Scottish Birds

THE JOURNAL OF THE SOC

Vol 24 No 2 June 2004

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The distribution of the Scottish Crossbill 1995–2003
Estimating breeding wader populations of Scottish uplands
Origins of Common Starlings wintering in the Highlands

Scottish Birds – The Journal of the SOC

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Scottish Birds, the official journal of the SOC, publishes original material relating to ornithology in Scotland. Papers and notes should be sent to The Editor, *Scottish Birds,* SOC, Harbour Point, Newhailes Road, Musselburgh EH21 6SJ

Scottish Birds is published each year in June. *Scottish Birds* is issued free to members of the SOC, who also receive the quarterly newsletter *Scottish Bird News*, the annual *Scottish Bird Report* and the annual *Raptor Round Up*.

Published by: The Scottish Ornithologists' Club, Harbour Point, Newhailes Road, Musselburgh EH21 6SJ.

Design by: Pica Design, 51 Charlton Crescent, Aboyne, Aberdeenshire AB34 5GN.

Printed by: Meigle Colour Printers Ltd, Block 11, Units 1 & 2, Tweedbank Industrial Estate, Galashiels TD1 3RS

Canoe and walking surveys of wintering Goosanders, Red-breasted Mergansers, Great Cormorants and Common Goldeneyes on the River Spey, 1994-2003

P J COSGROVE, J R A BUTLER & R L LAUGHTON

Winter surveys of Goosanders, Red-breasted Mergansers, Great Cormorants and Common Goldeneyes on the main stem of the River Spey were carried out in December 2002 and February 2003 using a novel survey methodology based on canoe counts. The River Spey holds nationally important wintering populations of Goosanders and Common Goldeneyes, but not Red-breasted Mergansers or Great Cormorants. These data were compared with historical survey data, which demonstrated that wintering Goosander densities have remained stable on the River Spey between 1994 and 2003. Recommendations are made for future survey methods of Goosanders, Red-breasted Mergansers, Great Cormorants and Common Goldeneyes on the River Spey.

Introduction

Recent work in north east Scotland has shown the national importance of rivers for some birds such as Goosander *Mergus merganser,* Red-breasted Merganser *Mergus serrator* (collectively known as 'sawbills') and Common Goldeneye *Bucephala clangula* (Duncan & Marquiss 1993, Marquiss & Duncan 1994a, Cosgrove 1996, 1997 and Watson *et al* 1998). Unfortunately, there have been very few estimates of whole river populations of sawbills and Common Goldeneye in Great Britain (GB), with most estimates made on standing waters and a few on sections of rivers. As a result, estimates of wintering populations of sawbills and Common Goldeneye have been compromised by a lack of systematic counts on rivers (Owen *et al* 1986, Marquiss and Duncan 1994).

On the River Spey, and elsewhere in Scotland, fishery managers often perceive sawbills and Great Cormorants *Phalacrocorax carbo* as a major threat to salmonid populations and fisheries because of the large number of fish that they consume (Spey Catchment Management Plan 2003). Sawbills are protected by law under the 1981 Wildlife and Countryside Act although Section 16 of the Act does make provision for the issue of licences to kill them to *prevent serious damage to fisheries, where no other satisfactory solution can be found*. However, this approach has been disputed by others who believe that there is no direct scientific evidence linking sawbills to damage of fisheries or fish stocks and that no licences should be issued until such evidence is available (Spey Catchment Management Plan 2003). Controversy has also surrounded estimates of sawbill and Great Cormorant abundance on Scottish rivers.

The main River Spey stakeholders (eg local residents, fishery proprietors, conservationists, anglers, local authorities, government agencies etc) have agreed that further research on sawbills and Great Cormorants on the River Spey is necessary and that this should be taken forward at the earliest opportunity (Spey Catchment Management Plan 2003). Only when more information is available can informed decisions and progress be made on fishery management and perceived predation issues.

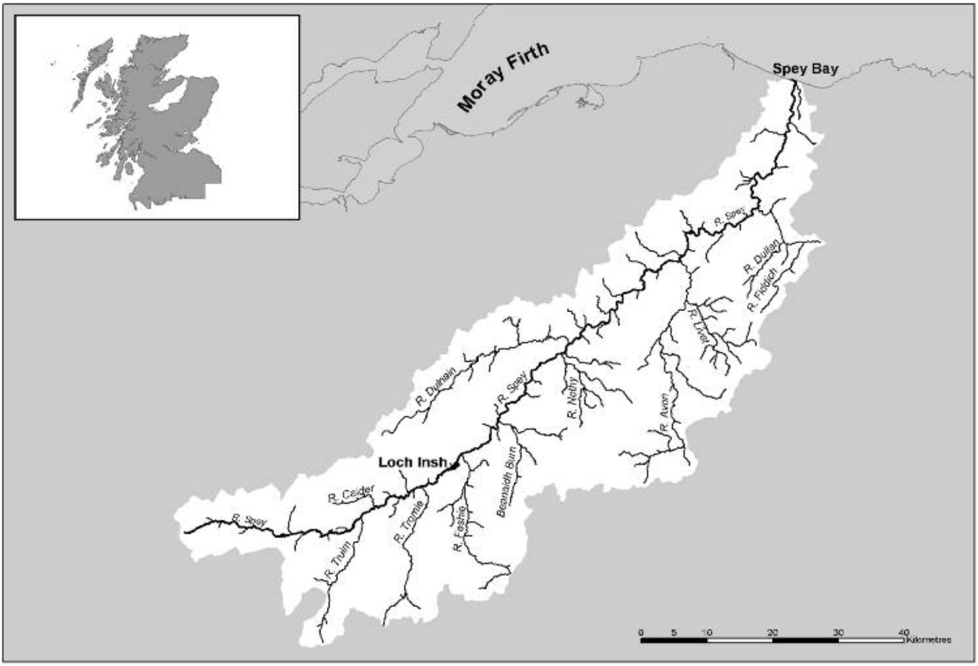

Figure 1. ***Map of the River Spey***

Historically, counts of sawbills and Great Cormorants on the River Spey have been undertaken for some sections of the river, but not for all of the main stem. Also, counts have been irregular, so few, if any comprehensive historical data sets exist. This situation has arisen for several reasons, including the practicalities, costs and logistics of adequately counting birds on Britain's seventh longest river, which measures 157km from source to sea (Figure 1).

The standard survey methodology developed for counting sawbills, Goldeneye and Great Cormorants on rivers is by means of walked transects along the main stem of the river. This is time consuming, labour intensive and needs to be undertaken during periods of similarly mild weather conditions to minimise the possible effects of weather related bird movements along the river. In a full survey of the River Deveron, north east Scotland during the short daylight period in mid winter, it took 2 teams of 2 surveyors 4 days to survey the main stem of the river which was 87km long (Cosgrove 1996). The River Spey is almost double the length of the River Deveron and so would require considerable resources to regularly survey by means of a walked transect count.

The aims of this study were (1) to census the wintering population of sawbill ducks, Common Goldeneyes and Great Cormorants on the main stem of the River Spey from Loch Insh to Spey Bay, using a new survey methodology; (2) to compare the recent census with relevant historical survey data; and (3) to make recommendations for future survey methods of sawbills, Common Goldeneyes and Great Cormorants on the River Spey.

Methods

In December 2002 and February 2003, a novel method for surveying sawbills, Common Goldeneyes and Great Cormorants based on counts from Canadian canoes on the River Spey was trialled. On 4 December 2002 and 26 February 2003, 6 teams of trained surveyors simultaneously surveyed 6 contiguous sections of the main stem of the River Spey from Loch Insh to Spey Bay, a distance of 116km. The upper River Spey from Loch Insh to Spey Dam was not surveyed, so these data presented represent a minimum figure for the whole river. The teams drifted and paddled downstream to a predetermined location where the next team had started their survey and a vehicle waited to collect the personnel and canoes.

In their River Dee study, Marquiss and Duncan (1984b) investigated the diurnal activity patterns of Goosanders. Birds spent most of the daytime foraging and loafing on rivers. The timing and arrival at communal still water roosts was noted, with most birds arriving from 50 minutes before to 10 minutes after sunset. Thus, the 2002 and 2003 river surveys were carried out during normal daylight hours avoiding the first light and dusk period, when birds may have moved to communal roosts away from the river.

Each team consisted of one canoeist and one trained surveyor. The surveyor carefully scanned the river and sky ahead with binoculars and recorded every bird, its sex, the time it was seen and the location of each sighting on 1:25,000 OS maps. Occasionally the surveyor helped the canoeist paddle through more turbulent river sections. When a group of birds was sighted eg 3 male Common Goldeneyes and 2 female Common Goldeneyes, the surveyor counted these birds, noting the group composition and location and added them to the totals. To avoid double counting, if these birds flew downstream, the surveyor did not add another group of Common Goldeneyes to the totals until 3 males and 2 females were seen to fly back upstream.

On 5 December 2002, 3 independent trained surveyors surveyed 3 randomly selected large sections of the River Spey, from Loch Insh to Spey Bay, using the standard walk transect method, which had been surveyed from canoes the day before. The bank based surveyors did not know of, or have access to, the canoe count data from the previous day.

During the winters of 1994-95, 1995-1996, 1998-1999 and 2001-2002, 5 walked transect counts were undertaken on main stem sections of the River Spey from Loch Insh to Spey Bay by the Spey Fishery Board. This historical data is presented to allow for comparisons of winter sawbill and Great Cormorant densities to be made with those in winter 2002-2003. No comparative data for Common Goldeneye exists however.

Results

Goosander

On 4 December 2002, 125 Goosanders were counted from canoe on the main stem of the River Spey up to Loch Insh at a density of 1.08 birds/km of river. On 26 February 2003, 90 Goosanders were recorded from canoe on the same section at a density of approximately 0.78 birds/km of river. Although Goosanders were spread throughout the river, the highest numbers occurred in the lowest reaches of the river, 0-40km upstream from the sea (Figure 2). However, there were some notable differences between the patterns of distribution recorded by the 2 counts. In particular, the highest Goosander counts occurred 30km from the sea on 04 December 2002, but none were recorded there on 26 February 2003.

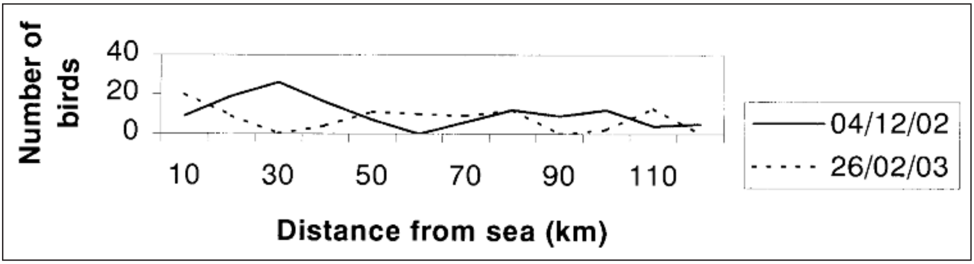

Figure 2. ***Goosander numbers in relation to distance from sea on the River Spey, winter 2002–2003***

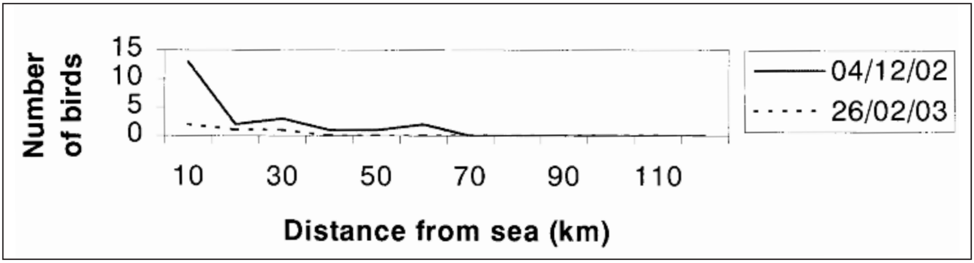

Figure 3. ***Red-breasted Merganser numbers in relation to distance from sea on the River Spey, winter 2002–2003***

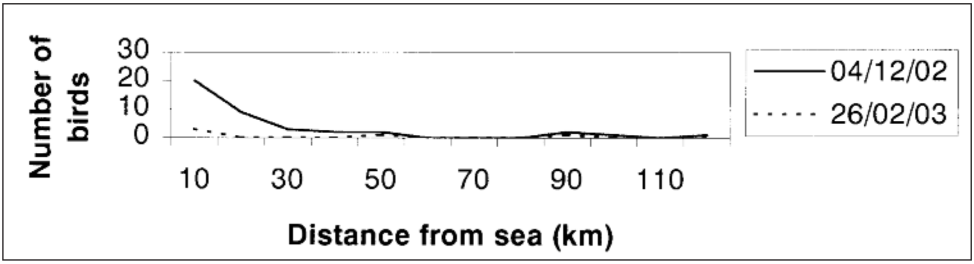

Figure 4. ***Cormorant numbers in relation to distance from sea on the River Spey, winter 2002–2003***

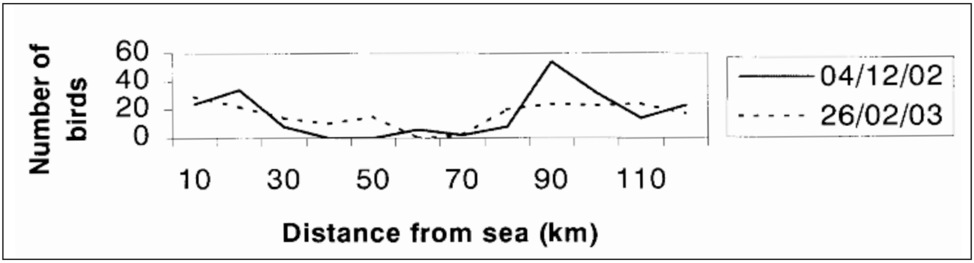

Figure 5. ***Goldeneye numbers in relation to distance from sea on the River Spey, winter 2002–2003***

The density of Goosanders recorded in winter by walked transect counts between December 1994 and January 2002 shows a remarkable consistency, with between 1.19 and 1.40 birds/km of River Spey (Table 1) in each survey. The density derived from the canoe count for December 2002 (1.08 birds/km) was also similar. The counts of Goosander made by canoe in December 2002 were similar to the walk transect counts undertaken 24 hours later for the same 3 sections of river (Table 2).

Red-breasted Merganser

Twenty two Red-breasted Mergansers were counted from canoe on the main stem of the River Spey up to Loch Insh on 04 December 2002, at a density of approximately 0.19 birds/km of river. Only 4 Red-breasted Mergansers were counted from the same section on 26 February 2003, at a density of 0.03 birds/km of river. Although the numbers of birds counted during both surveys were markedly different, Red-breasted Mergansers were mainly recorded in the lowest reaches of the River Spey, 0-20km upstream from the sea (Figure 3).

There was considerable variation in the density of Red-breasted Mergansers recorded by walked transect counts between December 1994 and January 2002, with between 0.03 and 0.52 birds/km of River Spey (Table 1) in each survey. The counts of Red-breasted Mergansers made by canoe in December 2002 were similar to the walk transect counts undertaken 24 hours later for the same 3 sections of river (Table 2).

Great Cormorant

Forty Great Cormorants were counted from canoe on the main stem of the River Spey up to Loch Insh on 04/12/02, at a density of approximately 0.34 birds/km. Only 5 Great Cormorants were counted on the same section on 26 February 2003, at a density of 0.04 birds/km of river. Although there was a large difference between the numbers of birds recorded in the 2 count periods, there were some similarities in the overall distribution of the birds on the River Spey, with most birds occurring 0-10km from the sea, and others 90km from the sea (Figure 4). The density of Great Cormorants recorded by walked transect counts between December 1994 and January 2002, varied considerably with between 0.04 and 0.84 birds/km of River Spey (Table 1) in each survey.

There was a 50% difference in the canoe and walked transect counts of Great Cormorants for the 3 sections of river surveyed in December 2002, with 31 counted from canoe and only 14 counted from the walk transect the following day (Table 2). However, much of this difference was attributed to a single flock of 20 Great Cormorants counted by the canoe survey on a shingle bar at the mouth of the Spey. Human disturbance at the mouth of the Spey or changes in the tide could easily have moved the birds elsewhere overnight and this one roosting flock, which may have used the sea and not the river, could account for the difference in the canoe and walk transect counts. Similarly high densities of Great Cormorants have been recorded during previous winter surveys (Table 1).

Common Goldeneye

There was remarkable similarity in the counts of Common Goldeneye between the December 2002 and February 2003 surveys. Two hundred and five Common Goldeneyes were counted from canoe on the main stem of the River Spey up to Loch Insh on 4 December 2002, at a density of 1.8 birds/km of river. Two hundred Common Goldeneyes were then recorded from canoe on the main stem of the River Spey up to Loch Insh on 26 February 2003, giving a density of 1.7 birds/km of river. Although Common Goldeneyes were spread throughout the length of the Spey surveyed, the highest numbers

Table 1. ***The density of Goosanders, Red-breasted Mergansers and Great Cormorants recorded in winter between 1994 and 2002 on the main stem of the River Spey.***

Date of count	Distance surveyed (km)	Goosanders surveyed (km)	R-b Mergansers surveyed (km)	Great Cormorants (birds/km)
December 1994	92km	1.22	0.24	0.84
November 1995	150km	1.19	0.11	0.07
January 1996	116km	1.40	0.40	0.30
December 1998	100km	1.34	0.24	0.30
January 2002	105km	1.19	0.52	0.32
December 2002*	116km	1.08	0.19	0.34
February 2003*	116km	0.78	0.03	0.04

* Canoe count data

Table 2. ***The number of Goosanders, Red-breasted Mergansers, Great Cormorants and Common Goldeneyes recorded using different methods on consecutive days on the main stem of the River Spey in December 2002.***

River Spey section	Goosander canoe/walk count	R-breasted Merganser canoe/walk count	Great Cormorant canoe/walk count	Common Goldeneye canoe/walk count
Spey Bay to Fochabers	9/10	11/12	20/6	22/17
Fochabers to Boat o' Brig	15/10	2/0	9/8	17/19
Rothes to Aberlour	11/9	1/0	2/0	8/9
Total	**35/29**	**14/12**	**31/14**	**47/45**

during both counts occurred in the lower reaches of the river 0-20km from the sea, and also around 80-100km upstream (Figure 5).

The counts of Common Goldeneye made by canoe in December 2002 were very similar to the walk transect counts undertaken 24 hours later for the same 3 sections of river (Table 2).

Discussion

Goosander

The lack of river population estimates for Goosander makes it difficult to put the River Spey count data into a national context. Nevertheless, the GB wintering Goosander importance threshold of 90 birds (Musgrove *et al* 2001) has been reached on the 2 most recent counts in December 2002 and February 2003. This indicates that the River Spey is a nationally important wintering site for Goosander, holding at least 1% of the estimated population in GB.

Although comprehensive historical sets of count data for the River Spey are unavailable, comparable density estimates for long sections over the last decade suggest that the river's importance for wintering Goosander is long

Table 3. ***Comparisons of the logistical considerations between walk transect counts and canoe counts of sawbills, Great Cormorants and Common Goldeneyes on the River Spey.***

Variable/logistics	Walk transect count	Canoe count
Number of person days to survey main stem	32 person days (4 teams of 2, 4 days).	12 person days (6 teams of 2, 1 day).
Number of competent surveyors needed	8 surveyors.	6 surveyors.
Importance of weather	High (4 stable days).	Low (1 stable day).
Access arrangements	Difficult – almost impossible to get permission from all riparian owners.	Easy, 7 entry and exit points. Sunday counts preferable in fishing season.
Health and safety considerations	High, although surveyors use a 'buddy system' of reporting when working alone.	High, trained canoeists needed. Working safely on water requires training.
Additional equipment necessary	None.	6 canoes.
Counting efficiency	High, most birds (c75%) are seen and flushed, despite efforts	High, most birds (c90%) are seen and flushed on all but

standing with densities remaining stable since 1994. This is surprising as WEBS count data have shown a decline in the number nationally by around two thirds, since the mid 1990s, which coincided with a fall in numbers on the Inner Moray Firth, for years the most important site in the country for this species (Pollitt *et al* 2003).

The pattern of birds spread throughout the river, with the highest numbers in the lowest reaches of the river is similar to data for other rivers in north east Scotland, such as the River Dee (Marquiss and Duncan 1994a) and River Deveron (Cosgrove 1997). Marquiss and Duncan (1994a) attributed this to the water in the upper river being very cold and the smaller fish living there being largely unavailable to Goosanders, at least during the daytime, because they are buried in the substrate.

The relatively constant densities derived from the River Spey winter counts are interesting in light of similar data from the River Dee. Marquiss *et al* 1998 showed large annual variation in the numbers of breeding Goosanders and their production of ducklings on the River Dee, but the midwinter population was remarkably stable year on year. Marquiss and Duncan (1994a) found that Goosander abundance varied between seasons and years reflecting their needs for food, security from predators, pairing and nesting, so it is strongly recommended that future work on the River Spey looks at autumn, winter, spring and summer populations. Goosanders breed along the River Spey, but the numbers of pairs currently involved is unknown. In April 1984, 30-50 pairs were estimated to be breeding on the River Spey (Dennis 1984).

Red-breasted Merganser

The lack of river population estimates makes it difficult to put the River Spey count data into a national context. The population and density estimates have varied considerably over time and suggest that the River Spey does not hold a nationally important wintering population of Red-breasted Mergansers.

Small, but variable numbers of Red-breasted Mergansers have used the lowest sections of the River Spey during the winter over the last decade and this fits into the general pattern seen during intensive studies on the River North Esk (Marquiss and Duncan 1993). Red-breasted Mergansers breed along the River Spey, but the numbers of pairs currently involved is unknown. In 1984, 10-15 pairs were estimated to be breeding on the River Spey (Dennis 1984).

Great Cormorant

The population and density estimates have varied considerably over time and suggest that the River Spey does not hold a nationally important wintering population of Great Cormorants, being well below the threshold of 130 birds (Musgrove *et al* 2001) during counts in December 2002 and February 2003. The distribution of Great Cormorants on the River Spey appears to reflect their choice in preferred feeding areas, with most birds in the lower river, close to the sea.

Common Goldeneye

As with the sawbills counted, the lack of river population estimates for Common Goldeneye makes it difficult to put the River Spey count data into a national context. Nevertheless, the GB wintering Common Goldeneye importance threshold of 170 birds (Musgrove *et al* 2001) has been reached on both of the recent counts in December 2002 and February 2003. In April 1984, 246 Goldeneye were estimated to be present on the River Spey (Dennis 1984). This indicates that the River Spey is a nationally important wintering site for Common Goldeneye, holding at least 1% of the estimated population in GB.

Duncan and Marquiss (1993) found high numbers of wintering Common Goldeneyes on whole river counts in north east Scotland and estimated that 62% of the region's Common Goldeneyes were on rivers, although numbers did vary between years. The River Spey population, along with those of the Rivers Deveron, Don and Dee, confirms that the north east of Scotland is a nationally important area for wintering Common Goldeneyes. However, along with Goosanders, the national population of wintering Common Goldeneye has been estimated without comprehensive rivers surveys, so that the figures and levels qualifying for national interest need to be reassessed following national surveys of all Common Goldeneye habitats.

After nesting for the first time in Britain in 1971, Badenoch and Strathspey has become the main British breeding site for Common Goldeneyes (Dennis 1995). In 2002 a concerted effort was made to monitor the Scottish breeding population and this survey revealed that at least 91 clutches were laid and only 2 of these were outside Badenoch and Strathspey (Goldeneye Study Group 2002 Newsletter). However, recent unpublished studies have revealed that as many as 2/3 of these clutches contained eggs laid by more than one female, making a firm breeding population estimate problematical (Begg 2002). Thus, the River Spey catchment is unique as it holds almost all of Britain's breeding Common Goldeneye and a significant nationally important wintering population as well.

Comparison of count methods

Although based on comparisons of counts from only 3 sections of the River Spey, the data collected suggests that the canoe count methodology is comparable to the walk transect count methodology. This comparison should be tested again elsewhere, but from our initial findings it would appear that counting from a canoe is an efficient and effective method of surveying sawbills on a large river like the River Spey. It is possible to see and count birds using both methods, but the window of vision provided by canoes may allow more complete counts, particularly in areas of dense riparian vegetation which obscure visibility for walk transects. Field experience shows that most birds are disturbed by both methods, despite attempts not to do so, suggesting that the risks of double counting flushed birds are similar in both cases.

Both methods have their advantages and disadvantages and some similar strengths and weaknesses (see Table 3), but by far the most efficient method is the canoe count. In terms of staff time and resources, the walk transect uses almost 3 times the number of 'person days' to complete the survey than the canoe count. This would provide a considerable saving in terms of direct staff costs (wages) and indirect costs (travel and overnight subsistence) for the canoe count method. The canoe count also requires 20% fewer competent surveyors than the walk transect count.

Formal access arrangements from the walk transect count are highly problematic and if carried out properly, add considerable logistical and staff costs. Very few access points are needed if using a canoe, but visits may need to be restricted to early mornings or Sundays during the fishing season, providing a time constraint. Both methods take account of health and safety considerations but the necessary presence of two personnel at all times in a canoe provides greater security for both surveyors.

If the canoe count method was adopted on other large rivers, which we recommend, it would significantly improve the efficiency and therefore feasibility of regular sawbill monitoring on rivers. There is a third well tried method that was not considered here. Aerial surveys have been used for a variety of bird monitoring purposes and could be trialled. In 1984, Dennis undertook an aerial survey of the River Spey from the sea to the source. It took 2 hours, one surveyor, one pilot, good weather, no access problems, high health and safety considerations and no additional equipment other than hiring a light plane. Although the counting efficiency of aerial river surveys is unknown, the costs of hiring a plane for such a survey appear to be comparable or perhaps even cheaper than the canoe count and, therefore, it is worthy of further consideration.

An increase in sawbill, Great Cormorant and Common Goldeneye monitoring data would be beneficial to all the main River Spey stakeholders and it would allow further investigations into the birds' biology and eventually into assessments of their potential impact on salmonid populations, as well as the relative conservation importance of populations.

Acknowledgements
This paper would not have been possible without the help of a large number of people and consequently we are very grateful to all the surveyors and canoeists who helped with the fieldwork. In particular, we would like to thank Tim Walker and Stuart Upward of Glenmore Lodge, Andy Wells, Dave Craig and Squadron Leader Malcolm Lee for their help with canoes. Many thanks to Mick Marquiss, Carl Mitchell, Keith Duncan, Kristin Scott and Robin Cosgrove who all made useful comments on an early draft of this paper.

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Revised manuscript accepted August 2003

The distribution of the Scottish Crossbill, 1995-2003

RW SUMMERS, DC JARDINE & RJG DAWSON

The breeding distribution of the Scottish Crossbill was investigated during January to April from 1995-2003. Identification was based on an excitement call, believed to be characteristic for this species. Woods with Scottish Crossbills are listed and mapped. Scottish Crossbills were found from the Caithness Flow Country in the north to Stirlingshire in the south, and from Glen Garry in the west to Fetteresso Forest near Stonehaven in the east. Additional records from outside the breeding season included one from Fife. Thus, their range is greater than previously thought. It is recognised that the list of woods is incomplete and that the range in any one year will vary depending on cone crops of different conifer species.

Introduction

The Scottish Crossbill *Loxia scotica* is regarded as Britain's only endemic bird species (BOURC 1980). Prior to this, it was alternately classed as a subspecies of either the Common Crossbill *L curvirostra* or the Parrot Crossbill *L pytyopsittacus* (see Knox 1975 for a review). The population size of Scottish Crossbills was thought to be around 1500 adults in the 1970s (Nethersole-Thompson 1975). Also, it has been assumed that Scottish Crossbills are associated primarily with the remaining fragments of the Caledonian pine forest, a small and threatened habitat (Nethersole-Thompson 1975, Knox in Gibbons *et al* 1993, Anon 1995). Because of the small population size and small area of its main habitat, the Scottish Crossbill was classed as a species of global conservation concern (Tucker & Heath 1994). However, this classification acknowledged a lack of information and recognised that the formal conservation status could change when more data became available on its distribution and population size. These aspects of the status of the Scottish Crossbill are key objectives for this species under the UK's Biodiversity Action Plan (Anon 1995).

The key difficulty about obtaining data on the status of the Scottish Crossbill was that a reliable method of field identification was lacking. In addition, Parrot Crossbills are now known to be nesting in Scotland and may breed alongside Common and Scottish Crossbills at the same site in a given year (Summers 2002), thus exacerbating the identification problem. There are no distinct plumage differences among the 3 species, and there are only small differences in overall size. The size of the bill is often mentioned as a defining character (Svensson 1992); the Common Crossbill has the smallest, Parrot Crossbill has the largest, while Scottish Crossbill is intermediate between these. However, overlap between the ranges of bill sizes of Common and Scottish Crossbills and between Scottish and Parrot Crossbills makes identification difficult (Knox 1976, 1990). Even when captured and measured, it may not be possible to identify some birds. Crossbills are also difficult to catch, so with the exception of museum specimens, in hand identification has been restricted largely to captures of irrupting birds, usually at coastal localities (Davis 1964) and to dedicated projects working in breeding areas (Marquiss & Rae 2002, Summers *et al* 2002).

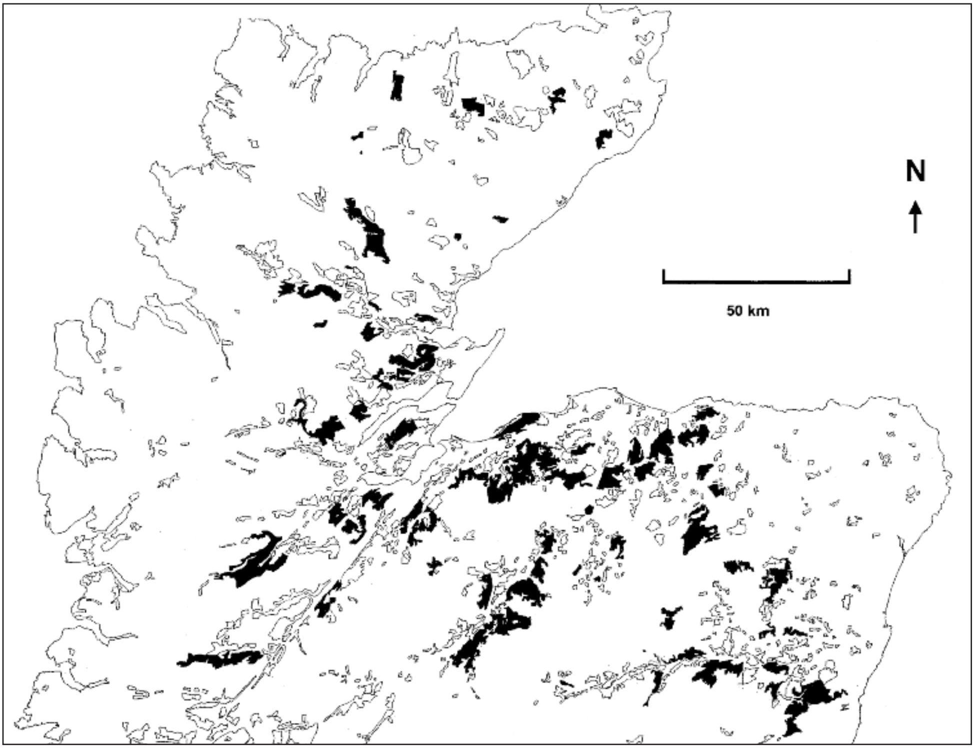

Figure 1. ***The distribution of woods occupied by Scottish Crossbills (in black) in northern Scotland (north of 56°50'N) during 1995-2003. Records south of this are not shown***

Crossbills breeding in Scotland have a range of distinct flight and excitement calls. However, individuals consistently give a particular flight and excitement call and combination of these calls. In addition, these calls are shared among birds with similar bill size (Summers *et al* 2002). This discovery provides the basis for a field method of species identification that distinguishes Scottish, Common and Parrot Crossbills. For reference, the different flight calls have been given numbers and the excitement calls letters. The combination of flight and excitement calls that characterises the Scottish Crossbill is flight call 3 and excitement call C. Although the different calls may be distinguished by ear with practice, the only way to confirm identification is to make a good quality sound recording and create a sound spectrogram (sonogram). This procedure allowed a description of the range of the Scottish Crossbill to be made, based on 10km squares occupied (Summers *et al* 2002). This paper presents the results in terms of woods occupied and updates the known distribution.

Methods

The study was carried out from 1995-2003, during January to April when it can be reasonably assumed that Scottish Crossbills are either breeding or on territory (Nethersole-Thompson 1975). All 10km squares north of

56°50'N with more than about 20% woodland were visited, and generally the larger woods were searched until at least one recording of a crossbill was made. Multiple recordings from 10km squares were restricted to only a few squares. Crossbills were lured using excitement call type D broadcast from mini speakers. Lured birds are usually vocal, and both flight and excitement calls can be tape recorded. For mapping, only the excitement call (type C) was used to indicate the presence of Scottish Crossbill, as this is regarded as characteristic. Birds that responded were recorded onto magnetic tape using a directional microphone. Sonograms were made from the tape recordings allowing species identification (see Summers *et al* 2002 for further details).

Boundaries of woods were taken from a 1:250 000 Ordnance Survey map. In some cases, a main road divided the wood, and the sections on either side of the road were treated independently. Any wood where at least one recording of the type C excitement call was made during 1995 to 2003 was regarded as occupied.

Results

Scottish Crossbills were recorded from 83 x 10km squares in 12 counties, representing 94 woods. The occupied woods are listed in Table 2. The highest number of woods (24, 26% of the total) was in Inverness shire (Table 1), while 4 counties (Sutherland, Ross shire, Inverness shire and Aberdeenshire) had 66 of all the woods (70%). Of the 94 woods, 9 (9.6%) were native pinewoods, the remainder being plantations, mainly planted after 1900. Scottish Crossbills were found mainly in the eastern Highlands. The limits were from Caithness in the north to Stirlingshire in the south, and from Glen Garry (Inverness shire) in the west to Fetteresso Forest (Kincardineshire) in the east (Fig 1). The single record of a Scottish Crossbill from Stirlingshire was of one bird associating with about 70 Common Crossbills in a spruce *Picea* sp and larch *Larix* sp plantation. No breeding activity was noted in this area and crossbill numbers declined over the following weeks presumably due to the dispersal of the winter flock. Outside our study period (January to April), there was a December record of 3 birds in Fife. The only other Fife records are specimens collected in 1897 (now in the National Museums of Scotland, Edinburgh).

Discussion

The earlier mapped distributions of the Scottish Crossbill (Nethersole-Thompson 1975, Lack 1986, Gibbons *et al* 1993) were incomplete but demonstrated the perception that Scottish Crossbills were concentrated in Strathspey and Deeside. The present survey confirms this but also shows that they are more widespread in northeast Scotland. Although Scottish Crossbills were recorded from several Caledonian pinewoods, supporting the earlier perceived association with this habitat, most records came from plantations. Scots Pine *Pinus sylvestris* is often a component of plantations, but further ecological work is required to understand the associations with different conifer woods.

The sampling unit was the 10km square, and often tape recordings were made from only one crossbill. However, repeated visits to some woods showed that all 3 species were present (eg Abernethy Forest, Summers 2002). In addition, excitement calls were not tape recorded in all cases. On some occasions, flight calls likely to be of Scottish Crossbills were recorded, but because this call is occasionally made by Parrot Crossbills, it is not diagnostic (Summers *et al* 2002). Therefore, by restricting our study to excitement calls, and often from a single bird, the distribution is likely to be incompletely described. Further,

Table 1 ***Counties where Scottish Crossbills were recorded between 1995 and 2003.***

County	Number of 10km squares	Number of woods
Caithness	2	2
Sutherland	15	16
Ross shire	9	11
Inverness shire	18	24
Nairnshire	2	3
Morayshire	9	9
Banffshire	7	8
Aberdeenshire	15	15
Kincardineshire	3	3
Angus	1	1
Perthshire	1	1
Stirlingshire	1	1
Total	**83**	**94**

Table 2 ***A list of 10km squares and locations where Scottish Crossbills were recorded in different counties during 1995-2003. Names in bold refer to woods classified as native pinewoods (Forestry Authority) and where Scottish Crossbills had been recorded in native stands (some sites have mixtures of stand types).***

Caithness	
ND04	Blar Geal
ND23	Rumster
Sutherland	
NC50	*Raemore Wood*
NC53	*Altnaharra*
NC54	*Loch a' Mhoid*
NC61	*Dalchork*
NC65	*Borgie Forest*
NC81	*Balnacoil*
NC85	*Dyke*
NC91	*Strath Ullie*
NH39	*Glen Einig*
NH48	***Amat***
NH49	*Inveroykel*
NH58	*Ardgay, Kincardine Hill*
NH68	*Kincardine Hill*
NH69	*Maikle Wood*
NH79	*Clashmore Wood, Ospisdale*
Ross shire	
NH35	*Loch Meig/Strathconon*
NH36	*Longart Forest*
NH46	*Strath Sgitheach*
NH56	*Glen Glass*
NH65	*Mount Eagle, Millbuie Forest*
NH66	*Millbuie Forest*
NH67	*Stittenham Wood, Wallace Hill, Kinrive Wood, Morangie Forest, Strath Rory West*
NH77	*Morangie Forest*
NH78	*Morangie Forest*
Inverness shire	
NH22	***Glen Affric***
NH33	*Cannich*
NH41	*Loch Knockie*
NH44	*Rheindown Wood*
NH53	*Loch Laide, Abriachan*
NH54	*Blackfold*

NH63	*Carr Ban, Farr Loch*
NH72	*Strathdearn*
NH73	*Moy, Meall Mór Forest*
NH82	*Sluggan*
NH90	***Glenmore Forest, Rothiemurchus Forest***
NH91	***Glenmore Forest, Abernethy Forest***
NH92	*Carrbridge Woods, Curr Wood,* ***Abernethy Forest***
NJ01	***Abernethy Forest***
NJ02	*Grantown-on-Spey, Craigmore Wood*
NJ03	*Tomvaich*
NN29	*Glen Garry*
NN89	***Glen Feshie****, Inshriach Forest*
Nairnshire	
NH84	*Carn na Caillich, Assich*
NH94	*Ferness Forest*
Morayshire	
NH95	*Darnaway Forest*
NJ05	*Altyre Woods*
NJ06	*Culbin Forest*
NJ13	*Hill of Dalnapot*
NJ14	*Knockando*
NJ15	*Hill of the Wangie*
NJ24	*Elchies Wood*
NJ25	*Teindland Wood*
NJ35	*Whiteash Hill Wood*
Banffshire	
NJ11	*Glenmullie, Tomintoul*
NJ12	*Bridge of Brown*
NJ23	*Morinsh Wood*
NJ34	*Ben Aigan Forest*
NJ44	*Balloch Wood*
NJ45	*Corskell Moss*
NJ46	*Bin of Cullen*
Aberdeenshire	
NJ20	*Gairnshiel*
NJ31	*Fordbridge Hill*
NJ40	*Loch Davan*
NJ42	*Clayshot Hill*
NJ43	*Strathbogie*
NJ50	*Tarland*
NJ52	*Correen Hills*
NJ54	*The Bin*
NJ60	*Torphins*
NJ62	*Bennachie*
NJ70	*Midmar*
NO19	***Glen Quoich***
NO39	*Alltcailleach Forest*
NO49	***Glen Tanar***
NO59	*Bogshiel Lodge*
Kincardineshire	
NO68	*Craigangower*
NO69	*Blackhall*
NO78	*Fetteresso Forest*
Angus	
NO55	*Montreathmont Forest*
Perthshire	
NN55	***Blackwood of Rannoch***
Stirlingshire	
NS68	*Carron Valley Forest*

the 10km squares sampled were those that contained at least 20% conifer woodland and were situated above 56°50’N. Thus, smaller woods and woods south of this line are poorly represented. However, it can be reasonably assumed that by visiting the bulk of larger woods, we sampled a significant proportion of the habitat available for Scottish Crossbills. Also, tape recordings made in southern Scotland yielded just 3 records of Scottish Crossbills, despite regular encounters with Common Crossbills (Summers *et al* 2002).

Numbers of crossbills in Strathspey pinewoods fluctuate in response to annual variations in Scots Pine cone crops (Nethersole-Thompson 1975, Summers 1999). In addition, ringing recoveries have shown that Scottish Crossbills move between Deeside and Strathspey (Marquiss *et al* 1995). Therefore, it is likely that the range in a given season or year will be smaller than the composite map derived from several years work (Fig 1). Such movements in response to food supplies probably play a role in the colonisation of new areas. This is demonstrated by the records in the Lodgepole Pine *P contorta* plantations of the Flow Country, an area previously unforested. The more southerly records also show their dispersive capability.

Further population and ecological studies are required to understand the dynamics of the distribution and abundance of Scottish Crossbills. In this paper, we have demonstrated the use of a distinctive call for field identification and mapping of Scottish Crossbills. We have confirmed the importance of northeast Scotland for this species, and shown that it is widespread in plantations.

Acknowledgements
Drs DW Gibbons, M Marquiss and J Wilson commented on the draft.

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Revised manuscript accepted October 2003

Estimating the breeding wader populations of Scottish uplands and salt marshes

M O'BRIEN & C S WHITE

Recent surveys have generated population estimates for 5 species of breeding waders on farmed land in Scotland. There have been no comparable surveys of the Scottish uplands, even though this habitat represents around 50% of total land area in Scotland. Surveys of selected sites have, however, been undertaken. The statistical relationship between wader densities from these upland surveys and information on the frequency of occurrence of the same species in upland habitats, as derived from data collected for the New Atlas of Breeding Birds, have been used as the basis for estimating population sizes for the whole of the Scottish uplands. These estimates are 2,500 pairs of Eurasian Oystercatcher, 4,500 Northern Lapwing, 9,100 Common Snipe, 13,100 Eurasian Curlew and 500 Common Redshank. These are compared with current farmland population estimates in Scotland.

Introduction

The populations of 5 breeding wader species (Eurasian Oystercatcher *Haematopus ostralegus*, Northern Lapwing *Vanellus vanellus*, Common Snipe *Gallinago gallinago*, Eurasian Curlew *Numenius arquata* and Common Redshank *Tringa totanus*) on the farmed land of Scotland have recently been estimated from a stratified random survey of c450 1km squares (O'Brien 1996, O'Brien *et al* 2002). These estimates exclude an unknown population of each of these species breeding in upland Scotland.

There have been a number of wader surveys of substantial areas within the Scottish uplands over the last 20 years, many of which have remained as unpublished reports within the offices of the Nature Conservancy Council (now Joint Nature Conservation Committee or Scottish Natural Heritage) and the Royal Society for the Protection of Birds. These provided a range of density estimates for a variety of species in a variety of selected areas of uplands. The fact that the areas surveyed had often been selected as 'good' for waders suggested that they were unlikely to be representative of wader densities in the uplands as a whole. Accordingly these figures have not previously been used to provide estimates of upland Scottish wader populations.

The New Atlas of Breeding Birds in Britain and Ireland was undertaken between 1988 and 1991 (Gibbons *et al* 1993). Fieldwork for the *Atlas* was based on surveys of 2x2 km squares (tetrads). Between 8 and 25 tetrads were surveyed in each 10km square and each species was scored as present or absent in each of the tetrads surveyed. The proportion of visited tetrads in each 10km square in which a species was recorded provides an approximate abundance (strictly, frequency of occurrence) index for each 10km square, and this has been used to derive the *Atlas* density maps for each species. In this study, we correlate *Atlas* frequency indices and density estimates derived from intensive surveys of selected areas for Eurasian Oystercatcher, Northern Lapwing, Common Snipe, Eurasian Curlew and Common

Redshank. Where a significant correlation exists, this is used as a basis for extrapolation to generate national density and, hence, population estimates for these species in the Scottish uplands. Slightly different methods were required for some Scottish island groups, these are outlined in the methods section.

Methods

Definition of upland

Land was classified as "upland", "lowland" and "other", according to the MacAulay Land Use Research Institute Land Capability classification (The MacAulay Institute for Soil Research 1982). The breeding wader survey of Scotland defined land classes 1 to 5.3 as farmed land (O'Brien 1996, O'Brien *et al* 2002), and so, by default, the uplands can be defined as land classes 6 and 7. These land classes are described as land suitable only for rough grazing (land class 6), or land of very limited agricultural value (land class 7).

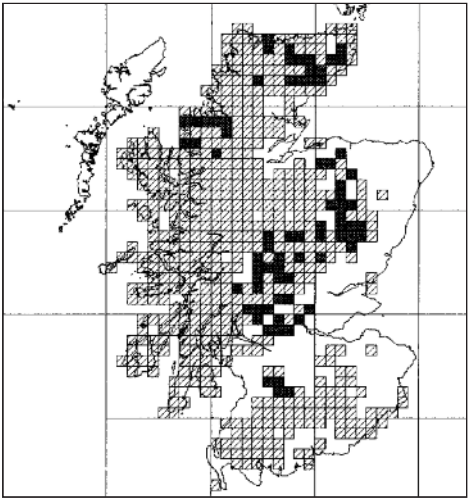

Figure 1. ***Relationship between the distribution of the uplands and the distribution of areas surveyed for breeding waders in upland habitats. The cross hatched squares are all 10km squares that include upland habitats and that have bird frequency index scores derived from the New Breeding Atlas. The shaded squares are those areas where detailed breeding wader surveys have been undertaken using appropriate methods and within the given time period (see Methods).***

Saltmarsh is a scarce habitat, totalling approximately 60km^2 of saltmarsh vegetation in Scotland, that has been identified as being an important habitat for breeding waders, in particular Common Redshank (Allport *et al* 1986, Brindley *et al* 1998). Saltmarsh habitats are included in the above definition of upland. The number of pairs of Common Redshank breeding on saltmarshes in Scotland has previously been estimated (Brindley *et al* 1998), while the numbers of other breeding waders recorded on a sample of Scottish saltmarshes were presented in Allport *et al* (1986). Using this data to estimate the saltmarsh population, together with confidence intervals, of these species was undertaken in the manner described in Brindley *et al* (1998).

This definition of the uplands represents land totalling 39,817 km^2, or 51.6%, of all land in Scotland together with a further 60km^2 of saltmarsh.

Estimating populations in the uplands of mainland Scotland

For the 5 breeding wader species considered, we determined which of the tetrads, surveyed for the Atlas, were predominantly upland (ie 80% or more of the land in the tetrad in land classes 6 and 7), and used only these tetrads to estimate an Upland Frequency Index for each species across all upland 10km squares in mainland Scotland. For the purposes of this analysis mainland Scotland includes the Inner Hebrides, but excludes Shetland, Orkney and the Outer Hebrides.

Only those Scottish upland surveys that were conducted between 1985 and 1995 (see Figure 1 for the distribution of these studies) to coincide approximately with the period of *Atlas* fieldwork were used. Also, only those surveys that had employed either the Brown and Shepherd (1993) or 200m transect (Stroud *et al* 1987) methods were used. Each of these methods cover ground in a manner similar to the farmed land breeding wader surveys, ie they get to within 100m of all parts of the surveyed area and map all birds observed. Other methods, such as 500m transects, do not aim to record all birds in the study area. Information on the location of breeding waders was obtained from survey maps from these studies and assigned to appropriate 10km squares. Any survey work in areas of these squares that would be classed as lowland, using the definition defined above, was excluded. Note that the land class based definition of lowlands does not exclude areas of moorland if these areas are deemed to be potentially suitable for agricultural improvement. Consequently, some areas that were intensively surveyed as upland habitats will be classed for the purposes of this analysis as lowland. These areas have been excluded from this analysis, but will have been included as part of the survey of breeding waders on farmed land.

We used a regression analysis to model density estimates (pairs km^2) derived from intensive surveys as a function of Upland Frequency Indices for all upland 10km squares where both data were available (see Appendix for details). A null model (ie mean density over all intensively surveyed 10km squares) was compared with a model that measured the extent to which the upland frequency indices explained variation from this null model. If the frequency index scores significantly improved the model (at $p<0.05$) then this latter model was used to derive population estimates (and 95% confidence intervals). If the frequency index score did not significantly improve the model then the best estimate was derived from the mean of the density estimates from the intensive surveys.

Population estimates for the Scottish mainland were then derived as follows:

1. Population density over the upland area covered by intensive surveys was converted into a total population estimate for that area.
2. The mean upland frequency index was substituted into the regression model in order to estimate an upland population density. This value was multiplied by the remaining upland area (ie that not included in 1, above) to generate a population estimate for upland area not covered by intensive surveys.
3. The standard errors derived from the regression model were used to derive upper and lower confidence intervals ($p=0.05$) around the generated population estimates for the upland area not covered by intensive surveys.
4. The overall population estimates were calculated by summing the population estimate from 1 and the estimate from 2. The upper and lower confidence intervals were estimated by adding the population estimate from 1 to each of the upper and lower confidence intervals from 3.

Estimating upland populations on the islands of Scotland

Breeding wader densities in parts of the Northern and Western Isles considerably exceed those on the Scottish mainland (Galbraith *et al* 1984). Consequently, where possible, island specific analyses were undertaken. The method used varied depending on the amount of information available on upland populations in the island groups. Comprehensive upland wader surveys have been undertaken on both Shetland and Lewis & Harris, while there have been no recent surveys of the uplands on the Uists, Benbecula and Barra or in Orkney.

The total area of uplands within Shetland has been estimated as 1,019km^2, 71% of the total area of land within Shetland (Macaulay Institute for Soil Research 1982). On Shetland a representative sample of these uplands was surveyed by Rothwell *et al* (1986); 29 of the 32 sites that they surveyed were classed as upland areas according to the definition used in the current paper. A number of additional areas known to have high wader densities were surveyed by Peacock *et al* (1985). Data from these 2 studies were considered to provide absolute counts for the survey areas covered (182 and 114 km^2, respectively). Mean wader densities from the sites surveyed by Rothwell *et al* (1986) were extrapolated to estimate the number of breeding waders on the remaining (723km^2) upland areas of Shetland. Confidence intervals were derived from the sample of 29 site specific density estimates for each species, by bootstrapping. 999 sets of 29 density estimates from the 29 sites were randomly resampled with replacement, a mean density was calculated for each set, and this was extrapolated to calculate a total population estimate for the unsurveyed area. The (known) population of the surveyed areas was then added to give a total population estimate for Shetland. All 1000 estimates were then ranked and the 25th and 975th ranked estimates were used as the 95% confidence intervals.

A survey of the number of breeding Eurasian Curlew on 24 randomly selected upland 1km squares on Orkney was undertaken in 1995 (Cadbury and Lambton 1995). This estimated the upland breeding Eurasian Curlew density at 4.98 pairs/km^2 on Orkney. This density estimate was used to calculate the total population of Eurasian Curlew on the uplands in Orkney outside of RSPB reserves. Information from the upland RSPB reserves on Orkney was included. Data for the RSPB reserves on Hoy, at Hobbister and Trumland and Birsay moors were extracted from the reserve management plans. Estimates for other waders on the uplands of Orkney were obtained by applying densities calculated for the Scottish mainland to the area of Orkney upland, excluding RSPB reserve areas. Population estimates were obtained by summing the count of waders on upland RSPB reserves and the estimates for the remaining upland areas on Orkney.

A detailed analysis of the upland wader populations of Lewis and Harris has recently been undertaken by Scottish Natural Heritage (Bates *et al* 1994). Surveys covering 259km^2 of the 1965km^2 of uplands in Lewis and Harris were extrapolated to areas of unsurveyed but suitable habitat as assessed by satellite imagery and LCS88 data. Population estimates for Common Snipe, Eurasian Curlew and Common Redshank were derived from this source. Population estimates were not attempted for either Northern Lapwing or Eurasian Oystercatcher by this method as these species were recorded less frequently than the other 3 species. Accordingly, the regression model derived from mainland Scotland was used to estimate these wader populations based on the mean *New Atlas* upland frequency index score for Lewis/Harris and the total area of uplands in the islands.

There have been no detailed wader surveys of the upland areas of the southern half of the Outer Hebrides (the Uists, Benbecula and Barra); 66 predominantly upland tetrads were surveyed for the New Atlas. These provide wader upland frequency indices specific to these islands. These, together with the total area of uplands in these islands (543km^2), were incorporated into the regression model derived for the Scottish mainland and used to produce total population estimates together with confidence intervals.

Combined Scottish population estimates

The breeding wader estimates for Scottish uplands can be calculated by summing the individual Scottish upland region estimates. Similarly, the overall Scottish population estimate can be calculated by summing the upland and lowland estimates. It is incorrect, however, to sum the 95% confidence intervals around these estimates to derive overall confidence intervals around the total estimate. Accordingly we used a randomisation approach to derive confidence intervals around the final population estimate (See Appendix for details).

Results

Identifying the relationship between wader density and upland frequency index

Upland breeding wader densities and upland frequency indices were jointly available for 76 10 km squares in mainland Scotland. The models that best fitted the data are presented in Table 1. Adding the quadratic term for upland frequency index did not significantly improve (at a $P<0.05$ level) the relationship for any of the 5 species. For 4 of the 5 species the best fit model included a linear and positive relationship between wader density and the upland frequency index. Only for Common Snipe was there no relationship. These models are used to estimate the wader populations in all subsequent analyses except on Shetland and, for 3 of the 5 species, on Lewis and Harris (see above).

Scottish mainland

The total area of upland on mainland Scotland has been calculated as 36,123 km^2. This is the total area of land capability classes 6 and 7 in Scotland less the area of land class 6 and 7 on Shetland, Orkney and the Outer Hebrides (The MacAulay Institute for Soil Research 1982). Of this, 719km^2 were covered by intensive surveys. For each of the 5 species, upland frequency indices for the intensively surveyed squares, and for all upland squares, are shown in Table 2. This indicates that, for Northern Lapwing, Eurasian Curlew and Common Redshank, the surveyed areas tended to be in squares with higher frequency index scores than upland squares in general. Correcting for inter square bias was therefore desirable. The reverse was true for Eurasian Oystercatcher, probably indicating that survey areas were chosen on the basis of a focus on upland wader species, whose habitat requirements will differ from those of Eurasian Oystercatchers. Survey areas may therefore have represented rather poor quality habitat for this species. The only species where there was no significant relationship between density and frequency index, Common Snipe, is one of the 2 species where the survey and upland frequency index scores are very similar. Simply extrapolating mean densities in survey areas therefore seems reasonable.

Table 1. ***Estimating the populations of breeding waders in the uplands of mainland Scotland. The intercept and slope coefficients are derived from a regression model with a Poisson error function of the form log(pairs km^{-2})= Intercept + slope * Upland Frequency Index. The analysis is derived from estimates of the density and upland frequency index on 76 separate 10 km squares.***

	Intercept		Slope	
	coefficient	Standard error	coefficient	Standard error
Eurasian Oystercatcher	-4.248	0.405***	1.863	0.733*
Northern Lapwing	-2.498	0.262***	1.508	0.473**
Common Snipe	-1.608	0.147***	0.000	
Eurasian Curlew	-1.805	0.342***	1.966	0.409***
Common Redshank	-5.332	0.576***	4.765	0.991***

Table 2. ***Upland frequency indices.***

	UFI Survey	UFI Upland
Eurasian Oystercatcher	0.195	0.203
Northern Lapwing	0.164	0.110
Common Snipe	0.179	0.174
Eurasian Curlew	0.324	0.246
Common Redshank	0.081	0.050

UFI Survey = upland frequency index for survey squares.
UFI Upland = upland frequency index for all upland squares.

Table 3. ***Population estimates for the uplands of mainland Scotland.***

	Population in survey areas	Estimated population in remaining upland areas	Total upland mainland population
Eurasian Oystercatcher	31	737 (326-1,686)	768 (357-1,717)
Northern Lapwing	116	3434 (2031-5644)	3,550 (2,147-5,760)
Common Snipe	160	7080 (5233-9162)	7,240 (5,393-9,322)
Eurasian Curlew	468	9437 (4477-18510)	9,905 (4,945-18,978)
Common Redshank	11	217 (67-710)	228 (78-721)

For each of the 5 wader species the total number of breeding pairs in the 719km^2 of the surveyed areas, the total population estimated for the remaining upland area (36,063-719 = 35,344km^2) based on the relevant regression model from Table 1, and the total upland population estimate for the Scottish mainland are presented (Table 3).

Scottish islands
Tables 4-7 present population estimates for the 5 key wader species for the uplands of Shetland (Table 4), Orkney (Table 5), Lewis & Harris (Table 6), the Uists, Benbecula and Barra (Table 7) and saltmarsh (Table 8).

Total population estimates
The Scottish upland population of the 5 wader species has been estimated by summing the totals for each of the regions (Table 9). A randomisation test was used to estimate the confidence intervals around these estimates (see Methods).

Combining the saltmarsh, upland and farmed land (O'Brien *et al* 2002) estimates gives the total population of the 5 species of breeding waders in Scotland (Table 10). For all species, the upland population represents only a small proportion of the Scottish total, for 3 species this is less than 5% of the total. The uplands represent an important habitat for just 2 of the species, Eurasian Curlew and Common Snipe.

Discussion

The upland wader population estimates presented here complement the results of the lowland wader surveys of 1992-93 and 1997-98 (O'Brien, 1996, O'Brien *et al* 2002). Estimates of the Scottish populations of Eurasian Oystercatcher and

Table 4. ***Estimates of breeding wader populations in the uplands of Shetland.***

	Number of pairs recorded on upland sites	Density estimate (pairs km^{-2})	Total number of birds surveyed	Upland Population Estimate (95% Confidence Intervals)
Eurasian Oystercatcher	276	1.52	597	1,694 (1,351-2,136)
Northern Lapwing	102	0.56	221	626 (496-766)
Common Snipe	139	0.76	241	793 (646-959)
Eurasian Curlew	313	1.72	487	1,731 (1,362-2,161)
Common Redshank	21	0.12	40	123 (88-171)

Table 5. ***Estimates of breeding wader populations in the uplands of Orkney.***

	Total number recorded on RSPB reserves (75km^2)	Upland Frequency Index scores for Orkney (from 26 tetrads)	Total upland estimate (95% confidence intervals) (216 km^2)
Eurasian Oystercatcher	20	0.42	24 (21-29)
Northern Lapwing	28	0.27	31 (29-35)
Common Snipe	140	0.88	157 (147-191)
Eurasian Curlew	418	0.88	1120 (1,003-1,314)

Eurasian Curlew exceed previously published UK totals by 2.4 and 1.5 times respectively (based on middle of range data summarised in Stone *et al* (1997)). The importance of the populations of breeding waders in Scotland within a European context has previously been highlighted (O'Brien *et al* 2002).

A significant proportion of the population of 2 of the species, Common Snipe and Eurasian Curlew, occurred in the uplands. These, combined with the large populations of Golden Plover *Pluvialis apricaria*, Dunlin *Calidris alpina* and, in parts of the uplands, Greenshank *Tringa nebularia* indicate that upland habitats provide an important resource for breeding waders in Scotland.

There are a number of assumptions in the analysis that need to be considered when assessing the accuracy of the population estimates.

■ The potential for bias in tetrad selection from within a 10km square is considered in *the New Atlas*. The *New Atlas* includes a comparison of measures of abundance obtained from the main Atlas survey with those from a survey of 'key squares'. The selection of tetrads in the Key Square Survey was random. The results of the comparison indicate that the Atlas survey contained a bias towards tetrads with Eurasian Oystercatchers ($P<0.05$ in Scotland), but no significant biases associated with any of the other target species (Gibbons *et al* 1993).

■ The patchy distribution of the survey squares that provided the density estimates (as shown by Figure 1) to compare with the frequency indices may bias the relationship. It is possible that the

Common Redshank	14	0.19	15 (14-16)

Table 6. ***Estimates of breeding wader populations in the uplands of Lewis and Harris.***

	Total pairs surveyed on Lewis/Harris	Upland Frequency Index (from 199 tetrads)	Lewis/Harris population estimate
Eurasian Oystercatcher	2	0.18	35 (15-77)
Northern Lapwing	33	0.20	221 (136-359)
Common Snipe	140		800 (649-992)
Eurasian Curlew	32		200 (105-390)
Common Redshank	21		100 (52-175)

Table 7. ***Estimates of breeding wader populations in the uplands of the Uists, Benbecula and Barra.***

	Upland Frequency Index (from 66 tetrads)	Uists, Benbecula and Barra population estimate
Eurasian Oystercatcher	0.27	13 (5-32)
Northern Lapwing	0.36	77 (41-146)

relationship varies within the Scottish mainland, for example between the west and east coasts of Scotland or between the Flow Country and other parts of the Scottish uplands.

■ Frequency Indices apply to the whole of the upland area within a 10 km square, whereas the detailed bird surveys covered only part of any 10km square (at times the densities were based on a survey of a single 1km square). Densities derived from these detailed surveys were then applied to the whole 10km square, with the assumption that survey plot densities are representative of densities in the 10km square as a whole. Any intra square bias caused by positively selecting areas from within the 10km square may inflate the apparent wader density for the given frequency index. Note that many of the density estimates in Eastern Scotland were derived from 1 km squares that had been randomly selected from within a 15km by 15km square so the bias associated with selecting the areas for survey would not be applicable to these sites (Shepherd *et al* 1989).

■ It has been assumed that wader populations in the uplands were reasonably constant between the years that the upland surveys were undertaken and the time of the Atlas fieldwork. The Atlas fieldwork was spread between the years 1988 and 1991. Frequency Index data does not identify the year in which data was gathered for a particular 10km square. The upland surveys analysed took place between 1985 and 1990. Any rapid change in wader numbers between the atlas and the survey years will reduce the level of accuracy. It should be noted, however, that a previous study of upland breeding wader populations found that there was very low inter annual within plot variation in wader densities (Langslow and Reed, 1985).

Common Snipe	0.33	109 (81-144)
Eurasian Curlew	0.08	101 (52-211)
Common Redshank	0.32	12 (3-42)

Table 8. ***Estimates of breeding wader populations on Scottish saltmarshes. Counts of breeding waders are derived from the 1985 survey (Allport* et al *1985) except for Common Redshank which were resurveyed in 1996 (Brindley* et al *1998). Total area surveyed was 9.81 km² – 88.89% of which was vegetated (Brindley* et al *1998)***

	Number recorded (8.72km²)	Population estimate (c60km²)
Eurasian Oystercatcher	107	702 (520-888)
Northern Lapwing	49	348 (141-623)
Common Snipe	0	0
Eurasian Curlew	17	114 (55-183)
Common Redshank	210	811 (397-1246)

Table 9. ***Breeding wader population estimates for the uplands of Scotland. The 95% confidence intervals around the population estimates were derived using a randomisation test (see Methods).***

	Mainland	Lewis and Harris	Uists, Benbecula and Barra	Orkney	Shetland	Scottish upland Population Estimate
Eurasian Oystercatcher	768	35	13	24	1,694	2,534 (1,950-3,600)
Northern Lapwing	3,550	221	77	31	626	4,505 (3,087-6,782)
Common Snipe	7,240	800	109	157	793	9,099 (7,282-11,212)
Eurasian Curlew	9,905	200	101	1,120	1,731	13,057 (8,209-22,521)
Common Redshank	228	100	12	15	123	478 (302-964)

Table 10. ***Total population estimates for farmland breeding waders in Scotland. The 95% confidence intervals have been derived using a randomisation test (see Methods).***

	Upland	Saltmarsh	Farmed Land	Scottish Total	% in uplands
Eurasian Oystercatcher	2,534	702	91,102	94,338 (80,152-107,170)	3%
Northern Lapwing	4,505	348	86,654	91,507 (71,801-105,842)	5%

■ The relationship between wader density and frequency index may not be linear. Frequency indices vary between zero and one while bird densities vary between zero and infinity. A frequency index of one (all surveyed tetrads being occupied) could have a minimum density of 0.25 pairs km^{-2} whereas the maximum densities recorded for any one 10km square in the current survey was 14 pairs km^{-2} (Northern Lapwing on Lewis). Attempts to fit curvilinear plots (x+x2) failed to significantly improve the fit of the models, perhaps because there was insufficient data to indicate a curvilinear relationship. This may be a particular issue in studies where a high proportion of the frequency indices are close to the maximum possible.

■ The density data for this analysis were derived from either 200m transect surveys or the Brown and Shepherd method (Brown and Shepherd, 1993). There have been few comparisons between the numbers of breeding waders recorded by the 200m transect surveys and the number recorded by intensive surveys (Jackson and Percival 1983, Stroud *et al* 1987). Jackson and Percival (1983) compared the single, June, survey on machair sites with intensive survey work and found that the single survey underestimated Ringed Plover and Dunlin by 16% and 21% respectively, but found no difference for Oystercatcher and Redshank. Stroud *et al,* working in the Flow Country, suggested that the number of breeding waders recorded by the transect method was between 65% (Dunlin) and 90% (Golden Plover) of the actual number of pairs present. The Brown and Shepherd method was found to record around 60% of all Eurasian Oystercatchers, 53% of Northern Lapwing, 73% of Common Redshank and 86% of Eurasian Curlew on a site when compared with intensive nest finding methods. The intensively studied sites used for the comparison with the species considered in the present analysis tended to be sites on agricultural sites. The applicability of these estimates to upland, and in particular low density, sites have not been determined. It is likely that the population estimates presented here represent minimum figures for each of the species.

The estimates presented here are currently the best available, based as they are on the use of Atlas frequency index data to compensate for the bias associated with site selection in previous upland surveys. They are, however, already more than 10 years out of date. It is unlikely that a more robust survey will be undertaken to specifically count the upland wader population in the near future. If an updated atlas provides similar opportunities for comparison across the uplands then undertaking upland surveys to calibrate atlas information may provide the best option for revising these population estimates. The only alternative way of improving on the accuracy of the current estimates may be to undertake a detailed analysis of the habitat requirements of breeding waders in the uplands, and use this to extrapolate to areas not previously surveyed. This type of approach has been attempted for Golden Plover, Greenshank and Dunlin in the flow country (Stroud *et al* 1987, Avery and Haines-Young 1990).

Acknowledgments

Many thanks to staff at the BTO, in particular Deborah Lang, Nick Carter, Rob Fuller and Carl Evans who provided the atlas derived data. Phil Whitfield at SNH, Andy Brown at EN and David Stroud at JNCC provided unpublished information. Within RSPB Ian Fisher, Mark Hancock, Murray Grant, James Pearce-Higgins and Innes Sim have all stimulated much discussion about the methods used while Ian Bainbridge, David Gibbons and Jeremy Wilson improved previous drafts of this paper.

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Appendix

We used a regression model with a poisson error function and a logarithmic link function to relate the number of birds surveyed in a square to the frequency index for that square. The number of birds surveyed will be dependent on the area surveyed, so we included log(area surveyed) as an offset in the model. This is equivalent to comparing the density of birds surveyed in the square with the frequency index. The advantage over using density as a dependent variable is that this approach weights the density by the area over which the density has been determined. The equation for the analysis is

Log(No of birds in survey) = intercept + log(area) [+ slope*frequency index].

We compare the equation with and without the term in square brackets by using change in the residual deviance, tested against a ˜2 distribution with the appropriate degrees of freedom. If adding the frequency index component significantly improved the model ($p<0.05$) then we can use the frequency index scores derived for all upland squares to estimate the average density of each of these species across all uplands in Scotland.

Summing the upper and lower confidence intervals for each of the areas is an inappropriate way of determining the 95% confidence intervals for the population as a whole. Rather, we generated a set of 999 standardised normal values at random from a normal distribution with mean=zero and standard deviation=1. We then multiplied each of these by the standard error derived from the regression model for the given species and used this figure to calculate a 'pseudo population' estimate for the species in the given region. We repeated this for all 999 values. We generated a new set of standardised normal values for each of the regions where we used the regression model to derive a population estimate. We added the actual population estimates for each region to this 'pseudo population' estimate, making 1000 estimates. We then combined this, in random order, with the bootstrapped estimates for each of the Shetland and the Lewis and Harris populations. We then summed the pseudo population estimates across each of the regions to provide 1000 estimates of the total wader population for each species. This is then sorted and the 25th and 975th value used as an estimate of the 95% confidence intervals around the total population estimate.

Origins and movements of Common Starlings wintering in the Highlands

HUGH CLARK & ROBIN M SELLERS

This paper presents an analysis of the origins and movements of Common Starlings wintering in the Highlands of Scotland based on 391 ringing recoveries generated over the past half century. They show that the midwinter population is made up of birds from 4 main areas, the breeding population of the Highlands, migrants from the continent, birds dispersing or in some cases migrating from Orkney and Fair Isle, and a small number of birds from southern Scotland and northern England. Information on the approximate percentage of birds from these different areas and their age and sex are tabulated.

The recoveries show that many birds depart in late winter or spring, with substantial numbers returning to the continent to breed, and much smaller numbers to Fair Isle. They reveal also a distinct and unusual series of movements of birds to the south of the Highlands. These movements take the birds to northeast, central and southern Scotland as well as northern England. For movements over 50 km, the frequency distribution of distances moved is approximately exponential with a 'half distance' of 193 ± 22 km. Most of the birds undertaking these long distance southward movements are first years, though some adults are also involved. The origins of these birds are discussed.

Introduction

Most mainland European populations of the Common Starling *Sturnus vulgaris* migrate along a broadly northeast/southwest axis, with substantial numbers moving into Britain to winter (*eg* Goodacre 1959, Dorst 1962, Feare 1984, 2002). The British breeding population, by contrast, has been viewed as largely sedentary, with movements generally confined to a few tens of kilometres from the natal site (Feare 1984, 2002, Thom 1986), though Rae & Morris (1978) and Duncan (1984) have presented some preliminary observations based on the ringing of Common Starlings in Aberdeen suggesting that more extensive movements orientated to the south may also occur. During the winter months Common Starlings are largely absent from high ground in Scotland, and appear in greatest numbers in Orkney, Caithness, Aberdeenshire and the Central Lowlands, according to the 1981-84 Winter Atlas Survey (Lack 1986). In Caithness they are one of the commonest winter birds, feeding by day mainly on farmland and congregating at night in large communal roosts in or on buildings, conifer plantations and other woodland, and sea caves. As a breeding species Common Starlings are very unevenly distributed in the Highlands. The 1988-91 Breeding Atlas Survey shows them to be concentrated in Caithness (excluding the Flow Country), around Dornoch in Sutherland, between the Dornoch Firth and the Cromarty Firth in Easter Ross, and in the Black Isle (Gibbons, Reid & Chapman 1993). In these areas winter numbers are appreciably greater than in the breeding season, typically building up in October and November, and decreasing between late February and the end of March. We report here the results of an investigation into the origins of Common Starlings wintering in the north of Scotland and the movements associated with the build up and decline of winter numbers.

Material and methods

For the purposes of this study the Highlands are taken as the former Highland Region (that is Caithness, Sutherland, Ross & Cromarty, Invernessshire, Nairn, and Argyll north of the Sound of Mull including the Glencoe area). The analysis is based on 391 recoveries, details of which were kindly supplied by the British Trust for Ornithology. Of these, 191 (49%) were birds ringed and recovered in the Highlands, 143 (37%) birds ringed in the Highlands and recovered elsewhere, and 57 (15%) birds marked elsewhere and recovered or recaptured in the Highlands. For those marked in the Highlands, the distribution of ringing sites showed a strong bias towards low lying land especially that between Wick and Inverness. This reflects primarily the distribution of ringers, but in midwinter, when Common Starlings become regular visitors to gardens, it seems to be a fair reflection of the distribution of birds. The principal ringing sites (or groups of sites) in the Highlands in terms of the number of recoveries generated were Wick (121 recoveries), Inverness (72), Golspie (22), Thurso (16), Beauly (13) and Invergordon (12).

In Caithness the vast majority of the birds were caught in elastic propelled ‘whoosh’ nets baited with household scraps and a mixture of fish, batter and fat waste. We have no direct information on the catching methods used elsewhere in the Highlands, but many of the recoveries originate from before the advent of mist nets and presumably involve clap nets and static traps such as Potter traps or chardonnerets. The biases inherent in these catching methods as concerns Common Starlings are unknown but the possibility of some bias needs to be borne in mind when considering the age and sex ratios described below.

The bulk of the recoveries were generated from ringing during the past half century, but there was some variation in the numbers marked in different parts of the Highlands at different dates. In Caithness most were caught between 1985 and the present, with especially large numbers of recoveries being produced from intensive ringing in the winters of 1985-86 and 1986-87. Ringing elsewhere in the Highlands was more evenly spread, but with a slight bias towards the 1950s. The majority (67%) of the recoveries refer to birds caught in the winter months (November - March inclusive). The 391 recoveries include 43 (11%) of birds ringed as nestlings.

Many of the recoveries were generated from birds found dead, but in the majority of such cases the cause of death was unknown and the birds were simply reported as found dead or dying (195 recoveries, 50%). Of those in which the cause of death was known, 46 (11.8%) recoveries resulted from birds killed by cats, 16 (4.1%) from birds found dead after becoming trapped in buildings, 13 (3.3%) from birds which had been shot, 9 (2.3%) were road casualties, 6 (1.5%) were from birds which had been predated, 2 (0.5%) were from birds which had flown into windows, 2 (0.5%) from birds which had collided with wires, 2 (0.5%) birds which had drowned and 1 (0.3%) was from a bird killed by a dog. In addition, 63 (16%) were birds caught (‘controlled’) by other ringers and 31 (8%) were birds which had been caught alive by non ringers and released (mostly birds trapped in buildings). In the remaining 5 (1.3%) the recovery circumstances were unknown. There is an obvious association with man and his world.

Sexing Common Starlings is relatively

straightforward but ageing techniques have improved considerably in the half century or so during which the recoveries were generated. Nevertheless some birds remain difficult to age (*cf* Williams 1991, Svensson 1992) and the possibility that some of the recoveries included in this study result from birds that were incorrectly aged on ringing needs to be borne in mind.

Statistical analysis was undertaken using the Minitab Statistical Software Package, release 13, or following procedures described in Bailey (1981) or Batschelet (1981).

Results

Common Starlings marked in the Highlands have been recovered in 4 main areas: (i) northern Europe, (ii) the United Kingdom south of the Highlands, (iii) the Northern Isles and (iv) the Highlands themselves. Movements of birds marked outside the Highlands and recovered there corresponded with categories (i), (ii) and (iii). These 4 categories form the basis of the analysis presented here. In none of them did the sex ratio differ significantly from 1:1 (Table 1).

Movements between the Highlands and northern Europe

A total of 66 recoveries relate to movements between the Highlands and Northern Europe, and include 2 from ships in the North Sea. Of these 56 (85%) were birds marked in the Highlands, and 10 (15%) on the continent. Fig 1 shows the distribution of ringing or recovery sites on the continent. The majority (85%) were in Norway, with a marked bias towards the Bergen and Stavanger areas in SW Norway and around Trondheim in south central Norway, the provinces of Rogaland, Hordaland, More og Romsdal and Sör-Tröndelag accounting for 66% of movements to or from Norway. In addition, there were movements to or from Denmark (5), Finland (2) and Estonia (1). The most northerly movement was of a bird recovered in Troms in N Norway (69ºN) within the Arctic Circle, the most southerly one in Fyn, Denmark (56ºN) and the most easterly a bird from Parnu, Estonia (24∞E). Ignoring the 2 recoveries in the North

Table 1. ***Age and sex composition of birds moving to and from the Highlands***

Category	Number of recoveries females[a]	males[a]	n	first-years	adults	n	Total no. of birds[b]
to/from Continent (age on handling in Highlands)	26 (43%)	34 (57%)	60	36 (67%)	18 (33%)	54	66
to South	37 (49%)	38 (51%)	75	51 (80%)	13 (20%)	64	80
from South	4 (57%)	3 (43%)	7	8 (80%)	2 (20%)	10	12
to Northern Isles	4 (67%)	2 (33%)	6	6 (100%)	0 (0%)	6	7
from Northern Isles	13 (57%)	10 (43%)	23	31 (94%)	2 (6%)	33	35
within Highlands (age on ringing)	65 (44%)	82 (56%)	147	109 (69%)	48 (31%)	157	191

a Sex ratio not significantly different from 1:1 in any case ($P > 0.1$)
b Note not all birds aged *and* sexed.

Sea, about 50% of birds had moved between 480 km (which represents the shortest sea crossing between the North of Scotland and the continent) and 800 km, and 75% between 480 km and 1100 km. The longest recorded movement was the bird ringed in Estonia, already referred to, which travelled to Wick, a distance of 1614 km. Movements (in terms of those from Scotland to the continent) were nearly all orientated between northeast and east.

The dates of handling of these birds are shown in Fig 2a. A very clear separation is apparent, with all the handlings in the Highlands falling in the winter months (November - March) with just one exception (a bird ringed in More og Romsdal, Norway in August and recovered in Caithness the following July), and those on the

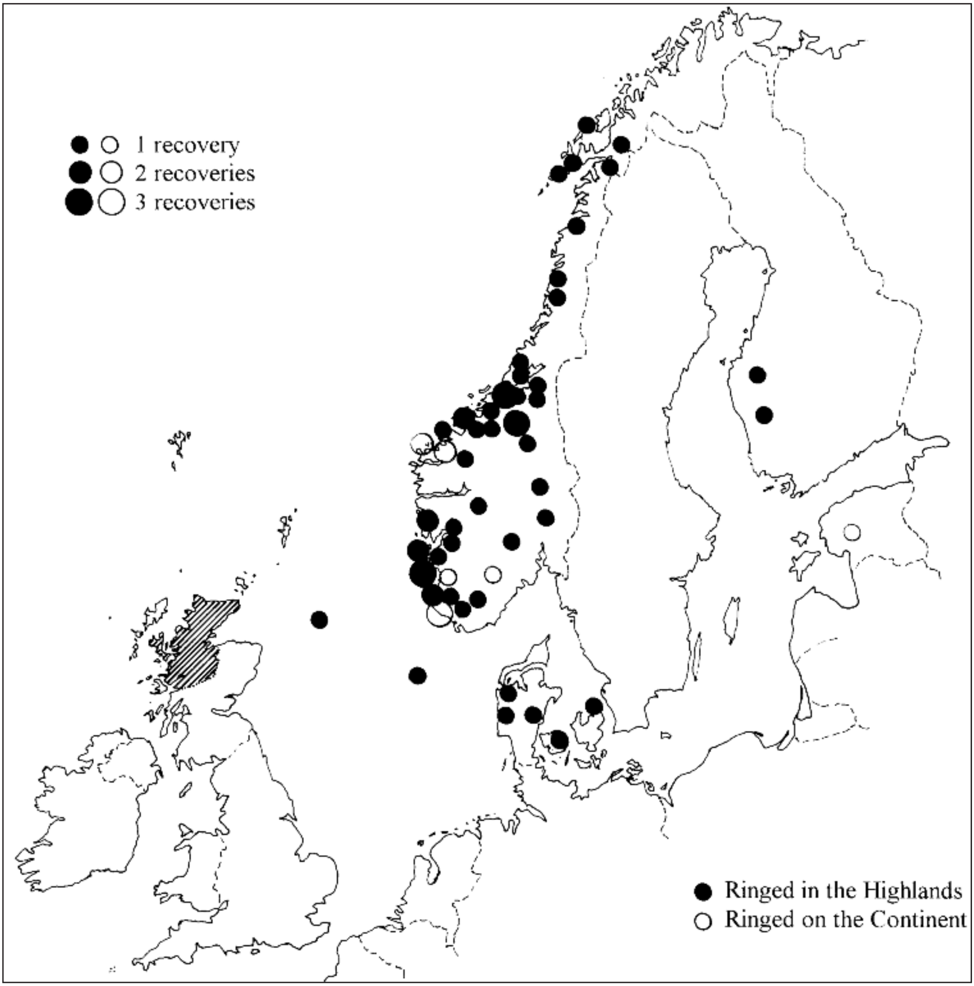


Figure 1. ***Starling movements between the Highlands and Northern Europe***

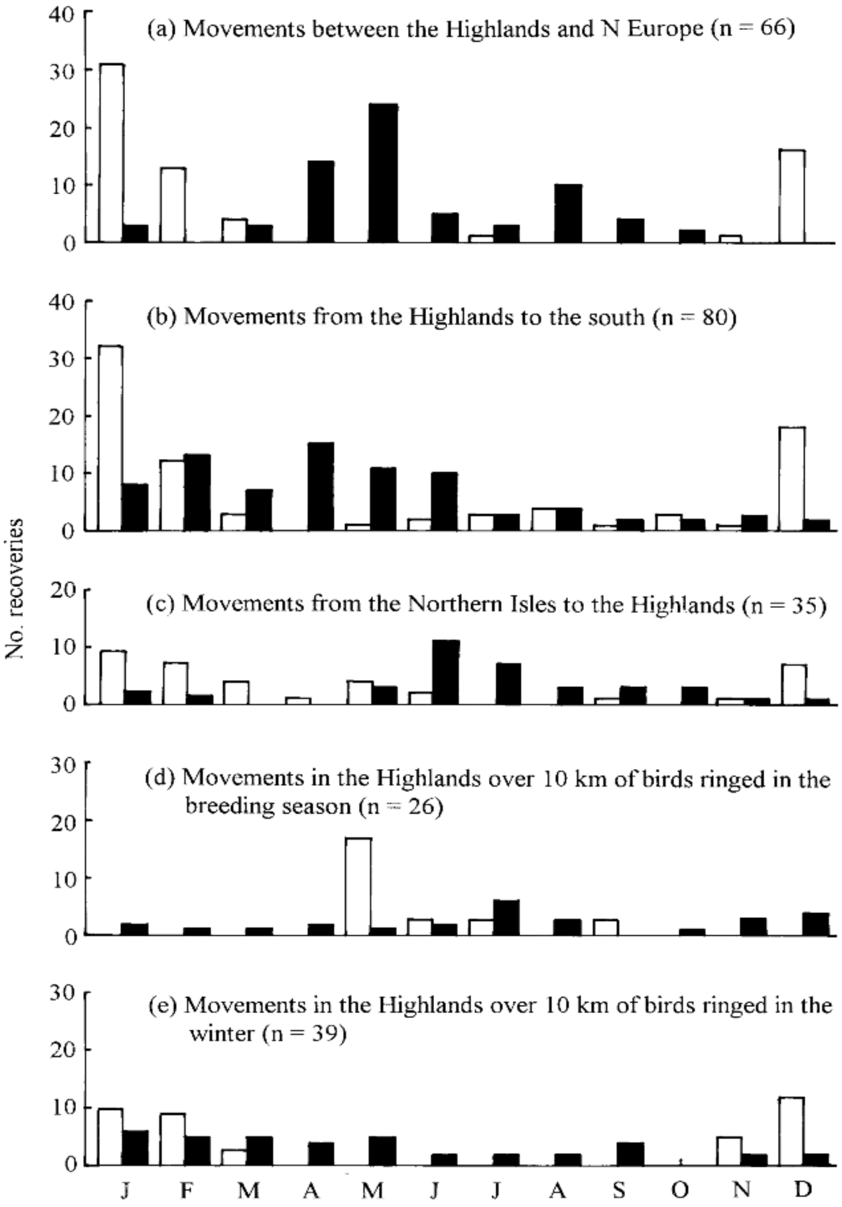


Figure 2. ***Dates of ringing and recovery of movements into and within the Highlands. (a) - (c) open columns, dates of handling in Highlands; solid columns, dates of handling out of the Highlands; (d), (e) open columns, ringing dates; solid columns, recovery dates***

continent being primarily in the breeding season (March - October) with just 3 exceptions. The latter were all birds ringed in Scotland in the winter months and recovered in Norway (2 birds) or on board a ship in the North Sea (one bird) in January in a subsequent season.

The ages and sexes of the birds involved in these movements are summarised in Table 1. First year birds outnumbered adults by about 2:1.

Movements between the Highlands and the South

Of the 92 recoveries involving movements between the Highlands and the South, 80 (87%) concerned movements from north to south, and 12 (13%) ones in the opposite direction. In the former group there were 56 (70%) recoveries widely distributed in Scotland with particular concentrations in Grampian and Tayside Regions, 23 (29%) in England, mainly in northern England but extending as far south as Avon, and one (1%) in N.Ireland. As Figure 3 demonstrates, most of these movements were orientated between ESE and south, with a substantial subset of movements to the east, mostly birds from near Inverness moving to NE Scotland and the Aberdeen area. The majority of recoveries were found between 50 and 150 km, with mostly decreasing numbers in each subsequent 100 km interval above this (Fig 4a). A plot of the logarithm of the number of recoveries in each 100 km interval against distance was close to linear (Fig 4b), showing the frequency distribution of distances moved to be approximately exponential. From the slope of the line in Fig 4b, the 'half distance'1 can be estimated as 193 ± 22 km. The longest movement recorded was from Nairn to Bath, Avon, a distance of 695 km.

Among birds that were aged, first year birds outnumbered adults by about 4:1. Two of the recoveries involved birds ringed in the Highlands as nestlings.

The dates of handling and recovery of birds moving out of the Highlands to the south are shown in Fig 2b. The majority of these were birds marked in the winter months (December - February inclusive), and, although there were recoveries in all months, most were in late winter and spring (February - June inclusive), suggesting that the movements had taken place in late winter.

The timing of ringing and recovery of 34 birds found within a year of being marked are illustrated in Fig 5, and showed 2 distinct phases of movements, one in the summer months (mostly July - October inclusive) and a second from late winter into spring (mid-January - April inclusive). The former involved only first year birds, with movements not clearly orientated in any particular direction (movements fell between NNE and SW, *cf* Fig 6a) and distances moved of mostly <100 km. The later movements, by contrast, though mostly undertaken by first year birds, also involved some adults, were nearly all orientated to the south or SE and involved many movements over 200 km (*cf* Fig 6b).

Southward movements were recorded in the majority of years for which we have data, though the number of recoveries showing such movements appeared to vary between years. This could, of course, simply reflect differences in the numbers of birds marked, but, except for Caithness, we have no information on the numbers of birds ringed each winter. To allow for this, we normalised for variations in ringing effort by expressing the number of recoveries over 50 km to the south of the Highlands as a percentage of the total number of UK recoveries of birds ringed in the Highlands in each November to March period. In any one such period the percentage of recoveries to the south over 50 km

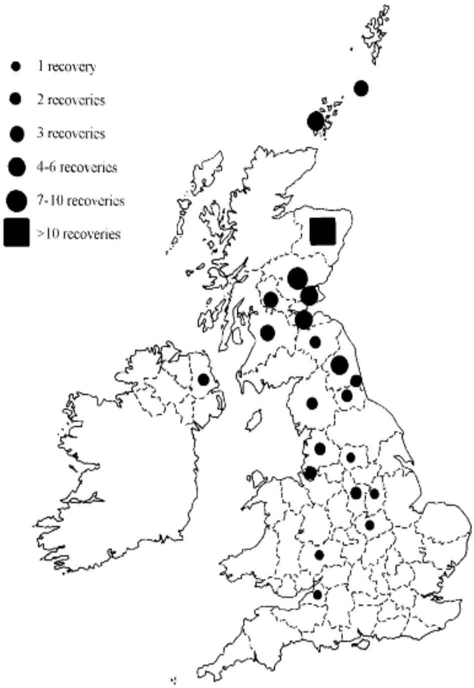


Figure 3. ***Movements from the Highlands to other parts of Britain and Ireland.***

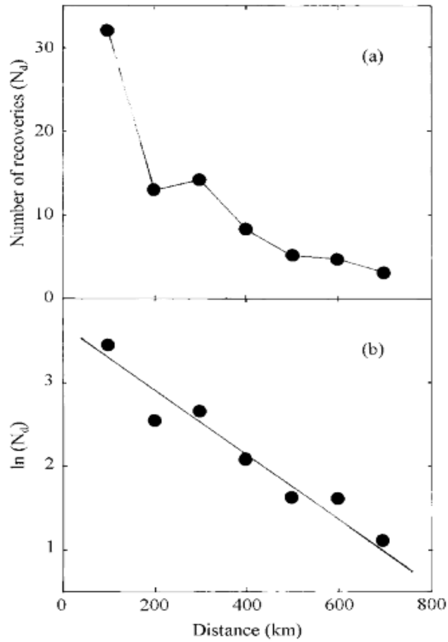


Figure 4. ***Frequency distribution of distances moved over 50 km for birds moving from the Highlands to the South. (a) Plot of number of recoveries against distance. (b) Plot of ln(number of recoveries) against distance.***

varied between 0% and 100%, with an overall mean of 43%. Sample sizes in any one period were generally small, however, and the results mostly not suitable for statistical analysis. Low numbers moved more than 50 km south in 1976/77 (1 of 8 recoveries), 1984/85 (1 of 8) and 1990/91 (none of 5), and each of these were significantly different from each of 4 other winters which gave rise to at least 10 recoveries (Fisher Exact Probability Test, $P < 0.05$ in all cases). It appears that the numbers moving south do vary between one year and the next to some extent, but this conclusion must remain tentative until a larger data set becomes available.

There were too few recoveries of birds moving *into* the Highlands *from* the south to provide any detailed characterisation of such movements. Of the 12 such recoveries, ringing locations were equally divided between Scotland and England and involved 5 movements in the range 100-200 km, 2 between 200 and 400 km and 5 between 400 and 700 km. Three of the birds were marked as nestlings, 4 others as first years and 2 as adults. The 3 birds ringed as nestlings were all marked in May and recovered (i) 136 km away in the following month, (ii) 151 km away 7 months later, and (iii) 8 months later, having moved 697 km from Slough, Berkshire to Inverness, the longest south to north movement recorded.

Movements between the Highlands and the

Northern Isles

There were 42 recoveries of birds moving between the Highlands and the Northern Isles, 7 (17%) from south to north, and 35 (83%) in the opposite direction. The northward movements included 3 from Caithness to Orkney, 3 from Caithness to Fair Isle and one from Nairn to Orkney, the latter at 169 km was the longest of these 7 movements. All bar one of these were birds ringed in their first year of life. They included one marked as a nestling in Caithness and found on South Ronaldsay, Orkney, 44 km away, 2 months after ringing, and another marked as a first year female in Wick on 26 February 1994, caught on Fair Isle on 17 May 1995 and retrapped back in Wick on 6 December 1998.

The ringing and recovery locations of the 35 movements from the Northern Isles to the Highlands are summarised in Table 2. Most common amongst these were birds ringed on Fair Isle and found in Caithness, a distance of around 150 km SW. Nearly all the birds making these movements were in their first year of life having been ringed either as nestlings (8 birds) or first year birds (23 birds); just 2 were aged as adults on ringing and 2 were unaged (*cf* Table 1). These movements appear to take place mainly in late summer, autumn and early winter. Thus the majority of the birds were marked in either June or July and recovered or recaptured between December and March (Fig 2c). This is supported by the timing of 13 birds recovered or recaptured in the same season as they were ringed.

Movements within the Highlands

The largest single group of recoveries were those in the Highlands, comprising some 191 in total. Of these 114 (60%) were within 5 km of the place of ringing, 160 (84%) within 25 km and 179 (91%) within 50 km. The general pattern of distances moved (the majority near

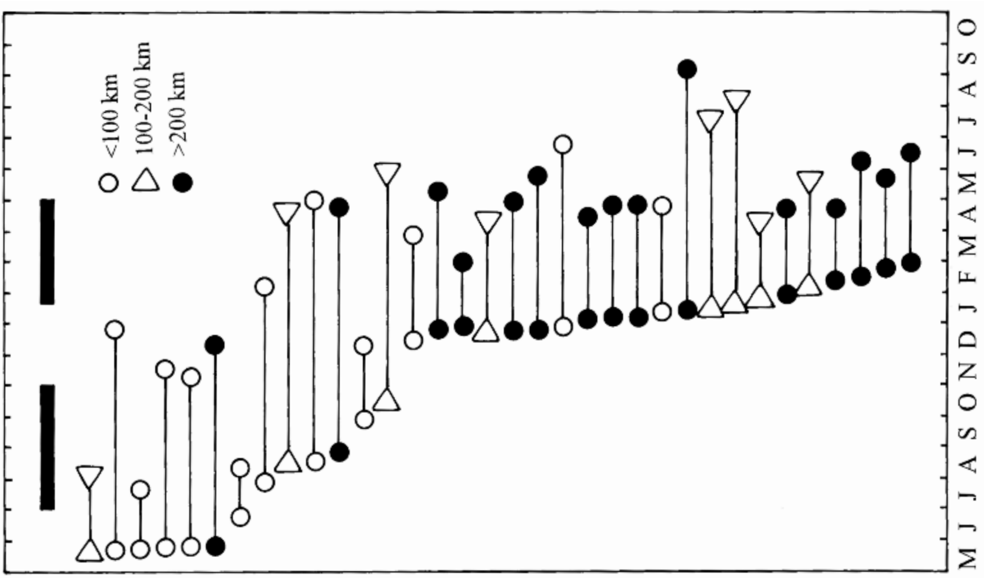
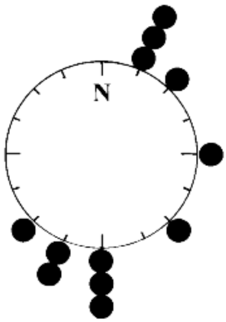
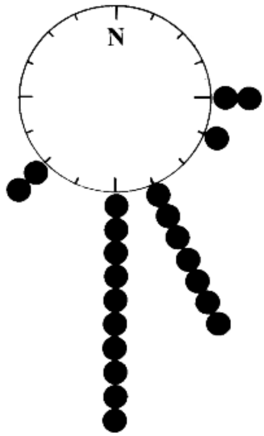


Figure 5. ***Dates of ringing and recovery of birds moving south from the Highlands and recovered in the same season***



(a) Birds ringed June - November
(Rayleigh test, z = 1.071, n = 12, $P > 0.05$, N.S.)



(b) Birds ringed December - April
(Rayleigh test, z = 16.06, n = 22, $P < 0.01$)

Figure 6. ***Orientation of same season movements over 50 km of birds ringed in the Highlands and recovered in Britain. (a) Birds ringed June - November (Rayleigh test, z = 1.071, n = 12, P > 0.05, N.S.); (b) Birds ringed December - April (Rayleigh test, z = 16.06, n = 22, P < 0.01).***

the place of ringing, with declining numbers as the distance from the place of ringing increases) was the same regardless of whether birds had been ringed in the breeding season (May to September inclusive) or during the winter (November to March) (Fig 7). Movements of 10 to 50 km showed no particular orientation, regardless of when the birds were ringed (Fig 8a & 8c), whilst those over 50 km were orientated mainly to the SSW/SW if the birds were ringed in winter (Fig 8d). There was some clustering in the opposite direction for birds marked in the breeding season, but the number of recoveries was small and the results were not (quite) statistically different from random (Fig 8b).

Of birds marked in the non-breeding season (November - March) and moving more than 10 km, 61% were in their first year of life compared with 65% for those recovered within 10 km. By contrast of those ringed in the breeding season and moving more than 10 km, 88% were first year birds, compared with 59% in birds remaining within 10 km. Some 23 of these recoveries involved birds ringed as nestlings, that is were drawn from the local breeding population. Of these, 7 (30%) were found within 10 km, and 16 (70%) beyond this.

The dates of handling and recovery of birds remaining in the Highlands but moving at least 10 km are shown in Figs 2d and 2e, but give little indication of any seasonality in the movements. Birds recovered within the same season as they were ringed also show that movements of 10 km or more take place at almost any time between fledging and the following spring. Some birds ringed as nestlings moved within a few months of fledging, indeed in some instances within a few weeks, and included, for example, a bird ringed as a nestling at Dores, Invernessshire which was found 11 weeks later in Thurso, Caithness, 150 km away. Movements of 10-100 km within the Highlands

Table 2. ***Ringing and recovery locations of birds moving from the Northern Isles to the Highlands***

Ringing location*	Recovery location	No. of recoveries (%)	
Fair Isle	Caithness	21	(60%)†
	Sutherland	2	(6%)
	Ross & Cromarty	1	(3%)
	Inverness-shire	1	(3%)
Orkney	Caithness	5	(14%)
	Sutherland	2	(6%)
	Inverness shire	3	(9%)

* There were no movements from Shetland excluding Fair Isle to the Highlands.
† Most of these were birds caught ('controlled') as part of our ringing programme.
1 'Half distance' (d_-) is related to the slope (a) of plots such as Fig 4b by $d_- = (ln2)/a$ (*cf* Boddy & Sellers 1983) and is the distance by which half the birds moving beyond a particular distance will have stopped moving. Thus 50% of birds moving more than 50 km will have stopped within 243 km (50 + 193), 75% within 436 km (243 + 193), 87.5% within 629 km, and so on.

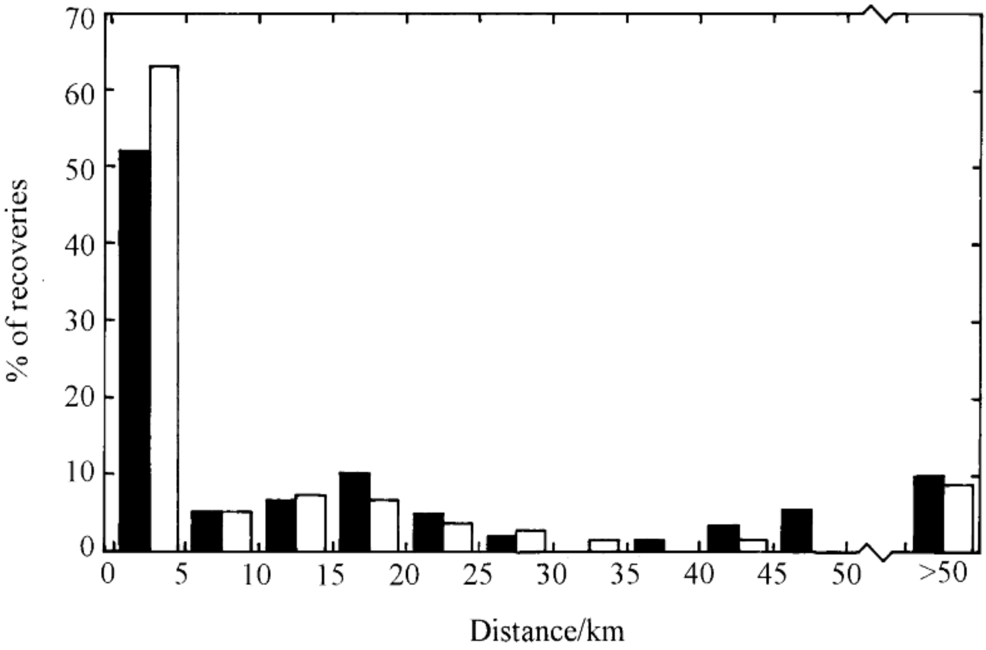


Figure 7. ***Frequency distribution of distances moved for movements within the Highlands. (Open columns, birds ringed November - March; solid columns, birds ringed May - September)***

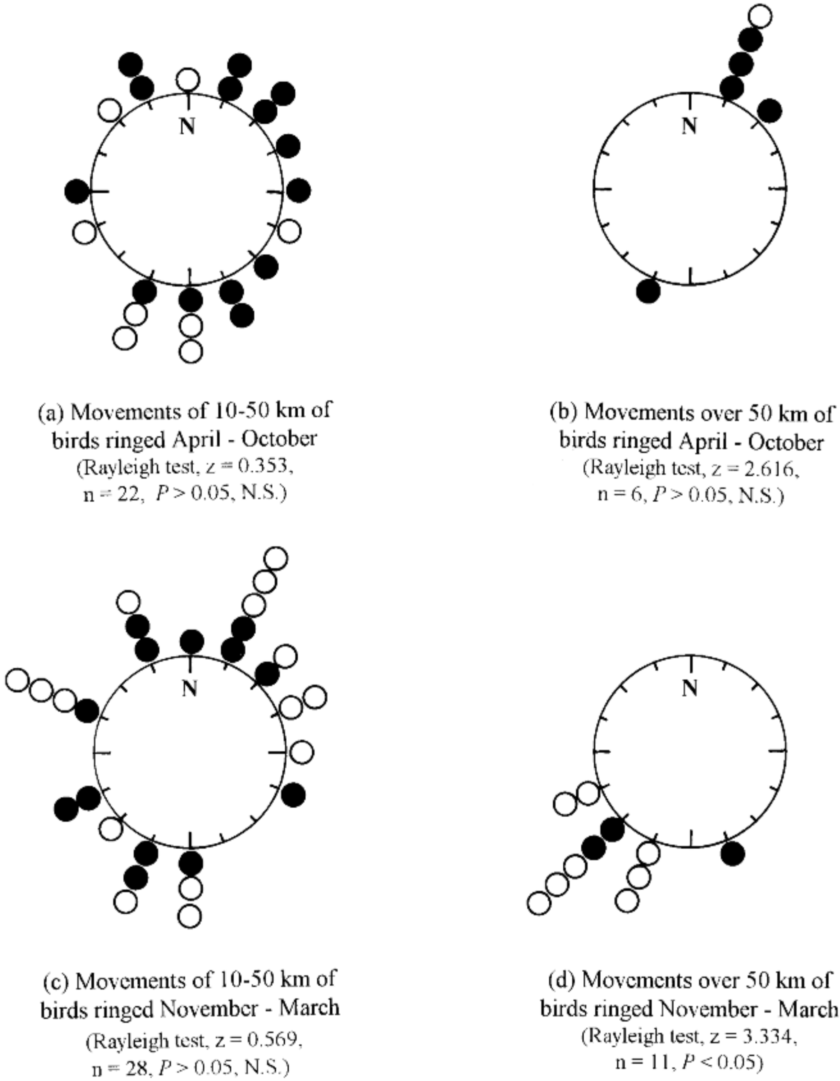


Figure 8. ***Orientation of movements over 10 km of birds ringed and recovered in the Highlands. l Recovered before or during the next breeding season; ° Recovered after next breeding season.***

occurred more or less throughout the winter months, and included an adult male ringed in Wick, Caithness in February and recovered in Fort William, Invernessshire, 217 km away, the following May. We conclude that movements within the Highlands occur more or less throughout the summer, autumn and winter with no obvious seasonality

Discussion

Many of the birds ringed in the Highlands during the breeding season, that is, those drawn from the local breeding population, remained within a short distance of the site of ringing. Some, however, do move and these seem disproportionately to involve first year birds. Movements of 10-50 km showed no particular orientation and appear to have taken place at almost any time during the year except spring. Although the evidence is not conclusive, we suspect that these movements are primarily dispersive in nature, reflecting not only post fledging dispersal, but also movements associated with the formation of post fledging flocks in the late spring and summer, and, in autumn and winter, those connected with the establishment of winter roosts and movements between these and daytime feeding areas, which may typically be up to 30 km away (*eg* Wynne-Edwards 1930, Eastwood *et al* 1962, Hamilton & Gilbert 1969, Bray *et al* 1975).

The growth in numbers in late autumn/early winter is a result of influxes into the Highlands from at least 3 distinct areas. Firstly, and most obviously, there appears to be a major influx from Northern Europe, primarily from Norway, but also from other countries around the Baltic. Most birds arrive in the Highlands in October/November and return in late February and March, though it is evident from the Norwegian ringed bird recovered in Caithness in July that some, possibly sickly, birds may occasionally remain in Britain during the breeding season.

A second group of birds arrives in the Highlands from the Northern Isles. Mostly these are birds from Fair Isle. Some may have been caught on passage from Northern Europe, but from the dates of ringing probably the majority originate from Fair Isle itself (and certainly those ringed as nestlings are Fair Isle birds). The precise nature of the movements beginning in Fair Isle is unclear, but we suspect that they are true migrations rather than dispersals. The bird moving from Wick to Fair Isle and back to Wick is consistent with this. It could conceivably have been a continental bird, though the handling date in Fair Isle (mid May) argues against this. The Common Starlings of Shetland are a separate subspecies, *S v zetlandicus*, and it is difficult to see how such subspecifc differences could be maintained if there were permanent movements in either or both directions.

A third group of birds wintering in the Highlands originates from southern Scotland and northern England. Such movements are, however, represented by only 12 recoveries in the dataset available to us, and with such a limited sample it is not possible to reach any definite conclusions about the nature of the movements concerned.

Movements from the Highlands to the South are represented by a much larger number of recoveries and have the following principal features: (i) they predominantly involve birds in their first year of life, (ii) the movements principally take place in late winter and early spring, (iii) the movements are in approximately the same, seasonally inappropriate, direction (S/ESE), (iv) the distances moved are approximately exponentially distributed (with a half distance of around 200 km) and, more tentatively, (v) the number of birds undertaking such movements varies between seasons.

There remains the question of where these birds begin their lives. The pattern of movements, described in the previous paragraph mirror some movements described by Rae & Morris (1978) and by Duncan (1984) for birds ringed in the Aberdeen area. Rae & Morris proposed that these were continental birds arriving in Britain across the southern North Sea and then moving north through Britain into NE Scotland, returning by the same route at the end of the winter. Duncan (1984) noted that this was not consistent with the results which had subsequently become available, especially the dates of ringing and recovery, which clearly show the birds to be in northern Scotland in winter and further south in Britain in the spring and summer and where, presumably, they were breeding, and the absence of recoveries on those parts of the continent adjacent to the southern North Sea (Belgium, Netherlands, Germany *etc*). We agree with these conclusions; the birds which move south from the Highlands and the Aberdeen area are not of continental origin.

The only other reasonable options for the origin of these birds are that they start their lives in the Highlands, or that they are birds from northern England and southern Scotland returning there at the end of winter. There is not much to choose between these 2 alternatives. Some (2 of 80 recoveries) definitely originated in the Highlands itself, where they were ringed as nestlings. There is a marked disparity between the number of northward movements (12) and those in the opposite direction (80), but we feel that too much should not be read into this as it may simply reflect differences in the finding rate between the Highlands and further south. Some of those going south are certainly Highland birds (where they were ringed as nestlings), but the possibility that a proportion are southern birds returning south cannot be ruled out.

Whichever explanation is correct, it is clear that these southward movements are of a highly unusual nature, particularly as regards their orientation and late winter timing, and bear little or no resemblance to the various kinds of movements found in European Common Starling populations (*eg* Perdeck 1958, Cramp & Perrins 1994). Exponentially distributed and orientated movements have been recorded in a number of species including the Cormorant *Phalacrocorax carbo* (Coulson & Brazendale 1968), Shag *P aristotelis* (Potts 1969, Swann & Ramsay 1979), Guillemot *Uria aalge* (Birkhead 1974), Western Gull *Larus occidentalis* (Coulter 1975) and Greenfinch *Carduelis chloris* (Boddy & Sellers 1983), but in all these cases the birds move in summer or early autumn, retrace these journeys the following spring, and appear to repeat these out and back movements annually throughout the rest of their lives. The movements of the Rosy Starling *S roseus*, especially its periodic spring 'irruptions', which appear to be due to food shortages, have some similarities with what we describe here for *S vulgaris* in terms of timing and the long distances involved, but are not sufficiently well characterised to enable a proper comparison to be made (Cramp & Perrins 1994).

Acknowledgements

A large number of people, many unknown to us, have contributed to the generation of the ringing recoveries on which this study was based and we owe a tremendous debt to them all. In particular we would like to thank Keith Banks, Stuart Mackay and the late Iain Mackay for their help in catching and ringing Common Starlings in Caithness which resulted in about half of the total sample of recoveries available. A listing of all ringing recoveries of Highland Common Starlings was kindly made available through the BTO Ringing Scheme which is supported by the BTO, and the Joint Nature Conservation Committee (on behalf of the Countryside Council for Wales, the Department of the Environment (Northern Ireland), English Nature and Scottish Natural Heritage, the National Parks and Wildlife Service (Ireland), and the ringers themselves.

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Revised manuscript accepted November 2003

SHORT NOTES

Sunning behaviour by a fledgling Merlin

In the Merlin *Falco columbarius* the subject of sunning behaviour has been generally overlooked in Britain and the only documented records are of a female/juvenile Merlin standing in a loose spread wing posture in winter and an adult female sun basking and sunning in the spreadeagled position on the ground in summer (Dickson 1998. Merlin's sunning behaviour in winter. *Scottish Birds* 19:176; Rollie 1999, Merlin's sunning behaviour in summer. *Scottish Birds* 20:-39).

On 7 July 1992, from 0915 to 1200 hours on a warm and sunny day, I watched a fledgling male Merlin, aged about 4 weeks old and less than a week out of the nest, standing on a stone wall about 5m from my hide in west Galloway. At 1047 hrs the fledgling yawned, preened his rump, lay flat on the wall facing the sun and covered his eyes with his nictitating membranes, and apparently sun basking. After preening at 1100hrs the young Merlin looked up into the sky, facing the sun, with his nictitating membranes again drawn across his eyes and sat erect, sun basking for 4 minutes.

Merlin

Most sunning birds often stare into the sun while sunning (Heinroth & Heinroth 1924-33. *Die Vogel Mitteleuropas*, Berlin) but it would appear that by drawing its nictitating membranes across its eyes, the young Merlin could have used them as protection from strong sunlight. Like a fledgling Hen Harrer *Circus cyaneus* (Dickson 2002. Hen Harrier's sunning behaviour in summer and winter. *Scottish Birds* 23:48-49) it would seem that the sunning behaviour by a young Merlin at a very early age was an unconditioned (innate) response to sunlight (Simmons 1986, *The Sunning Behaviour of Birds*, Bristol).

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Revised manuscript accepted June 2003

An early record of a Parrot Crossbill in Scotland

The Parrot Crossbill *Loxia pytyopsittacus* is the largest of the crossbills. It is distributed across FennosScandianavia and northern Russia where it is primarily associated with Scots Pines *Pinus sylvestris* whose seeds are its major food source (Cramp and Perrins, 1994. *The Birds of the Western Palearctic*, Vol 8, Oxford). During the 19th century, it was clearly regarded as rare within Scotland, as it is rarely mentioned in the 'Vertebrate Fauna' series. Harvie-Brown and Buckley (18897. *A Vertebrate Fauna of Sutherland, Caithness, and West Cromarty*, Douglas, Edinburgh) give records from a fishing boat off Caithness and at a plantation at Lyth (Caithness). Harvie- Brown (1906. *A Fauna of the Tay Basin and Strathmore*, Douglas, Edinburgh) also notes collections of Parrot Crossbills at Murthly (see below) and Stanley (Perthshire), and suspected breeding in East

Ross. In addition, Gray (1871. *Birds of the West of Scotland, including the Outer Hebrides*, Murray, Glasgow) records them from Wemyss Bay (Firth of Clyde), Ross-shire and Lochend (Inverness). Once the Scottish Crossbill *L. scotica* was described (Hartert, 1904. *Die Vögel der Paläarktitschen Fauna*, Freidländer, Berlin) (initially as a subspecies of the Common Crossbill *L curvirostra*), ornithologists were presented with further problems when identifying Parrot Crossbills in Scotland, given the similarity in plumage and the apparent overlap in size between Scottish and Parrot Crossbills (Knox, 1976. The taxonomic status of the Scottish Crossbill *Loxia* sp *Bull BOC* 96: 15-19). There were, in fact, calls to classify the Scottish Crossbill as a subspecies of the Parrot Crossbill, prior to the former becoming recognised as a species in its own right (Knox, 1975. In Nethersole-Thompson, *Pine Crossbills,* Poyser, Berkhamsted). As a result, in the first major review of the status of Scotland's birds, Baxter and Rintoul (1953. *The Birds of Scotland*. Oliver & Boyd, Edinburgh) found no compelling evidence for Parrot Crossbills occurring in Scotland. They concluded that all records were 'open to doubt', but did list the counties in which it had been recorded: Dumfries, Wigtown, Renfrew, Perth, Inverness, Ross and Caithness.

With the establishment of coastal bird observatories during the early to mid 1900s, it was not long before a migrant Parrot Crossbill was captured. A bird trapped on the Isle of May in 1953 was identified as a Parrot Crossbill. During the following decades, there were further records, on Fair Isle and other northern isles, associated with periodic invasions from northern Europe (Thom, 1986. *Birds in Scotland*, Poyser, Calton). In addition, there are now inland records from native pinewoods and plantations, including breeding records (Summers, 2002. Parrot Crossbills breeding in Abernethy Forest, Highland. *British Birds* 95: 4-11. Marquiss and Rae, 2002. Ecological differentiation in relation to bill size amongst sympatric, genetically undifferentiated crossbills *Loxia* spp *Ibis* 144: 494-508).

In a review of museum skins of crossbills collected in Scotland, Summers *et al* (2002. The distribution and habitats of crossbills *Loxia* spp in Britain, with special reference to the Scottish Crossbill *Loxia scotica*. *Ibis* 144: 393-410) found 8 whose bill depths indicated that they could have been Parrot Crossbills. These included 2 19th century specimens in the Perth Museum that the collector had obtained from Murthly and identified them as Parrot Crossbills (Millais, 1884. Notes on the occurrence of the Parrot Crossbill in Perthshire, and probable nesting. *Proceedings of the Perthshire Society of Natural Science* 1881-18862: 182). However, although the bills of all these museum specimens were within the range of Parrot Crossbills, they were not particularly large, so they could have been large Scottish Crossbills. Therefore, the 1953 record on the Isle of May remains as the first accepted record in Scotland.

Since the publication of our review (Summers *et al* 2002), another specimen has come to light. It refers to an adult male collected by Frank Nisbet near Pitlochry in August 1928 and sold to HF Witherby. At this stage, it was identified as a Scottish Crossbill *Loxia curvirostra scotica*. However, presumably in an exchange with a Dutch collector (PA Hens), the skin made its way to The Netherlands and was renamed *Loxia pityopsittacus* [sic] *scotica*. Latterly, the Hens collection was obtained by the National Museum of Natural History, Leiden and the bird (catalogue number 56978) was renamed again, by Kees Roselaar as *Loxia p pityopsittacus* [sic]. This latest identification was confirmed on measurements. It had a bill depth of 13.9 mm, which is at the upper end of the range for Parrot Crossbills (Summers *et al* 2002). It was, therefore, very unlikely to be a Scottish Crossbill. The bill length (20.0 mm), bill width (13.5 mm), and wing length (105 mm) were also consistent with it being a Parrot Crossbill (Knox 1976). This new observation puts the first record of a Parrot Crossbill in Scotland back 25 years. The fact that it was an adult inland in August suggests that it might have been breeding there, because invasions of this species, unlike Common Crossbill, typically occur in late autumn.

The Parrot Crossbill is known for its invasions in mainland Europe, though these are not as large or as and frequent as those of Common Crossbills (Newton, 1972. *Finches*, Collins, London). Given that Common Crossbill invasions reach Britain, it therefore seems likely that Parrot Crossbills have also been invading Britain for many decades. It is only their small numbers, infrequency and similarity to Scottish Crossbills that have made them difficult to detect. However, it is impossible to say whether they have been breeding continuously or only sporadically after invasions.

I thank René Dekker of the National Museum of Natural History, Leiden and Bob McGowan of the National Museums for Scotland for arranging the loan of the crossbill from The Netherlands, and Kees Roselaar of Zoological Museum, University of Amsterdam who alerted me to this specimen. Bob Dawson, René Dekker, David Gibbons, David Jardine, Bob McGowan, Kees Roselaar and Jeremy Wilson commented on the draft.

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Revised manuscript accepted July 2003

Peregrine Falcon predating Slavonian Grebe

On 29 May 2003 Hugh Insley and Pete Mayhew were ringing a brood of 4 Peregrine Falcon *Falco peregrinus* chicks at a cliff nest site in Inverness-shire. Among the prey remains in the eyrie was part of a bird's wing which we did not immediately recognise. This wing was grey brown on the upperside and creamy white below. Enough remained of the wing to enable us to measure a maximum chord which was 150mm. The most significant feature was the oily nature and slightly fishy smell of the feathers from which we concluded that it had belonged to a water bird. Apart from the main wing bones, all that remained were some of the coverts, the noticeably curved primaries (11 plus a greatly reduced 12th) and a single white secondary feather. This strongly suggested that the bird was a grebe and the wing length indicated that it fell only within the size range for Slavonian Grebe *Podiceps auritus*. This conclusion was subsequently confirmed by comparison with reference material in the National Museums of Scotland by Robert Y McGowan. Feather size, shape and colouration of the wing were fully compatible with Slavonian Grebe skins and the humerus length (76.9mm) matched the mean (77.3mm) for 3 skeletal specimens.

No grebes of any species are listed in the analysis of prey taken by British Peregrines given by Ratcliffe (1993 *The Peregrine Falcon*, London), although Ratcliffe *pers comm* is of the opinion that Peregrine Falcons will take any bird species within the constraints of size and opportunity. BWP gives prey size for Peregrine Falcon as ranging from Goldcrest *Regulus regulus* to Grey Heron *Ardea cinerea* and goose *Anser* ; weight range 10 to 1800 g, with females taking larger prey items than males. The weights for Slavonian Grebe of 415 to 470g (Iceland and Norway, during summer, *BWP*) fall well within this range.

This appears to be the first time that Slavonian Grebe or a grebe of any species has been recorded being taken as prey by Peregrine Falcon in Britain.

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Revised manuscript accepted August 2003

Forest nesting Merlin apparently specialising on Barn Swallows

As part of a long term study of the breeding ecology of Merlin *Falco columbarius* in north-east Scotland (Rebecca *et al* 1992, *Scottish Birds* 16: 165-183; Rebecca & Cosnette 2003, in *Birds of Prey in a Changing Environment*, chapter 14, eds D B A Thompson, S M Redpath, A H Fielding, M Marquiss & C A Galbraith, HMSO, Edinburgh) prey remains at breeding areas are collected and identified. When more than one

Table 1 Bird prey identified at a forest nesting Merlins site in north east Scotland in 1991.

Species	Adult	Juvenile	Fledgling	Total
Barn Swallow *Hirundo rustica*	35	16		51
Meadow Pipit *Anthus pratensis*	11		7	18
Chaffinch *Fringilla coelebs*	9			9
Common Linnet *Carduelis cannabina*	7			7
Pied Wagtail *Motacilla alba*	6			6
Goldcrest *Regulas regulas*	5			5
Willow Warbler *Phylloscopus trochilus*	4			4
Eurasian Siskin *Carduelis spinus*	3			3
Yellowhammer *Emberiza citrinella*	3			3
Common Starling *Sturnus vulgaris*	2			2
Northern Wheatear *Oenanthe oenanthe*	1			1
Sky Lark *Alauda arvensis*	1			1
Whinchat *Saxicola rubetra*	1			1
House Sparrow *Passer domesticus*	1			1
Hedge Accentor *Prunela modularis*	1			1
European Robin *Erithacus rubecula*	1			1
Great Tit *Parus major*	1			1
Coal Tit *Parus ater*	1			1
Blue Tit *Paris caeruleus*	1			1
Long-tailed Tit *Aegithalos caudatus*	1			1
			Total	118

Note: 22 Northern Eggar moths *Lasiocampa quercus* were also found.

individual of the same species is found at a plucking place distinct primary or tail feathers are counted giving a minimal number for that species.

In 1991, I located a successful repeat breeding attempt within Fetterresso Forest. This was only the second Merlin nest located in a mature conifer plantation in north east Scotland (Rebecca 1992, *North-East Scotland Bird Report* 1991: 61-62, Aberdeen). The site was an old Carrion Crow *Corvus corone* nest, about 12 m from the ground, on the edge of an unthinned 38 year old Sitka Spruce *Picea sitchensis* block bordering a 7 year old Lodgepole Pine *Pinus contorta* plantation. The first breeding attempt was approximately 500 m away in the pine plantation. After the 2 young fledged in mid July prey remains were collected at plucking places up to 150 m from the nest. A total of 118 birds were identified including 35 adult and 16 juvenile Barn Swallow *Hirundo rustica* (43%). This was an exceptionally high number of Barn Swallow in comparison to prey identified at this breeding area in 1980, 1983, 1984, 1986-88 and 1990 when only one was found in 232 items (unpublished data). The remainder of the prey items in 1991 were typical for breeding Merlins (Table 1). In Britain, Barn Swallows usually represent a small proportion of the breeding season diet of Merlin (Table 2) and in north east Scotland they are normally found in similarly low numbers annually (unpublished data).

It is interesting to reason where these Barn Swallows might have been taken. There was no known or potential Barn Swallow nest sites within a 2 km radius of the Merlin nest and the main habitats in that area were coniferous plantations; estimated at 50% aged 5-10 years and 40% aged at least 35 years, with the remaining 10% unplanted Ling heather *Calluna vulgaris*. At 2-4 km radius there was a more complex habitat mix of various aged coniferous

Table 2 The number of Barn Swallows taken by breeding Merlins from extensive diet studies in Britain.

Areas and years	**No. of Barn Swallow / Total prey items**	**% Barn Swallow**	**Reference**
NE Wales, 1973-89	50 / 1645	3	Roberts & Jones 1999, *Welsh Birds* 2: 88-108
Wales, 1981-84	146 / 6366	2.3	Bibby 1987, *Bird Study* 34: 64-70
Northumbria 1974-82	8 / 2001	0.4	Newton *et al* 1984, *Bird Study* 31: 49-56
Kielder Forest, Northumbria 1991-92	4 / 880	0.5	Petty *et al* 1995, *Forest Ecology & Management* 79: 133-146
SW Scotland 1973	0 / 161	0	Watson 1979, *Bird Study* 26: 253-258
SE Scotland 1984-94	2 / 2040	0.1	Heavisides *et al* 1995, *Scottish Birds* 18: 88-94
Orkney 1981-87	1 / 845	0.1	Meek 1988, *Bird Study* 35: 209-218
Shetland 1984-87	0 / 1248	0	Ellis & Okill 1990, *Bird Study* 37: 101-110

plantations, heather moor, rough hill grazing and intensive farmland, with 8 farms as potential Barn Swallow nesting sites. The Merlin using this breeding area in 1984 and 1988 took unfledged waders on rough farmland at 3.8 km from their nests (Rebecca *et al* 1990, *Scottish Birds* 16: 38-39) and Merlin in Wales, tracked by radio telemetry, were known to hunt up to 4 km from the nest (C J Bibby *pers comm*). Some of these Barn Swallows may have been caught near the farms but it is unlikely that the majority were. Other typical farmyard species such as Common Starling and House Sparrow only featured in small numbers (Table 1) and breeding Merlin are not usually associated with occupied farms or intensive farmland (BWP2). An alternative, and possibly more realistic, explanation is that they were caught as they foraged over the forest canopy. Hirundines are commonly seen hawking insects over Fetterresso Forest and adjoining coniferous plantations, and perhaps 1991 was a particularly good year for insects and Barn Swallows. I thank the Forestry Commission and Fountain Forestry for access to study the Merlins and Mick Canham for the details of the Sitka Spruce plantation

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Revised manuscript accepted October 2003

Ring Ouzel killing and feeding shrew to nestlings

As part of a study of the breeding ecology of Ring Ouzels *Turdus torquatus* in north east Scotland nests are located, and nestlings and adults are metal and colour ringed (Sim *et al* 2003, *Scottish Bird News* 69: 8-9). The study area, in Glen Clunie upper Deeside Aberdeenshire, holds a stable and relatively high density population of Ring Ouzels (Rebecca 2001, *Scottish Birds* 22: 9-19). In 2003 detailed nest and foraging watches were carried out as part of an environmental science MSc degree (Prigmore J, 2003, *The foraging behaviour of breeding Ring Ouzels at Glen Clunie, north east Scotland*. Unpublished dissertation, University of Aberdeen).

On 5 June 2003, we were watching a nest with 4 x 7 day old nestlings situated on a 4 m high crag on a tributary of the River Clunie. A Ring Ouzel was alarm calling which we initially attributed to our movements. However, the female of the pair was still alarm calling when we were about 60 m from the nest, well outside the normal range for this behaviour. Simultaneously, we watched the female, and set up a tripod and telescope (20-40 x zoom).

The female was seen attacking something on the ground about 10 m from the nest. It repeatedly pecked and then jumped back quickly for about 4 to 5 minutes in an area of about one m^2. It had obviously killed the prey as it then held it motionless in its beak. The female proceeded to peck and bash the prey from side to side for 2 to 3 minutes. By this stage we had identified the prey as a shrew, later judged by size and colour to have probably been a Pygmy Shrew *Sorex minutus* (Corbet, G B & Southern H N 1977, *The Handbook of British Mammals*, Blackwell, Oxford). The female then stood with the shrew in her beak for about a minute, flew to the nest and was seen, through the telescope, to feed the nestlings. When the female was alarm calling and killing the shrew the male perched nearby and appeared calm and quiet. However, when the female had the dead shrew in her beak, the male's behaviour changed. He became very agitated, and flew around alarm calling.

The breeding season diet of Ring Ouzels is reasonably well known consisting almost entirely of insects, earthworms and small snails or slugs, with small lizards sometimes recorded; at other times their diet is mainly berries (BWP, volume 5). This would appear to be the first documented record of a Ring Ouzel preying on a mammal. We could not determine which species began the encounter and the Ring Ouzel may have reacted in defence. In 2003 we witnessed Ring Ouzels successfully defend their nests against Stoats *Mustela erminea* by distraction, on 3 out of 4 occasions. We thank Invercauld Estate for cooperation with the study.

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Revised manuscript accepted November 2003

European Robin feeding on dead road casualties

On 13 December 1975, a very cold day with hard frost, I saw a European Robin *Erithacus rubecula* peck at the exposed flesh of a Brown Hare *Lepus europaeus* carcase that was lying on a minor road on low ground in west Galloway for over 5 minutes. On 2 January 1977, a very cold frosty day, on the same road, I again saw a Robin pecking at the exposed flesh of a dead female Common Blackbird *Turdus merula*. Robins' food in hard weather is known to include carrion and once, meat in a butcher's ship (Cramp 1988, *The Birds of the Western Palearctic*, vol 5, Oxford), and there is a record of one feeding on a Eurasian Collared Dove *Streptopelia decaocto* at a frozen pond (Waters 1990, *British Birds* 83:123). This note appears to be the first record of Robins feeding on road casualties.

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Revised manuscript accepted January 2004

Soaring behaviour by Merlins

According to Cramp & Simmons (1980, *The Birds of the Western Palearctic*, Vol 2, Oxford) the Merlin *Falco columbarius* soars infrequently while Feldsine & Oliphant (1985, *Raptor Research* 19:60-67) considered that high circling/soaring was a mild territorial display by *F c richardsonii* in an urban population in Canada. During studies of Merlins in Galloway, I recorded soaring flights, on set wings, in summer, in winter and at communal winter roosts. Most were associated with birds and animals, including man, and all were made at heights up to 150+m and usually initiated from a perch. My data suggest that aggressive soaring behaviour by Merlins may not be that uncommon.

Summer

Between 1973 and 1997, of the 23 occasions on which I observed Merlins soaring over breeding areas, 10 were by males, 11 by females and 2 by young fledglings. Four soaring flights by males and one by a female occurred above humans and a dog that had intruded into their nest areas, although one person was .09km away walking up a forestry track. A male soared above his nest on a steep cliff face after a pair attacked a Golden Eagle *Aquila chrysaetos*; another swooped on a Common Wood Pigeon *Columba palumbus* then soared to 50m; another chased a non resident female Merlin away from his breeding area then soared to 100m. A male soared over moorland and attacked a female Hen Harrier *Circus cyaneus* and a Peregrine Falcon *Falco peregrinus*, and thereafter carried out a series of 'switch backing' flights. A female soared above a Peregrine Falcon and Common Kestrel *Falco tinnunculus*, and another soared above a Carrion Crow *Corvus corone*; another soared above a Short-eared Owl *Asio flammeus* and stooped on it; another soared to 50m directly above a Hen Harrier's nest; another soared above a loch and called. On 2 occasions after food passes by pairs they soared together to 70m and 100m. Another male soared after a nest relief and on 3 occasions a female soared above her nest during reliefs (Dickson 1995, *Scottish Birds* 18:20-23). On 24 July 1992 2 young fledglings rose from a moor and soared together to a height of about 150m, sometimes touching, departed their natal area for the last time and landed about 3-4 km away; another fledgling soared above its nesting wood and landed on a stone wall. The only recent documentation of soaring in the breeding season was that by Orton (1980, *The Merlins of the Welsh Marches*. London) who recorded a male soaring and stooped closely on 2 sheep.

Winter

Between 1970 and 1997 6 soaring flights by Merlins were observed in winter in west Galloway, involving birds, 3 by males and 3 by females/juveniles at heights of 20m-70m. A male soared above another hunting male; another male soared repeatedly above moorland attacking 2 Carrion Crows for 20 minutes (Dickson 1991, Country-Side 27:14-15); another soared 70m above hunting a male Common Kestrel. A female/juvenile Merlin soared above a female/juvenile Common Kestrel and stooped on the other falcon; another female, near a breeding area, soared above 2 Common Buzzards *Buteo buteo*, one Eurasian Sparrowhawk *Accipiter nisus* and a Common Kestrel over moorland; another female/juvenile soared with a Peregrine Falcon, 2 Sparrowhawks and a female/juvenile Common Kestrel over moorland.

Winter roosts

On 4 occasions soaring flights were observed at a communal roost, twice by female/juveniles before going to roost in sallows; another female/juvenile rose from sallows at midday and began to soar before swooping down out of sight. A male and 2 females/juveniles soared together and were joined later by a soaring male Hen Harrier before roosting (Dickson 1973, *Scottish Birds* 7:288-292).

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Revised manuscript accepted January 2004

OBITUARIES

Gordon Booth (1905-2003)

Gordon Booth, well known to birdwatchers visiting Islay in the 1970s and 1980s, died in November 2003. After a lifetime working for a family textile firm in Yorkshire, he and his wife, Phyllis, retired in the mid 1960s to a lovely house in the Yorkshire Dales. However, in winter 1967-68, Gordon accompanied me on a goose counting visit to Islay. He was so struck by the island that he took Phyllis there in the summer of 1968 and within a year the house in Yorkshire had been sold and he and Phyllis had moved to Islay. Here they stayed until the end of 1985 when they moved again, to Comrie, to be near their 2 daughters for what, they fully expected, would be the last few years of their lives, only for both to survive well into their 90s, Phyllis dying in July 2003 aged 95 and Gordon reaching 97, both thankfully retaining all their faculties until the end.

Gordon's interest in birds and other wildlife soon led him to become bird recorder for Islay and, being a very well organised person, he began to collect and collate all the bird records for the island and to systematically transfer them to an extensive card index file. At the same time, he recorded his own observations in meticulous detail. This culminated in the publication of his *Birds in Islay* in 1975, with a second edition in 1981. Gordon was always pleased to be called on by visiting birdwatchers and was both interested in what they saw and ready with advice. He was a member of the SOC for over 30 years and attended a number of annual conferences. When the Islay Natural History Trust for founded in 1984, Gordon, with typical generosity, passed over not just his invaluable card index, but a great many books, papers and other material which formed the basis of both the Trust's database of natural history records and its library. Birds were not Gordon's only interest on the island, as he was largely instrumental in the creation of the very successful Museum of Islay Life in Port Charlotte.

Gordon Booth

Gordon retained his interest in Islay and in birds right to the last, and each time I called to see them both in Comrie he would present me with magazines, journals and cuttings that he thought I should have for the libraries of either the Natural History Trust or the Museum.

Malcolm Ogilvie

Peter Webster (1950–2003)

Many SOC members will be sad to learn of the death at the end of December of Peter Webster, RSPB Scotland's Reserve manager at Loch of Strathbeg since 1994. During his career with RSPB, Peter worked efficiently and with great enthusiasm at the reserve improving its bird habitats and visitor facilities plus the infrastructure. At the same time he was always aware of the importance of high standards of health and safety.

In his 10 years at Loch of Strathbeg he oversaw the introduction of a very successful arable farming regime that was of great benefit to seed-eating passerines, improving wetlands and reedbeds, creating tern islands, a new hide and walkway and renovating the visitor centre. He was fiercely proud of "his" reserve and worked hard to ensure that it remained the premier coastal bird site in eastern Scotland.

Peter will be greatly missed by many but none more than his wife Kate, son Peter and daughter-in-law Sarah to whom we offer our sincere condolences for their loss.

Ian Francis

Advice to contributors

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

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Scottish Birds

Volume 24 June 2004

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Front Cover Goosander *Edmund Fellowes*

Published by the Scottish Ornithologists' Club, Harbour Point, Newhailes Road, Musselburgh, EH21 6SJ.