



Site fidelity of Icelandic Greylag Geese between winters

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Britain supports almost the entire Icelandic population of Greylag Geese *Anser anser* in winter and has a special responsibility for the conservation of these birds. To facilitate the successful management of this population, the aim of this analysis was to ascertain the degree of site fidelity on the wintering grounds in relation to age and sex. Observations of marked Icelandic Greylag Geese suggest that most Greylag Geese are faithful to a region from one winter to the next. No significant differences were found according to age or sex groups. In the light of a recent major shift in the distribution of Icelandic Greylag Geese wintering in Scotland, these results are surprising as they provide evidence of a high level of site fidelity in the non-breeding season.

During the non-breeding season most of the Icelandic population of Greylag Goose *Anser anser* leave the breeding grounds and migrate south to winter in Britain & Ireland, with smaller numbers wintering in the Faeroe Islands and southern Norway (Swann & Brockway 2002, Swann *et al* 2005). Most birds arrive in their wintering grounds during October and remain highly mobile until December, often moving quickly between different regions (Swann *et al* 2005). During the midwinter period (January–February) birds are much less mobile. This is also the case during the spring period (March–April), when most birds remain on their final wintering grounds, prior to a direct flight back to Iceland (Swann *et al* 2005).

Previous studies (Raveling 1979, Warren *et al* 1992) have shown that migratory geese have a strong tendency to return to favoured areas in subsequent winters. This is presumably an evolutionary response, as familiarity with safe feeding and roosting sites will enhance overall survival and reproductive output. Some studies, however, have shown that juvenile geese are more likely to wander in a subsequent winter than adults (Boyd 1955).

The aim of this analysis was to ascertain whether Icelandic Greylag Geese return to the same region from one winter to the next and whether the pattern of return varies between the sexes or between older and younger birds. Britain supports almost the entire Icelandic population of this species in winter and therefore has a special responsibility to ensure that the population is managed in a sustainable way. Management techniques for a very sedentary species will be different from those for a very mobile species.

METHODS

Capture and marking

Between October 1992 and November 2003, 2,185 Greylag Geese were caught at Loch Eye, Ross-shire, Scotland. All were marked with a BTO metal ring. In addition, between 1992 and 1994, 501 of these birds were marked with an engraved plastic (Darvic) leg ring, bearing a unique code. From 1994, 1,483 birds were marked with a plastic neck collar, also bearing a unique code. In Iceland, 532 adults and 213 large goslings were marked with neck collars and, in addition, 423 goslings and 98 adults were marked with plastic leg rings, between 1996 and 2000. In Tayside, 109 birds were marked with collars between February 1998 and November 2003, and a further 60 birds were marked with collars in Aberdeenshire between November 2001 and March 2003. Birds in Scotland were caught with cannon nets at baited sites. Those in Iceland were captured by rounding up, whilst flightless at moulting sites or whilst attending young.

Resighting effort and analysis

Requests for sightings of marked birds were placed in ornithological publications and popular bird watching magazines, resulting in a network of goose-ring readers covering most of the main Scottish wintering areas. Coverage was most intense in the Moray Firth where ring readers were checking flocks almost daily in some instances, although nowhere was observer effort constant through time.

Neck collars can be read using a telescope with a x20 – x60 eyepiece at up to 500 m. Leg rings are more difficult to read, however, as they are smaller and more

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frequently obscured. The analysis that follows includes only three birds that were identified by leg rings.

In this paper we analyse the sightings and recoveries of 309 birds recorded in more than one consecutive midwinter period and the 235 birds recorded in more than one consecutive spring period, up to April 2005. Because of the great mobility of the geese in the early part of the winter this analysis is restricted to the midwinter period (January–February) and the spring period (March–April). To calculate the number of movements from one year to the next only consecutive winter/spring periods were taken into account. If a bird was seen in winters 1, 3, 4, 5, 7 and 8, only the movements between winters 3 and 4, 4 and 5 and 7 and 8 were used in the analyses. A small number of birds were seen in more than one region during a midwinter or spring period. If a bird was seen in region A in year 1, then region B and A in year 2, it was still deemed to be site faithful. If in year 3 it was found only in region B it was classed as a mover in that year. Data for all years and all sites have been pooled. For the purpose of this analysis, Britain & Ireland was split into 11 geographical regions that have traditionally held important concentrations of Greylag Geese (Fig 1). Although ring-reading effort varied between regions, we assumed, based on the regularity of observer submissions to the sightings co-ordinator, that it was relatively constant within a region throughout the ‘winter’ and ‘spring’ periods.

RESULTS

Fidelity to a region in a subsequent midwinter period

Table 1 shows the number of resightings of a bird in two consecutive winters. Of 466 resightings, 293 (63%) occurred within the region in which the bird had been recorded in the previous midwinter period. This left 173 (37%) resightings in a different region, though 51 of these (11%) were relatively close, wintering in an adjacent region.

To determine the proportion of birds that were very site faithful, all birds with sightings in four consecutive midwinter periods were examined (Table 2). This showed that 42% of birds were recorded in all four consecutive midwinter periods in the same region, 30% in three consecutive midwinter periods in the same region and 24% in two consecutive midwinter periods in the same region. Only 3% of birds switched to a new region in each midwinter period.

An examination of individuals with a long resighting history shows that some birds were very faithful to a particular region or even sites within a region. BZV, for example, was observed in the same region in seven midwinter periods. For the first five winters it returned to

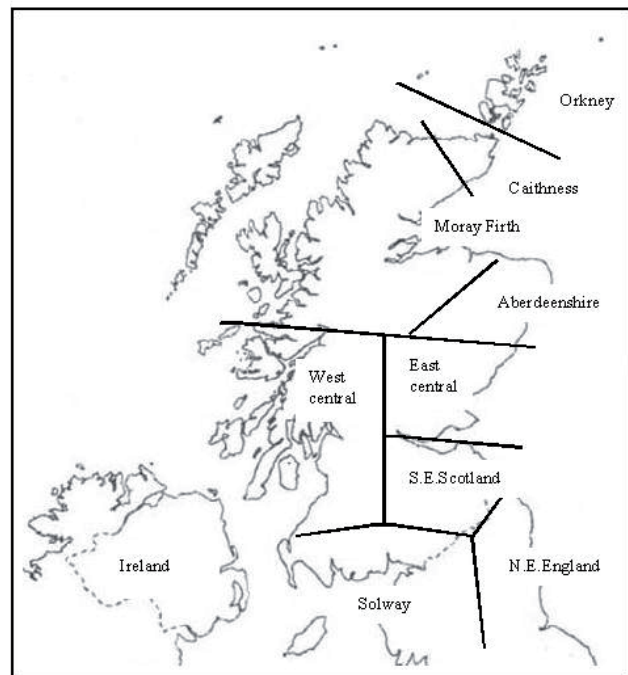


Figure 1. Regional divisions employed in the analysis. Shetland was also covered as a separate region but is not shown on the map.

the Rossie Bog area of Fife. In the sixth winter it was not located but in its seventh and eighth winters it was found 35 km to the southwest in Clackmannanshire. Conversely, NVZ was not as site faithful. It was located in its first winter around Loch Eye in Easter Ross, then the next three winters still in the Moray Firth region but 40 km to the southeast around Lossiemouth in Moray. The following year it switched region, being found near Stromness in Orkney. NFC was typical of a group of birds that tended to switch region on a regular basis. It was located in its first winter near Stromness in Orkney, its second near Wick in Caithness, its third on the Isle of Bute (west central), before being located in the Deerness area of Orkney for its fourth, fifth and sixth winters.

Movers were examined to see if there was a tendency for them to relocate further north or further south in a subsequent midwinter period. No particular trend was apparent, with 76 birds moving north and 87 moving south (Table 1).

Fidelity to a region in a subsequent spring period

Table 3 shows the number of resightings of a bird in two consecutive spring periods. Of 348 resightings, 223 (64%) were within the region in which the bird had been recorded in the previous spring period. Of the 125 (36%) resightings in a different region, 43 (12%) occurred in an adjacent region. The proportion of movers and non-movers was not significantly different to that recorded in the midwinter

Table 1. Resightings of Greylag Geese between consecutive midwinter periods.

	Region where bird was resighted in year 2											Total
	Orkney	Caithness	Moray Firth	Aberdeenshire	East Central	West Central	Southeast Scotland	Solway	Northeast England	Ireland	Norway	
Orkney	58	4	9		4	1		1				77
Caithness	8	11	12		4	2		1				38
Moray Firth	16	4	156	5	25	7	1		1	1	1	217
Aberdeenshire	2	1	6		2	1						12
East Central	6	3	13	1	40	1			3			67
West Central	1	1	1		1	19					1	24
Southeast Scotland					3		1					4
Solway						1			5			6
Northeast England	2		1		2				7			12
Ireland			1			2				1		4
Norway	1		2							1		4
Faeroes			1									1

Note: Regions in bold are where each bird was sighted in year 1. Figures in bold indicate the number of birds returning to the same region in year 2.

period ($\chi^2 = 0.078$, $P = 0.779$, Yates' correction applied). Although some birds do remain on the same midwinter site through into spring, others move to different spring staging sites (Swann *et al* 2005). As with the winter period analysis, all birds with sightings in four consecutive spring periods were examined to estimate the extent of site fidelity between years (Table 2). The results were similar to those for the winter period and showed that 52% of birds were located in all four, 36% in three and 12% in two consecutive spring periods in the same region.

Some birds were very site faithful during the spring period. The pair DFZ and DIU were recorded in the same area of fields on the inner section of the Dornoch Firth in eight consecutive spring periods. Similarly CF was located in six consecutive springs around Ospisdale on the Dornoch Firth, whilst PD was located five springs in a row in the Cullerlie area of Aberdeenshire. Others showed more changeable patterns. PL was located in two consecutive springs in Easter Ross (Moray Firth region), then in the next five springs around Winless in Caithness. Others showed less fidelity, such as HNP which was located

Table 2. Number of birds recorded in four consecutive midwinter or spring periods that were sighted in the same region in consecutive years.

	Midwinter	Spring
4 consecutive years	14	13
3 consecutive years	10	9
2 consecutive years	8	3
no consecutive years	1	0
Total	33	25

in its first spring at Firth in Orkney, its next two around Loch Watten in Caithness, its fourth back in Orkney at Sandwick and its fifth in Aberdeenshire.

Movers were examined to see if there was a tendency for them to relocate further north or further south in a subsequent spring period. There was a tendency for birds to be further north, with 70 moving north compared to 56 moving south (Table 3).

Norwegian birds

It has recently been discovered (Swann *et al* 2005) that a small number of Icelandic Greylag Geese winter in southern Norway. Twenty-two marked birds have been observed there since 1999, and 21 of these were sighted in more than one winter season. However, 18 of these were sighted only once in Norway, all other sightings being in Scotland. The pattern of resightings of these birds in Scotland varied greatly, with some birds returning to their favoured wintering region, whilst others were more mobile, switching between regions. Two birds were sighted in two consecutive winters in Norway, though both birds were also sighted in other years in Scotland. One bird was sighted one winter in Norway, then the next two in Scotland, then, after a year with no sightings, it was recorded back in Norway in the same area as recorded previously.

Age and sex differences

There were no significant differences in the numbers of juveniles and adults, and males and females, that were resighted in the same region or in a new region in a subsequent midwinter period (Table 4). The proportion of each age class that was resighted in a new region did

Table 3. Resightings of Greylag Geese between consecutive spring periods.

	Region where bird was resighted in year 2											Total
	Shetland	Orkney	Caithness	Moray Firth	Aberdeenshire	East Central	West Central	Southeast Scotland	Solway	Northeast England	Ireland	
Shetland		1										1
Orkney	46		4	3	4	3	1					60
Caithness	7	17		7	1	1	2					35
Moray Firth	1	15	4	108	5	9	6	2	1	2	1	154
Aberdeenshire		5	1	4	5		1					16
East Central			3	9	2	14	2					30
West Central		3		2		5	20					30
Southeast Scotland		1				2		5				8
Solway				1								1
Northeast England		1		2	1					6		10
Ireland		1									2	3

Note: Regions in bold are where each bird was sighted in year 1. Figures in bold indicate the number of birds returning to the same region in year 2.

not change significantly between the first two winters after capture up till the fifth winter after capture ($\chi^2 = 5.997$, $df = 9$, $P = 0.740$), nor did the proportion of each sex ($\chi^2 = 4.839$, $df = 9$, $P = 0.848$).

DISCUSSION

Overall, almost two thirds of resightings involved birds located in consecutive midwinter or spring periods in the same region as their initial sighting. Three quarters of all resightings involved birds returning to the same or an adjacent region in a consecutive year and around half of birds recorded in four consecutive winter or spring periods returned to the same region in all four winter or spring periods, respectively. This suggests that there is benefit to be gained by returning to an area with which the bird is familiar, so it can locate safe roost sites and potentially good feeding areas. It also suggests that if safe refuges are established for this species it is likely to make use of them.

Why then do all birds not return to the same region in a subsequent winter? The lowland agricultural areas occupied by Greylag Geese in the non-breeding season are subject to continual change. Crop rotations and variations in stocking regimes can alter feeding sites. Disturbance from farmers, shooters, and other recreational activities can change the attractiveness of a feeding or roost site. This may force birds to change their midwinter or spring region in a subsequent year. Some birds may have a strategy to visit a variety of regions in order to assess where the best feeding opportunities or safest roost sites are and so will switch region from one season to the next.

The distribution of Icelandic Greylag Geese during the non-breeding season has also changed very markedly over the last 30 or more years (Hearn & Mitchell 2004) with birds tending to winter further north. For instance the population wintering in Orkney has risen from 525 in 1982 (Hearn & Mitchell 2004) to over 40,000 in 2005 (Rowell 2006). This study found no evidence of birds relocating to more northerly sites in subsequent winters. The results, however, could possibly be biased by higher reporting rates

Table 4. Number of Greylag Geese resighted in the same region, or resighted in a new region, according to age, sex and year after first capture.

	Juv male	Juv female	Ad male	Ad female
Between years 1 and 2				
New	11	8	20	19
Same	23	22	29	41
Between years 2 and 3				
New	8	9	16	18
Same	12	13	23	31
Between years 3 and 4				
New	4	4	6	8
Same	11	11	16	14
Between years 4 and 5				
New	5	3	3	7
Same	3	6	8	7

Note: All results non-significant. Between years 1 and 2, $\chi^2 = 1.916$, $P = 0.590$, $df = 3$; between years 2 and 3, $\chi^2 = 0.212$, $P = 0.975$, $df = 3$; between years 3 and 4 (juveniles v adults combined), $\chi^2 = 0.047$, $P = 0.828$, $df = 2$, Yates' correction applied; between years 4 and 5 (juveniles v adults combined), $\chi^2 = 0.019$, $P = 0.890$, $df = 2$, Yates' correction applied.

of marked birds in more southerly areas, compared with northerly areas, such as Caithness and Orkney, where observers were fewer.

Studies of between-winter site fidelity of Pink-footed Geese *Anser brachyrhynchus* in Britain revealed similar high rates of return (Fox *et al* 1994). Of 736 birds marked in winter in Lancashire, 76% were resighted in that region in a consecutive winter. This species, like the Greylag Goose, spends the winter in lowland agricultural areas and it is subject to similar pressures. The resighting rate of Greenland White-fronted Geese *Anser albifrons flavirostris* between consecutive winters at Wexford Slobs in Ireland was even higher at 86%. This was believed to be a result of their more specific feeding requirements (Warren *et al* 1992).

These studies support the view of Boyd (1955) that there is an element of 'tradition' involved in geese returning to favoured areas. His assertion, that without detailed information about factors such as cropping types and disturbance we may never know what causes individuals to change sites, still holds – but what we can do is describe these shifts through counts and ring sightings. It is, therefore, important to keep a proportion of marked birds in the population for such monitoring work.

It was by such marking that the establishment of a wintering population of Icelandic Greylag Geese in southern Norway was detected. This could be due to birds 'overshooting' Scotland on autumn migration and then remaining to winter. If this were so we would expect birds not to show any fidelity to Norwegian wintering sites. This is the case for the majority of the birds that have been reported from Norway. Evidence from subsequent resightings showed that these were probably a combination of accidental overshoots and birds prone to exploring new wintering sites. The fact that three birds have overwintered in Norway on more than one occasion suggests, however, that a small part of the population is deliberately choosing southern Norway as a wintering location.

Warren *et al* (1992) found no sex bias amongst Greenland White-fronted Geese in Ireland that made between-winter movements but did find that significantly more young birds moved in their second and third winters than would be expected by chance. They assumed this was a result of family break-up and subsequent pair formation. Fox *et al* (1994) similarly found that the sexes of Pink-footed Geese wintering in Britain did not differ in their probability of moving between years. They showed, however, that there was also no difference in the probability of young birds moving between winters. This present study shows that Icelandic Greylag Geese, like Pink-footed Geese, showed no significant differences in site fidelity in a subsequent winter according to sex or age.

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