a road casualty was of a common toad in Eskdalemuir while BWP gave no records. Similarly Hope-Jones (1980. Bird scavengers on Orkney roads. *Brit. Birds* 73:561-568) makes no mention of Kestrels feeding on road casualties but Hodson (1966. Some notes on the habits of roadside carrion feeders. *Bird Study* 13:272-273) surmised that Kestrels were responsible for eating dead birds that he had placed along a stretch of road but gave no direct observation of this behaviour.

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Hunting times by Merlins in winter

Casual or anecdotal observations of Merlins *Falco columbarius* in their wintering habitats suggest that they are either active or inactive during much of a short winter day. There are, however, few published records of how Merlins spend their day and, in particular, on the times they hunt. Because little attention has been paid to this, I timed and noted every individual hunting foray, whether successful or not, by 'brown' and 'blue' Merlins from November to February 1966-92 in west Galloway (Fig. 1).

There was a late morning peak of activity at 1030-1200 hrs both by brown and blue Merlins and a similar peak in the afternoon at 1430-1600 hrs by brown and blue Merlins respectively with a lull in activity at midday.

Hunting forays were also plotted between August and March (longer

daylight) and a similar pattern emerged (Fig. 2), with a further minor secondary peak of activity by brown birds around 1830 hrs.

Peak activities in the mornings occurred some 2-3 hours after the Merlins had left their roosts. Unexpectedly, there was no indication that Merlins tried quickly to replenish energy stores lost overnight. A need to replenish energy stores to last them during a long winter night is, however, suggested by the greater pattern of activity during the late afternoon. Some Merlins hunted until it was nearly dark but no hunts at their roosts are included.

These findings broadly agree with Warkentin & Oliphant (1990. Habitat use and foraging behaviour of urban Merlin in winter. *J. Zool. Lond.* 221:539-563) who found that nine radio-tagged Merlins in urban Saskatoon, Canada, were relatively

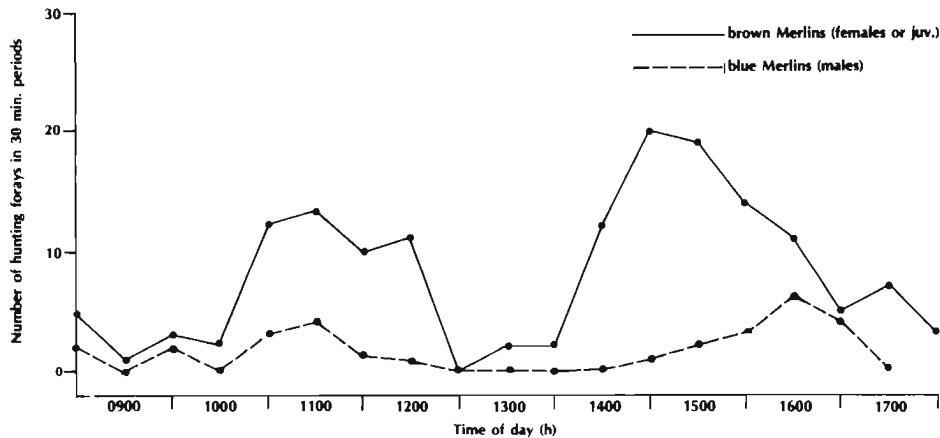


FIGURE 1. Hunting times of Merlins in west Galloway, November – February 1967-92.

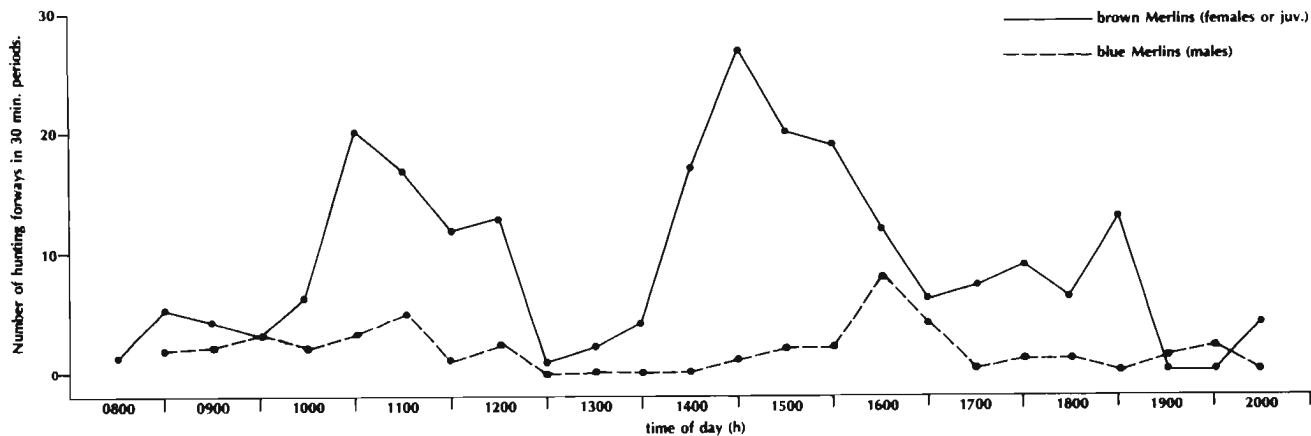


FIGURE 2. Hunting times of Merlins in west Galloway, August – March 1966-92.

inactive for large parts of the day with activity in the early morning, a midday lull and a second activity peak in late afternoon. Newton (1986. *The Sparrowhawk*. Calton) gave a similar pattern of hunting times in

radio-tagged Sparrowhawks *Acciper misus*. First-winter birds, however, were more active than adults and had an afternoon peak in activity which was absent in adults.

R.C. Dickson, Lismore, New Luce, Newton Stewart DG8 0AJ.

Hunting associations between Merlins and Hen Harriers in winter

Hunting associations between Merlins *Falco columbarius* and Hen Harriers *Circus cyaneus* have previously been described and documented (*Brit. Birds* 77:72-73, 481-482, 79:430; *Ibis* 102:136; *BWP* Vol.2; Watson 1977. *The Hen Harrier*. Berkhamstead). This could be a common hunting strategy, but in west Galloway, during a study of Merlins' hunting activities between 1965-92, it only occurred in 18 out of 270 hunts (6.6%). In winter in west Galloway, Merlins occur in the same open habitats as Hen Harriers and other birds of prey often hunting the same food supply in the same areas at different times and intensity. When the hunting areas of Merlins and Hen Harriers overlapped, Merlins seemed deliberately to take advantage of hunting harriers (and vice versa) but Merlins were usually already at a hunting place before harriers appeared. When a harrier arrived and hunted the same ground, the Merlin would instantly follow and attack prey flushed by the harrier, flying above, behind or ahead and overtaking the hunting harrier as prey was flushed. Both raptors then exploited the prey in the confusion and alarm caused. As long as the harrier was present, the Merlin would continue to hunt with it, but as soon as the harrier left, the falcon continued hunting on its own or flew away. However, I saw only one successful capture by a Merlin in this way, a Lapwing *Vanellus vanellus*; all the rest were unsuccessful.

Nonetheless the confusion to the prey is probably advantageous to both species of raptor (see Watson 1977; *Brit. Birds* 79:430;

81:269-274) and has an element of commensalism about it, since both raptors chased the same prey. Merlins chased Skylarks *Aluada arvensis* nine times, Meadow Pipits *Anthus pretensis* twice, Linnets *Carduelis cannabina* four times and a Pied Wagtail *Motacilla alba* once, while harriers chased the same Skylarks six times, Meadow Pipits once, Linnets three times and a Pied Wagtail once. Merlins hunted with male Hen Harriers on 11 occasions and with 'ringtails' on seven. Calls by Merlins were heard once on 29 December 1991, when a male harrier twisted after some Skylarks, swooped up and met a female or juvenile Merlin head-on which uttered a call; the Merlin then chased the Skylark. During these hunting associations, interactions between Merlins and harriers only occurred four times: twice when a Merlin swooped on a harrier, once when a harrier displaced a Merlin from a perch, and once when a harrier chased a Merlin.

In addition, Merlins also associated with Sparrowhawks *Accipiter nisus* on three occasions. Again the Merlin was always present before a Sparrowhawk arrived and both chased Chaffinches *Fringilla coelebs* and a Linnet flushed by Sparrowhawks beating low across root crops and stubble. Raines (1972. Hunting association of two birds of prey. *Cheshire Bird Report* 1972:20) has also noted similar behaviour.

As well as hunting with other raptors, Merlins will apparently exploit prey species flushed by others, since it has also been reported that they have chased prey flushed by people (Brennecke 1951. *Zug Jagdweise*

des Merlin-Falken. *Vogelwelt* 72: 82-84; Brown 1974. *Lakeland Birdlife 1920-70*. Carlisle; Dekker 1988. Peregrine Falcon and Merlin predation on small shore birds and passerines in Alberta. *Can.J.Zool.* 66:

925-928); by motor vehicles and Kestrels *Falco tinnunculus* (*Brit. Birds* 79:431) and by a moving train (Kenyon 1942. Hunting strategy of pigeon hawks. *Auk* 59:443-444).

R.C. Dickson, Lismore, New Luce, Newton Stewart DG8 0AJ.

Behaviour of Herring Gulls feeding on turnips

In a study of damage to turnips by brown hares *Lepus europaeus*, Hewson (1977) found that gulls *Larus* spp. fed only on turnips from which the hard peel had been removed first by hares (Food selection by brown hares (*Lepus capensis*) on cereal and turnip crops. *J. appl. Ecol.* 14: 779-785). However, in March 1989 Herring Gulls *Larus argentatus* were feeding on turnips in a 2.7 ha field at Eriboll, north-west Sutherland, where there were no rabbits *Oryctolagus cuniculus* or hares to break into

the turnips. By 12 March, the gulls had damaged 3.6% of the 36,000 turnips by pecking out a hole big enough for water to collect in, causing rotting or frost damage, and destroyed 6.9% leaving only an empty shell. A month later, and before sheep were folded on the remaining 18,000 turnips, (the rest had been removed to feed cattle and sheep), 7.5% had been damaged and 13.7% destroyed by Herring Gulls. While feeding, gulls pecked in a desultory manner at several turnips before they found one which had

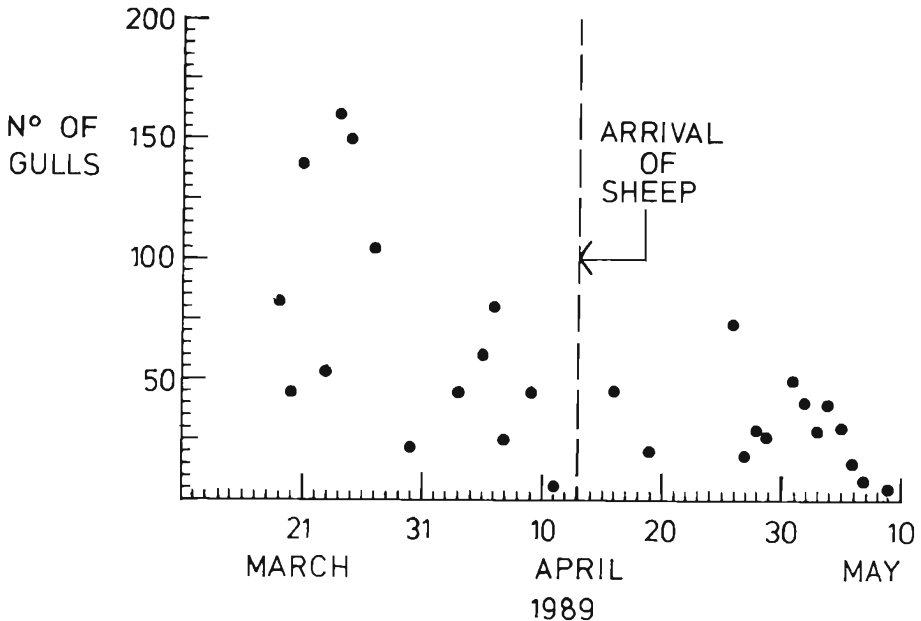


FIGURE 1. The decline in the numbers of Herring Gulls feeding on turnips at Eriboll following the arrival of sheep in April 1989.

been opened up, as if only a proportion of the gulls were adept at breaking into turnips.

Before the sheep arrived, gulls fed in a tight flock over about 10% of the field. They moved away from feeding sheep, which by opening turnips made it easier for the gulls to feed. Gulls then fed over more than 50% of the field in a loose flock, but fewer gulls continued to forage (Fig. 1). Sub-adult Herring Gulls reacted more strongly than adults to the presence of sheep as juvenile Ravens *Corvus corax* do in an unfamiliar situation (Heinrich, B. 1990. *Ravens in winter*. London. Barrie & Jenkins), and the proportion of sub-adults in the flock declined (Fig. 2).

In 1990, red deer *Cervus elaphus* fed widely in the same field from January onwards; consequently many turnips were

made available to Herring Gulls. Sheep arrived on 8 January and there were usually about 80, often foraging all over the field. Gulls started feeding in late January and ranged widely in loose flocks. There was no falling-off in numbers as in 1989; indeed there were more gulls in late April than earlier (Fig. 3).

Herring Gulls did not feed on turnips only when bad weather restricted their normal coastal foraging areas. There was no significant difference in the numbers of gulls in the turnip field in winds up to and including force five on the Beaufort scale and in stronger winds.

By contrast, in March 1989 there were no Herring Gulls feeding in 23 turnip fields in north-east Scotland, 11 of them along the coast, although sheep were folded in five

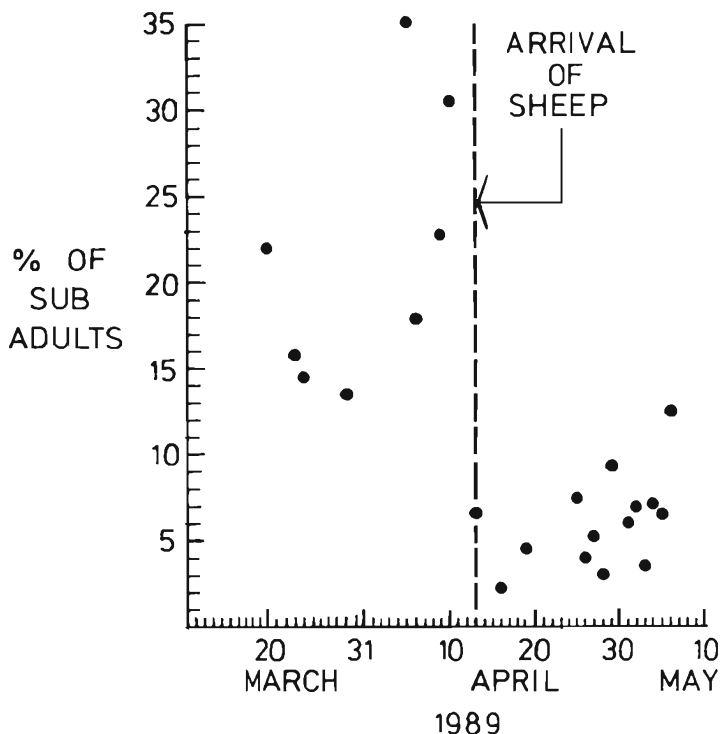


FIGURE 2. The proportion of sub-adult Herring Gulls in the flock following the arrival of sheep.

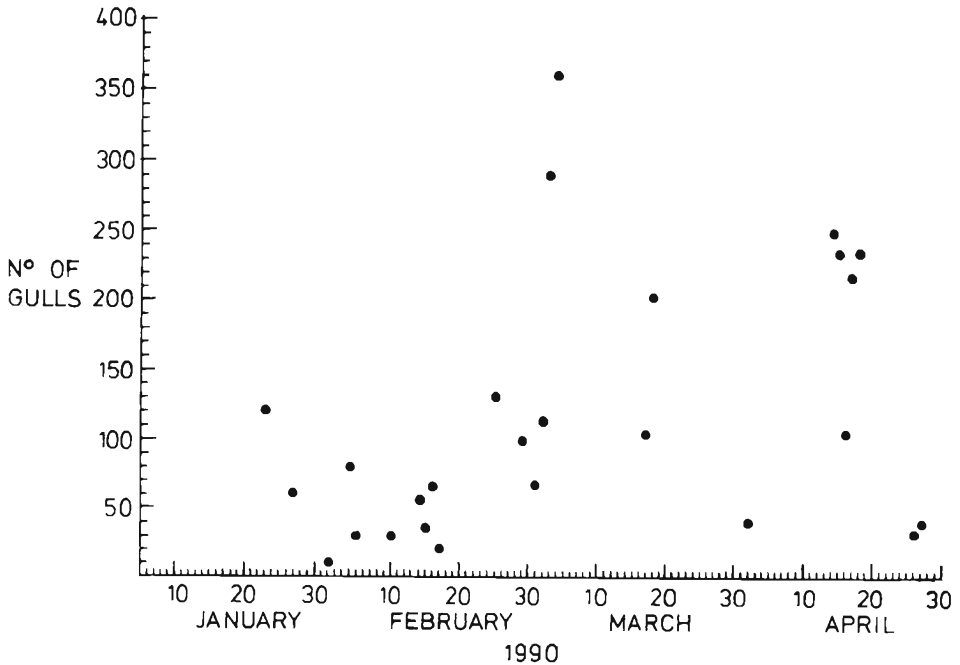


FIGURE 3. Herring Gulls feeding on turnips at Eriboll in 1990, when sheep were present from January though more widely dispersed than in 1989, and Red deer were feeding on turnips in early January, making them more easily available to Herring Gulls.

fields and had been folded earlier in others, and in four fields turnips had been damaged, probably by rabbits.

The extent of the damage at Eriboll was unusually severe when compared with damage to turnips by brown hares, followed by minor damage by birds, in north-east Scotland where 2.8% and 6.0% of turnips on two study areas had suffered minor damage. Of seven varieties involved there,

Doon Major, the variety grown also at Eriboll, was the most widely damaged, perhaps because it is a soft-skinned turnip (MacFarlane Smith, pers. comm.). Proximity to the long shoreline of Loch Eriboll may have accounted for the high concentration of gulls on the study area. The nearest other turnip crops were 21km north-west and 20km east.

*R. Hewson, Department of Zoology, University of Aberdeen,
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Rare Migrants

(It has been decided by the Editorial Committee that full descriptions will appear in *Scottish Birds* only of species which are new, or at most second records, for Scotland.

Ed)

Solitary Sandpiper on Fair Isle: a third Scottish record

After several days of September gales, mostly from a westerly quarter, the atmosphere at the Fair Isle Bird Observatory was somewhat strained, and visitors to the observatory a little desperate. It was therefore with some relief that Sunday 13 September dawned bright and sunny, with only light to moderate south south-west winds. The wind direction was not especially promising, but at least it might now be possible to see what birds there were.

The morning census produced little of real note, although a good fall of Meadow

Pipits *Anthus pratensis* (360) and a thin scattering of common warblers were logged. At 1215 hrs I headed up the drive towards Field Croft in search of a first-winter Grey-headed Wagtail *Motacilla flava thunbergi*, which had been reported earlier. As I rounded the corner of the cow byre, I flushed a small brownish wader. The immediate impression was of a brown Green Sandpiper *Tringa ochropus*, with a dark rump and central tail. It did not call and flew only a few yards before alighting. When the bird was at rest, I was struck by its slim, attenuated and 'leggy' appearance, while the bold white eye-ring was much more striking than the indistinct pale loreal stripe. I knew instantly that it just had to be a Solitary Sandpiper *Tringa solitaria*. Almost immediately the bird flushed again, this time flying to a tiny pool by the main island road. I hastened to the croft to phone the observatory. Jane Wheeler listened to my garbled request for the telephone with a calm no doubt borne of several years' experience of Fair Isle assistant wardens.



Solitary Sandpiper on Fair Isle

There was no response from the observatory but, seeing the minibus heading back for lunch, I ran out to try and flag it down. It did, however, lurch to a stop before I reached it, and warden Paul Harvey and his two small daughters, Holly and Bryony, were already grilling the bird as I galloped up. Paul's face registered a classic mixture of emotions: delight at the discovery of the superb rarity and the realisation that I had found it first.

The sandpiper flew back to the cow byre as other birders were summoned. Here it remained until the evening of 15 September. It was a particularly confiding individual and provided stunning views to

locals and visiting birders during its short stay. A full description may be obtained from the author.

The Solitary Sandpiper breeds over most of Alaska and Canada, wintering in Central America, South America and The West Indies. It is a vagrant to Britain and Ireland, the Fair Isle individual being the 29th documented record. Previous records have all been in the period July-October, with a marked bias to south-west counties of Britain, particularly Scilly. This is the third Scottish record and the first for Shetland. Previous Scottish records are: one shot, Lanark, before 1870; and a juvenile, Maleclete, North Uist, 20 October 1990.

*Roger Riddington, Fair Isle Bird
Observatory, Shetland ZE2 9JU*

Kumlien's Gull in Shetland – the fourth Scottish record

On 15 January 1993, MM was conducting a Beached Bird Survey along the pebble beach at Scatness, Shetland, when he noticed a 'white-winged gull' *Larus glaucooides/hyperboreus* roosting on the fringes of some inland freshwater pools. His initial impression, based on head and wing structure, was that of an Iceland Gull *L. glaucooides*. However, on obtaining closer views, he noticed grey in the outer primaries, characteristic of the subspecies *L. glaucooides kumlieni*, also known as Kumlien's Gull. It soon became apparent that the bird was in an exhausted condition and it was taken into care but, unfortunately, it died soon afterwards. It was thoroughly examined by HRH and MM to eliminate the possibility of it being a Thayer's Gull *L. thayeri*, or a Thayer's x Kumlien's intergrade (which freely interbreed, see e.g. Snell 1989). Reference to Grant (1986) made the eventual identification straightforward by virtue of the almost textbook pattern exhibited by the outer five primaries. A detailed description

was taken and may be found in *Birding World* 6: 105.

Kumlien's Gull breeds on Baffin Island and on the north-west sector of the Ungava Peninsula in north-east Canada. It winters along the Atlantic coasts south to Long Island, USA (Harrison 1987; Lewington *et al.* 1991), and is a vagrant to Europe.

Excluding the Faeroes, where there were at least 38 in January 1983 (Fjeldsa & Jensen 1985), most of the records originate from Britain and Ireland, where a total of 11 individuals have been recorded up to the end of 1991 (Lewington *et al.* 1991; Rogers *et al.* 1992). In addition, and subject to acceptance by British Birds Rarities Committee (BBRC), a further six individuals were recorded in Britain during 1992 (Anon. 1992), including an adult in Highland, bringing the Scottish total to three. These are: Lerwick Harbour, Shetland, adult, 4-8 February 1983 (*Shetland Bird Report* 1983); Banff Bay, Grampian, adult, first seen on 17 March



Kumlien's Gull in Shetland

1985, returning sporadically during winter months until at least February 1992 (Anon. 1992, A Murray pers. comm.); Inverness, Highland, adult 1 January 1992 (Anon. 1992, A Murray pers. comm.).

The Scatness individual, probably a fourth winter bird due to the tail band and primary covert pattern will, upon acceptance by BBRC, constitute the fourth record for Scotland. The skin is now held at the Royal Museum of Scotland.

Acknowledgements

We are grateful to Kevin Osborn for commenting on and improving the manuscript and Angus Murray for providing information on previous Scottish records.

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*Hugh R. Harrop, Fairview, Scatness,
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Mick Mellor, Fairview, Quendale,
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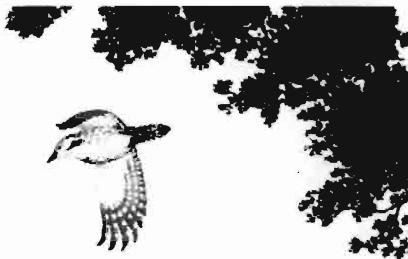
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Obituary

Dr William Serle O.B.E. (1912-1992)

William Serle died in Edinburgh on 7 October 1992 following a short period of declining health. He was born in Duddingston Manse, Edinburgh on 29 July 1912 and attended George Watson's Boys' College before studying for a degree in medicine at Edinburgh University.

His enthusiasm for ornithology was fired largely by his father's own activity in the subject. The Reverend William Serle collated extensive field notes and built up a comprehensive (worldwide) collection of birds' eggs. As a boy, William Serle accompanied his father on many excursions from which he produced his own meticulous notes. He travelled widely throughout the Lothian and Border counties by bicycle and made longer journeys to the north and to Orkney. The first of a long series of ornithological publications was a note on Mergansers *Mergus serrator* in *Scottish Naturalist*, written while he was still in his teens.

With ready access to current bird literature in his father's library, William Serle recognised the potential for increased ornithological research in West Africa. Following his graduation in 1936, the year in which he was elected to the British Ornithologists' Union, he joined the Colonial Medical Service and he sailed for Lagos in 1937.

For the next 20 years William Serle made extensive and valuable collections in Nigeria, Sierra Leone, British Cameroon (as then known) and parts of East Africa. This research yielded some 60 publications from his pen covering aspects of status, distribution, breeding and taxonomy. A number of these papers were classics of their period and it must be remembered that his ornithological work was accomplished very

much as a sideline to his professional duties as a doctor. Not unexpectedly, in view of his medical background, William Serle maintained detailed and comprehensive field notes which bore the stamp of a methodical mind; his publications fully reflect this clarity of thought and expression. Despite the fashion of these years for 'splitting', William Serle pushed a conservative line in taxonomic problems, in many cases suggesting that their resolution should be dependent on the availability of a larger series of specimens. Nevertheless, he is credited with the descriptions of 18 new avian taxa, including the Kupe Mountain Bush-Strike *Malaconotus kupeensis*, a bird with a very restricted range and always considered rare.

During the war he was called up to serve with the West African Field Ambulance Corps and he saw active service in India and Burma. He was awarded the O.B.E. in 1946 for his outstanding army service.

He married in 1956, and after a further short period in Africa, he felt called to train for the ministry in Scotland. In 1959, he was ordained and inducted to Drumoak in Kincardineshire where he remained until his retirement in 1987. Following his return to Scotland, he continued research and publication on personal material, much of which had been presented to the British Museum (Nat. Hist.). In 1977, he co-authored Collins' *A Field Guide to the Birds of West Africa* – a work familiar to many. A lower profile, yet significant, role was his position as a referee for the *Birds of Africa* series for which his knowledge and expertise proved invaluable.

In 1987, Dr Serle donated his scientific collection of West African birds' eggs to the

National Museums of Scotland, where it joined material previously donated by him as early as 1932. The bulk of his skin collections are in the Natural History Museum at Tring, though he also sent material to major natural history museums in Africa, Europe and North America. The NMS has c.500 of these skins.

Following his death, field notes and other early notebooks joined his zoological material in collections of the NMS. His collections and published works are a lasting reminder to a very full and varied life. William Serle is survived by his wife Sheila, five daughters and a son. To them all we express our deepest sympathy.

*R. Y. McGowan, Department of Natural History, Royal Museum of Scotland,
Chambers, Street, Edinburgh EH1 1JF.*

Correspondence

(The Editor welcomes correspondence on suitable topics in *Scottish Birds*. It is essential, however, that all letters are

addressed to the Editor and that personal or libellous comments should be avoided.

Eds)

Letters

Further aberrant plumage in Peregrine

I read with considerable interest G. Bates's article in *Scott. Birds* 16: 219 concerning aberrant plumage in a pair of Peregrines *Falco peregrinus* in north Scotland. Just a few days earlier I had come across a Peregrine with aberrant plumage, albeit of an entirely different nature. On 15 June 1992 I visited a location in Central Region where a fortnight earlier two birdwatchers had reported a pair of Peregrines. There had been no breeding records from this site before but it was certainly a very promising location. After searching around, I found a nest and received a shock when I saw the sitting female. She was facing me and, at a distance of no more than 70m, the bird showed a bright salmon-pink breast. The rest of the bird was more normal, with a very black head and moustachial streak, a blue-grey back, a greyish bill with yellow at the base, a dark iris and a yellow eye-ring. After a while the bird took off and flew close overhead. The underparts were heavily barred but I could clearly see that the salmon-pink colour extended to all areas of the underparts that are usually white or off-white. The tail was noticeably very short and was tipped with the same salmon-pink colour. The bird's alarm call and general flight pattern were that of a typical Peregrine. However, when I looked at the nest site, I received another surprise. It contained two tiny chicks, no more than a couple of days old, but instead of having the usual white coloured down, both young were bright salmon-pink all over.

Two days later I visited the site again, this time in the company of Roger Broad. The female Peregrine was present again, but sadly one of the two chicks was now dead, lying with its feet in the air in the nest scrape. On my third and final visit on 11 July the scrape was empty and there was no sign of any birds. On none of these occasions did I see the male Peregrine, but according to Patrick Stirling-Aird, who visited the site once, this was a normal plumaged bird. All site visits were carried out under licence from the Scottish Natural Heritage as part of a national monitoring exercise.

On looking through the literature, there is very little reference to salmon-pink colouring in the nominate race *peregrinus*. Derek Ratcliffe in his book *The Peregrine Falcon* wrote that "the underparts are white or cream, though the actual shade is variable, the chest usually tending to a warm buff or even salmon-pink or pale rufous tint, especially in the female, whereas the males are whiter". However, there is considerable geographical variation in the Peregrine population and *BWP* gives two races that show traces of pink – *F.p. brookei* (Mediterranean basin to Caucasus) is described as "more rufous below", while *F.p. madens* (Cape Verde Islands) has "underparts suffused with dull pink-buff". Both these races seem unlikely to occur in Scotland by their own efforts as neither is known for its migratory movements. In plumage characters, *madens* approaches the

Barbary Falcon *P. peregrinoides* (which the Scottish bird clearly was not), and *brookei* that I have seen in Algeria were very different from this Scottish individual. The possibility of an escape from captivity cannot be entirely ruled out, although this bird did not have any jesses. *Brookei* and *brookei* x *peregrinus* and other crosses are

kept in some numbers in this country. Nevertheless, perhaps this is another case of aberrant plumage in Scottish Peregrines. Like the author of the previous article, I would be very interested to see the results of successful breeding if the bird returns to the site next year.

Mike Trubridge, Garrison Cottage, Inversnaid, Stirling FK8 3TU.

Fulmar oiling of Peregrines

I noted with interest W.R.P. Bourne's letter (*Scott. Birds* 16: 290) suggesting that the aberrant plumage of a pair of Peregrines *Falco peregrinus* in Sutherland (*Scott. Birds* 16: 219) was due to oiling by Fulmars *Fulmarus glacialis*.

I agree with him that Fulmar oiling is a problem for Peregrines and this is definitely the case in Orkney, where there is also competition with Fulmars for nesting ledges. Typically, oiled plumage is stained dark brown and appears to be wet or shiny as though the bird had just been bathing. There is often impairment of flight, the bird only moving a short distance before alighting again.

The incidence of Fulmar oiling of birds appears to have increased in Orkney in recent years (Booth, C.J. & Reynolds, P. 1987. Fulmar oil contamination of birds in Orkney. *Orkney Bird Report* 1986: 70-75). Ravens *Corvus corax*, particularly newly

fledged juveniles, and Peregrines were found to be most often affected, but altogether 16 species were recorded with Fulmar oil contamination. From 1971 to the end of 1992, there have been 21 cases of Fulmar oiled Peregrines, 11 of which were either found dead or dying and three others were taken into care for cleaning and then released.

Chemical pollutants also continue to pose a threat to Orkney Peregrines and at two sites that I monitored in 1992 both clutches failed to hatch, the females continuing to sit for longer than the normal incubation period. It would seem that, with only a small number of pairs in Orkney successfully rearing young and with the combination of pollutants and Fulmar oiling, the Peregrine population in the county will have difficulty in making a recovery similar to that seen in other parts of Britain.

C.J. Booth, Ronas, 34 High Street, Kirkwall, Orkney.

Attacks by Great Skuas on an Eider and a Mute Swan

Further to Martin Heubeck's note on Great Skuas *Stercorarius skua* attacking a flock of moulting Eiders *Somateria mollissima* (*Scott. Birds* 16: 284) I would like to add two interesting sightings here on Stronsay in 1992 concerning Great Skuas.

i. At approximately 1100 hrs on 6 May, Tony Hulls and I were watching a small flock of adult Eiders (two drakes, four ducks) swimming 50 yards off-shore at Bomasty Bay. The birds suddenly became agitated and we noticed a Great Skua wheel

round above the Eiders and suddenly dive down at the flock. The Eiders dived, but the Skua seemed to have singled out one individual and after a chase of some 20 minutes, during which time the Eider dived several times, the Skua eventually killed and ate the bird. The rest of the flock had come out of the water and watched the episode from the rocky shore. The singled out Eider escaped from the Skua several times but each time the Skua followed it, as it was swimming underwater, by a series of flapping 'lunges'. The Eider had been held by the wing and nape and finally again by the nape and seemed to be dead after about 20 minutes.

ii. At approximately 1500 hrs on 17 September, I noticed a Great Skua flying low over a pair of Mute Swans *Cygnus olor* with two almost full-grown cygnets, which were swimming in the sea at Whitehall Stronsay. The Skua suddenly wheeled round and attempted to grab one of the cygnets by the nape. The parents lunged at the Skua and it was driven off a few yards, where it landed on the sea. The Skua made several further attempts to grab the same cygnet, both from the water and from the air, but each time the parent Swans drove it off. After ten minutes, the Skua gave up and flew off.

John Holloway, 'Castle', Stronsay, Orkney.

The Fair Isle Baillon's Crake and other corpses

Unlike a number of other recent Shetland rarities, now in museums, the Fair Isle Baillon's Crake referred to by McGowan & Kitchener (*Scott. Birds* 16: 289) is in a glass case in my home in Shetland (address below). Anyone who wishes to see it is welcome to call. Suitable provision for posterity has been made in my will, but until that comes into effect I intend to keep the specimen!

Incidentally, a number of other corpses of birds found dead in Shetland in recent years have been sent to museums in Britain, including the following to the Royal Museum of Scotland: Two-barred Crossbill (2), Radde's Warbler, Icterine Warbler, Honey Buzzard, Kumlien's Gull, Spoonbill, Barn Swallow and American Redstart, the latter two being mummified corpses found onboard oil tankers arriving at Sullom Voe from the Americans.

*Dave Suddaby, 92 Sandveien, Lerwick,
Shetland ZE1 0RU.*



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Items of Scottish Interest

Most of the following papers and reports on birds in Scotland are available in the Waterston Library at 21 Regent Terrace for reference, and include all that have come to notice in the period September 1992 to February 1993. The librarian would be glad to learn of anything that has been missed, and to receive reprints or copies of papers on any aspect of ornithology or natural history.

Bird reports marked with an asterisk are available from the SOC at the prices quoted, but please add 50p per order for postage and packing.

Scientific papers

- Belaousoff, S. 1993. Northern Gannet and Common Guillemot nesting on Rockall. *Brit. Birds* 86: 16.
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Bird Reports

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- Fife Bird Report for 1991*. D.D. Dickson (ed) 1992. 74 pp. Includes a 46 pp systematic list, short papers on recent decisions on more birds in Fife, Weather, The Fife Bird Atlas, Coastal Birdwatching and four rarities reports. * £3.30.
- Forth Area Bird Report for 1991*. C.J. Henty (ed) 1992. Pp 27-53 of *Forth Naturalist and Historian* vol. 15.
- Grampian Ringing Group Report no. 7 for 1989-91*. M. Marquiss (ed) 1992. 86 pp. Includes a 45-page ringing record, and short reports on Teal, Oystercatchers, Dunlins, Meadow Pipits, Robins and Crossbills.

- Highland Region (South) Bird Report for 1989 and 1990*. J. Carruthers, R. Dennis, D. Galloway & A. McNee (eds) 1992. 40 pp.
- Isle of May Bird Observatory Report for 1991*. Ian Darling (ed) 1992. 48 pp. * £3.25.
- Lothian Bird Report for 1991*. P. Speak (ed) 1992. 125 pp. Includes a 71 pp systematic list, and 40 pp of censuses of Mute Swans, Geese and Herons. Also short articles on Oystercatchers, Blue Tits, Long-tailed Skua passage, and four rarity reports. * £4.25.
- North Sea Bird Club Report for 1991*. P. Doyle (ed) 1992. 75 pp. Includes a 35 pp systematic list, and a short article on migratory movements of Starlings through the North Sea.
- North-East Scotland Bird Report for 1991*. A. Webb (ed) 1992. 72 pp. * £4.50. Includes four full-page colour plates, a 50-page systematic list, and papers on Peregrines, Merlins, Shearwaters, and rare birds.
- Orkney Ringing Group Report no. 5 for 1989-90*. C.J. Corse & E.R. Meek (eds) 1992. 54 pp. Includes short papers on Curlew, Purple Sandpipers, Black Guillemots and Swallows, and a 34-page ringing record.
- Perth and Kinross Bird Report for 1991*. W. Mattingley & R. Youngman (eds) 1992. 40 pp. * £2.90.
- Scottish Bird Report for 1990*. R. Murray (ed) 1993. 72 pp. Includes a paper by David Jardine on the Crossbill invasion of 1990/91, and a 60-page species list. * £4.00.
- West Lothian Bird Report for 1991*. West Lothian Bird Club (comp.) 1992. 9 pp. This is their first report and is a commendable effort. It does not pretend to cover the whole of West Lothian, but consists of site descriptions and bird lists for five sites which are watched regularly.

Multi-paper reports

- RSPB Conservation Review no. 6*. C.J. Cadbury (ed) 1992. 96 pp. £7.00 post free from RSPB, The Lodge, Sandy, Bedfordshire SG19 2DL.
- Proc. Seabird Group Conference*. European Seabirds. M.L. Tasker (ed) 1992. Held at Glasgow University, March 1992. (Summaries only) 26 pp.

William G. Harper

European journals in the Waterston Library

The following selection of articles appeared in European journals received in the Waterston Library between September 1992 and March 1993, and thus follows on the list published in Vol 16 No 4. Articles are arranged in species order; square brackets indicate that the article is in the original language, other articles being in English. The reference, abbreviated for reasons of space, indicates merely the journal, its number and year of publication. Journals quoted are as follows:

- Netherlands: *Ardea*, *Limosa*, *Dutch Birding*
 France: *Alauda*, *L'Oiseau*
 Switzerland: *Der Ornithologische Beobachter*
 Belgium: *Aves*, *Mergus*
 Germany: *Seevögel*, *Journal für Ornithologie*, *Ökologie der Vögel*, *Corax*, *Die Vogelwelt*, *Limicola*
 Austria: *Egretta*
 Poland: *Acta Ornithologica*
 Italy: *Avocetta*
 Sweden: *Vår Fågelvärld*, *Ornis Svecica*
 Norway: *Vår Fuglefauna*, *Fauna Norvegica*
 Denmark: *Dansk Ornitologisk Forenings Tidsskrift*
 Finland: *Lintumies*, *Ornis Fennica*
 Iceland: *Náttúrufræðingurinn*

General:

- Flade, M. (ed) *et al.* Special issue on methods of monitoring bird populations – some articles in English, majority in German – *Vogelwelt* 4-5/92.
 Gatter, W. [Timing and pattern of Autumn migration: the influence of the greenhouse effect] – *Jour. für Orn.* 4/92.
 Hilgerloh, G. *et al.* Are the Pyrenees and the Western Mediterranean barriers for trans-Saharan migrants in Spring? – *Ardea* 3/92.

Deceuninck, B. & Baguette, B. [Breeding birds in Spruce plantations of successive ages on the Plateau des Tailles] – *Aves* 4/91.

Jonkers, D.A. [Population trends of breeding birds in the Netherlands 1969-85] – *Limosa* 3/92.

Beintema, A.J. [Mayfield, a necessity: methods of calculating nesting success] – *Limosa* 4/92.

Divers to Ducks:

Keller, V. [The importance of continuous nest-building during incubation by Great Crested Grebe] – *Orn. Beob.* 3/92.

Minguez, E. *et al.* [Status, distribution, population size and reproductive phenology of the European Storm Petrel in the Basque country of Spain] – *L'Oiseau* 3/92.

Netherlands/Belgium Goose Working Group. [Goose counts in the Netherlands and Belgium 1989/90] – *Limosa* 4/92.

Nilsson, L. & Persson, H. Feeding areas and local movement patterns of post-breeding Greylag Geese in S Sweden – *Orn. Svec.* 2/92.

Follestad, A. [Shooting pressure on Greylag Geese] – *Var Fuglefauna* 3/92.

Étienne, P. *et al.* [Updating of status of Bean Geese in the Somme estuary] – *Alauda* 2/92.

Devos, K. [The Tufted Duck as a breeding bird in the Belgian coastal polders] – *Mergus* 2/92.

Birds of Prey:

Pielowski, Z. [Population and breeding success of raptors on farmland near Czempin, W Poland] – *Acta Ornith.* 2/91.

Nielsen, O.K. & Björnsson, H. [Rare and vagrant birds in Iceland, Report No 8: Raptors] *Náttúrufræðingurinn* 3-4/92.

Bertel, B. Ageing of Marsh Harrier – *Dansk Orn. For. Tidss.* 3-4/92.

- Kostrzewa, R. [On the population ecology of the Kestrel] – *Ök. der Vög.* 2/91.
 Tishechkin, A.K. & Ivanovsky, V.V. Status and breeding performance of Osprey in N Byelorussia – *Orn. Fenn.* 3/92.

Grouse to Cranes:

- Spidso, T.K. Egg size in relation to reneating in Capercaillie – *Fauna Norveg.* 5/92.

Waders to Auks

- Piersma, T. & van de Sant, S. Pattern and predictability of potential wind assistance for waders and geese emigrating from W Africa and the Wadden Sea to Siberia – *Orn. Svec.* 2/92.
 Gudmundsson, G.A. & Linström, A. Spring migration of Sanderlings through S W Iceland: where from and where to? – *Ardea* 3/92.
 Trollet, B. [Ruff wintering in the Senegal delta] – *Alauda* 3/92.
 Wuorinen, P. Do Arctic Skuas exploit and follow terns during Autumn migration? – *Orn. Fenn.* 4/92.
 Willemyns, F. [Long-tailed Skua influx on Belgian coast Autumn 1991] – *Mergus* 6/92.
 Hoogendoorn, W. et al. Spring head-moult in Mediterranean Gull in N W France – *Dutch Birding* 6/92.
 Schramm, A. [Mass migration of Kittiwakes in Arctic waters in July] – *Seevögel* 3/92.

Pigeons to Woodpeckers:

- Ólafsson, E. [Rare and vagrant birds in Iceland. Report No. 7: Nightjars and Swifts] – *Náttúrufræðingurinn* 2/92.

Passerines:

- Kouki, J. Habitat associations of passerines breeding in peatland in Eastern Finland – *Orn. Fenn.* 3/92.
 Géroutet, P. [The Rock Pipit] – *Alauda* 2/92.
 Sachslehner, L.M. [Breeding density of Spotted, Collared and Red-breasted Flycatchers in Viennese woods related to tree die-back and selective cutting] – *Egretta* 2/92.
 Thingstad, P.G. Applicability of Pied Flycatcher's clutch size and breeding success as an environmental indicator – *Fauna Norveg.* 5/92.
 Nikander, P.J. [Identification of small pipits – Part I] – *Lintumies* 4/92.
 Grajatzki, B. [Diet and breeding behaviour of female robins in hedgerow habitat in Schleswig-Holstein] – *Vogelwelt* 6/92.
 Hansen, R.E. [Barred Warbler breeding records at Molen and in outer Oslofjord] – *Var Fuglefauna* 1/93.
 Möckel, R. [Effects of pollution damage to forests on population dynamics of Coal and Crested Tits in western Erzgebirge] – *Ök. der Vög.* 1/92.
 Mäck, U. [First results of a study of the Magpie in Ulm] – *Ök. der Vög.* 2/91.
 Henriksen, K. [Communal roosting in suburban Magpies] – *Dansk Orn For Tidsskr.* 3-4/92.
 Ellenberg, H. and Dreifke, R. [Ravens acting as protection for other species against Goshawk predation] – *Corax* 1/92.
 Barthel, P.H. et al. [Mongolian Trumpeter Finch in the Western Palearctic] – *Limicola* 6/92.
 Cordero, P.J. & Summers-Smith, J.D. Hybridisation between House and Tree Sparrow – *Jour. für Orn.* 1/93.

M.H. Murphy

Advice to Contributors

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

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

italics should follow the first text reference to each species and should follow Voous' 'List of Recent Holarctic Bird Species' as given in *The British Birds' List of Birds of the Western Palearctic* (1984).

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

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

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