SECTION 4: MIGRATION

Movements of Whooper Swans *Cygnus cygnus* neckbanded in Iceland

ARNTHOR GARDARSSON

Movements of Whooper Swans neckbanded at two moulting sites in east Iceland and one in west Iceland are described. In the first year 65% were reported, 62% resighted and 4% recovered. After four years, 73% had been reported, 69% resighted and 10% recovered. Nearly all neck bands disappeared in this period. In autumn the birds migrated on a broad front, with a mean direction close to 140°, W-Iceland birds mainly to Ireland and W-Scotland, E-Iceland birds largely to Scotland, but also N-Ireland and S-Scandinavia. The mean distance was about 1100 km for E-Iceland birds and about 1400 km for W-Iceland birds. In early winter 19% of E-Iceland, but no W-Iceland swans, were found in the easternmost parts of the range (Shetland and S-Scandinavia). In December-January about half the reported swans moved over 100 km, mainly south. Winter site fidelity varied greatly, 45% were found within 100 km of the previous winter, 55% were further away (up to 985 km). Within Iceland only 9% of E and W birds were reported in the opposite half of the country. About 600 E-Iceland Whooper Swans may winter on the continent of Europe and some thousands wintering in Britain may originate from the continent.

For anyone interested in bird populations the Whooper Swan, *Cygnus cygnus*, of Iceland seems an attractive study object. The Whooper is conspicuous and easily counted, and it can be caught and marked by various means. The Icelandic population is geographically isolated and may be expected to form a fairly discrete unit. It was estimated at 10,000-11,000 birds in autumn 1982, but improved coverage yielded about 14,000 in 1984 and 1985 (Gardarsson & Skarphedinsson 1984, 1985). Most Icelandic birds winter in the British Isles but 500-1300 winter in Iceland (Gardarsson & Skarphedinsson 1985, Salmon & Black 1986). Previous ringing recoveries are mainly from the British Isles, but two of 41 recoveries are from continental Europe (Gardarsson & Skarphedinsson 1984).

The aim of this study was to describe the movements and winter distribution of Whooper Swans neckbanded in 1984 and 1985 at widely separated moulting sites in Iceland and to relate the results to population studies. The following questions were of particular interest: to find what proportion wintered in continental Europe, to find if the winter and summer ranges were associated, and to look for pattern in the migration of individuals.

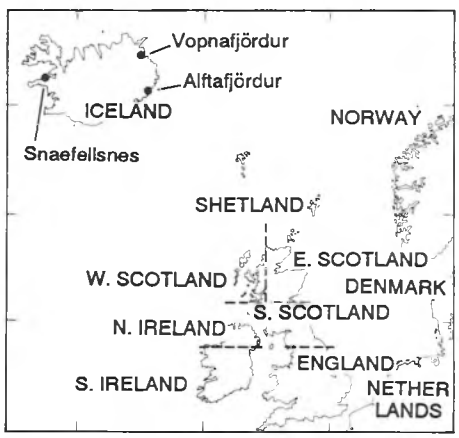

Fig. 1. Position of localities where Whooper Swans were neckbanded in Iceland, and geographical regions used for analysing the reports of marked swans.

Methods

Moulting non-breeding Whooper Swans were caught and marked at three localities (Fig. 1):

(1) Vopnafjördur at Skogalon (65° 45' N, 14° 52' W), N-Mulasysla, 30 July 1984. Skogalon is a brackish lagoon with small numbers of moulting Whoopers, 35 were neckbanded out of 40.

(2) Alftafjördur (64° 35′ N, 14° 27′ W), S-Mulasysla, 1 August 1984. A large brackish lagoon where several hundred Whoopers usually moult, 54 were neckbanded.
(3) Snaefellsnes (65° 00′ N, 22° 40′ W), 7 August 1985. The actual locality was Alftafjördur, Snaefellsnessysla, an inlet in a shallow marine bay where over 2,000 swans moulted; 108 were neckbanded.

Swans from Vopnafjördur and Alftafjördur are termed E-Iceland, in contrast to those from Snaefellsnes that are termed W-Iceland.

For each bird a record was made of age and sex and several other variables. Each bird was marked with a plastic (PVC) neckband (cf. Sladen 1973), inside diameter 58 mm, a PVC leg ring on the left tarsus, and an Icelandic Museum stainless steel ring on the right tarsus. The plastic rings were yellow with an engraved, black two-letter code employing 18 letters: A, B, C, D, F, H, I, J ,L, N, P, S, T, U, V, X, Y, Z.

For analysis, geographical regions, where not coincident with recognized political units, are defined by geographical coordinates as shown in Fig. 1. The scheme was announced in several NW-European journals and through other channels. Reports were mostly of resighted birds (including a few that were also recaptured) but some were recovered dead. Reports up to 1 August following banding are termed direct reports; reports after that are defined as indirect. Resightings from the respective marking localities up to 1 December following marking were omitted. Most of the swans made a long-distance southward migration in October. Many moved again in December-January, and distribution in October-December (early winter) and January-March (late winter) was therefore analysed separately.

Results

Reporting rates were similar ($\chi^2 = 0.014$, $P > 0.10$) for both E- and W-Iceland birds. In the

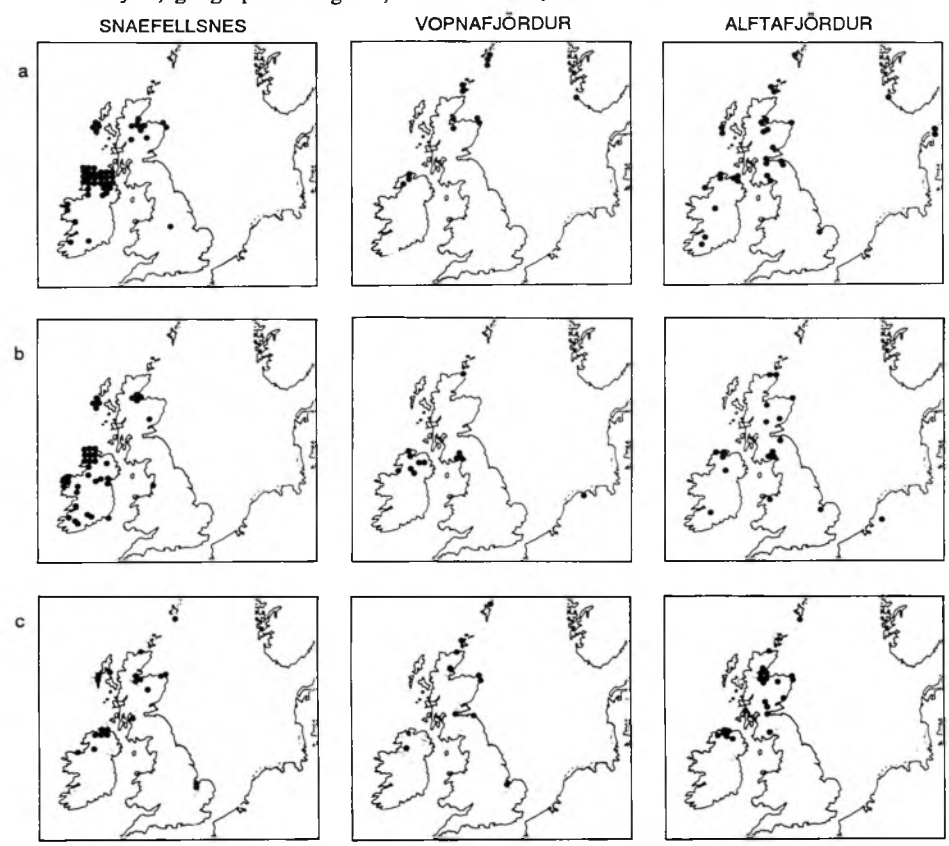

Fig. 2. Distribution of reports of Whooper Swans neckbanded at three localities in Iceland and resighted or recovered overseas: (a) direct reports in October-December, (b) direct reports in January-April, (c) indirect reports in October-December (dots) and January-May (circles).

Table 1. A summary of reports of Whooper Swans neckbanded in Iceland in 1984 and 85.

	Year (August-July) 1	2	3	4
Resighted only	115	36	8	3
Resighted and recovered	5	4	2	1
Recovered only	7	0	0	1
Total reports	127	40	10	5
Not reported before	—	10	3	1
Cumulative reports (%):				
Total n=194	127(65)	137(71)	140(72)	141(73)
E-Iceland n=88	57(65)	65(74)	66(75)	66(75)
W-Iceland n=106	70(66)	72(68)	74(70)	75(71)

Notes. A total of 197 was neckbanded but three were recovered in the marking localities shortly after marking and are excluded in table. Also omitted are five birds resighted locally in the same autumn as they were marked.

first year 65% were reported, 62% resighted and 4% recovered, after four years 73% of the total had been reported and 10% recovered dead (Table 1). The number of resighted birds declined by about 70% each year. After three years nearly all neck bands had disappeared and sightings were based on tarsus rings.

An overview of the distribution of reports is shown in Fig. 2. The longitudinal distribution of E- and W-Iceland birds differed markedly in the first winter after banding (Table 2). In October-December 14 (33%) of 43 E-Iceland

Table 2. Distribution of direct reports (i.e. in less than one year from banding) of neckbanded Whooper Swans by region. Banding localities are abbreviated as follows: V Vopnafjörður, A Alftafjörður, S Snaefellsnes.

	Early winter (Oct-Dec) V	A	S	Late winter (Jan-Mar) V	A	S
Eastern sector:						
Norway	1	1	—	—	—	—
Denmark	—	2	—	—	—	—
Netherlands	—	—	—	1	1	—
Shetland	3	1	—	—	—	—
Central sector:						
E-Scotland	6	8	9	—	6	5
S-Scotland*	—	6	—	3	4	—
England*	—	1	1	—	2	1
Western sector:						
W-Scotland	—	3	4	—	—	3
N-Ireland**	3	5	27	8	4	12
S-Ireland**	—	3	5	—	1	17
Iceland	—	—	3	2	1	3
Sum	13	30	49	14	19	41

*"S-Scotland" is defined as the region between 56° and 54°N, "England" as Britain S of 54°N.
**Delimited by 54°N as in Fig. 1.

Table 3. Distribution of indirect reports (i.e. more than one year from banding) of neckbanded Whooper Swans by region. Banding localities are abbreviated as follows: V Vopnafjörður, A Alftafjörður, S Snaefellsnes.

	Early winter (Oct-Dec) V	A	S	Late winter (Jan-Mar) V	A	S
Eastern sector:						
Norway	—	—	—	—	—	—
Denmark	—	—	—	—	—	—
Netherlands	—	—	—	—	—	—
Shetland	1	1	1	—	—	—
Central sector:						
E-Scotland	5	14	7	2	2	3
S-Scotland*	2	3	1	1	1	1
England*	1	—	2	1	—	1
Western sector:						
W-Scotland	—	1	3	—	1	2
N-Ireland*	1	4	7	5	—	2
S-Ireland*	—	—	—	—	1	1
Iceland	—	—	2	—	—	—
Sum	10	23	23	9	5	10

* See definitions in Fig. 1 and Table 2.

swans were reported from the western sector, i.e. Iceland, W-Scotland and Ireland, compared with 39 (80%) of 49 W-Iceland birds ($\chi^2 = 18.85$, $P < 0.001$). Eight (19%) E-Iceland, but no W-Iceland, swans were reported from the eastern sector, two each in Norway and Denmark, four in Shetland. In January-March this difference was still evident, with 16 (48%) of 33 E-Iceland birds in the western sector, compared with 35 (69%) of the 51 W-Iceland birds ($\chi^2 = 9.91$, $P < 0.01$).

The difference in regional distribution of E- and W-Iceland swans in October-December was retained in later years (Table 3), six (18%) of 32 E-Iceland swans being reported from the western sector, compared with 12 (57%) of 21 W-Iceland birds ($\chi^2 = 6.65$, $P < 0.01$). Indirect records in January-March of both E- and W-Iceland birds were equally distributed between the western and central sectors with seven of 14 E-Iceland and five of 10 W-Iceland swans in each ($\chi^2 = 0.17$, $P > 0.10$). No swans were reported from the continent of Europe after the first winter following marking.

Reports were divided between southern and northern regions along 56°N, in Ireland along 54°N (cf. Fig. 1). In October-December 19 (21%) of 92 direct reports (Table 2) were from the southern region, compared with 28 (35%) of 79 in January-March ($\chi^2 = 3.95$, $P < 0.05$). In October-December nine (16%) of 56 indirect reports (Table 3) were in the southern region

and in January-March four (17%) of 24 (χ^2 = 0.07, $P > 0.10$). No significant differences were found in the north-south distribution of E- versus W-Iceland birds.

Direct reports from overseas in October-December were used to calculate directions and great circle distances. The mean direction was close to 140° for all three localities. Mean distances were 1100 km for Vopnafjördur, 1122 km for Alftafjördur and 1407 km for Snaefellsnes. Nineteen swans that moved more than 100 km in winter made movements averaging 192° and 360 km, with a maximum of 756 km (Table 4).

Out of 30 swans that were reported both in October-December and later in the same winter 14 moved towards the south or southwest, and 16 stayed in the same general locality (within about 100 km from where they were first observed). The 16 reports of birds that stayed through the winter were in E-Scotland (2), S-Scotland (2), England and Wales (3), N-Ireland (6), S-Ireland (2) and Iceland (1); five of these were from reserves at Caerlaverock and Welney where swans are fed.

Of the 14 that moved five remained within the geographical region and nine left the region. One left south Norway in January and was seen in the Netherlands in March. Two left E-Scotland for N-Ireland and two for S-Ireland respectively. One went from Shetland to N-Ireland. Three left N-Ireland and went to S-Ireland.

Winter site fidelity of individuals in subsequent years varied (Table 5). Fourteen (45%) of 31 reports were within 100 km of the previous winter but the remaining 55% were found at distances of 272 to 985 km (mean 420, SE 43 km).

One of 13 E-Iceland birds was reported in western Iceland (in October) and three (two individuals) of 31 reports of W-Iceland birds came from eastern Iceland (Fig. 3). Thus, only 4 (9%) of 44 were reported in the opposite half of the country.

Table 5. Distances between winter localities of individual Whoopers in sequential years.

Distance km	Number of reports: Early winter	Late winter	Sum	%
0-100	9	5	14	45
101-200	0	0	0	0
201-300	3	2	5	16
301-400	4	0	4	13
401-500	4	1	5	16
>500	1	2	3	10
Total	21	10	31	100

Discussion

The neckbands disappeared faster than expected. Some birds lost the neck bands within a few hours. Several were seen or picked up with bands that were cracked or chipped. Yellow neck bands with a two letter code in black were used for several reasons. A four digit code, white on blue, had proved hard to read at long distances. A resighting rate of 48% in the first year, compared with the present 65%, was reported by Brazil (1983), using blue neck bands. Yellow collars would help to distinguish Icelandic birds from those marked in Sweden and Denmark with blue collars. Yellow was less likely than blue to be noticed by the general public who would be spared some anxiety.

Neckbanding produced results much more rapidly than is possible with conventional ringing. Banding in 1985 coincided with a census carried out in Britain and Ireland in January 1986 (Salmon & Black 1986) and this may have raised the resighting rate.

Table 4. Mean distances and directions between the marking localities and places where neckbanded Icelandic Whoopers were reported overseas in early winter, and between early and late winter localities.

	Distance: *n*	km	se	range	Direction (degrees): degrees	se	range
First journey overseas from:							
Vopnafjördur	10	1100	50	940-1314	140	4	122-160
Álftafjördur	32	1122	34	801-1583	144	2	117-163
Snaefellsnes	48	1407	15	1186-1813	138	1	123-149
Winter movements abroad:							
origin Vopnafjördur	5	491	94	293-756	201	12	168-221
origin Álftafjördur	5	321	60	152-444	214	14	179-246
origin Snaefellsnes	9	309	14	161-729	167	4	94-248
Total	19	360	37	152-756	192	9	94-248

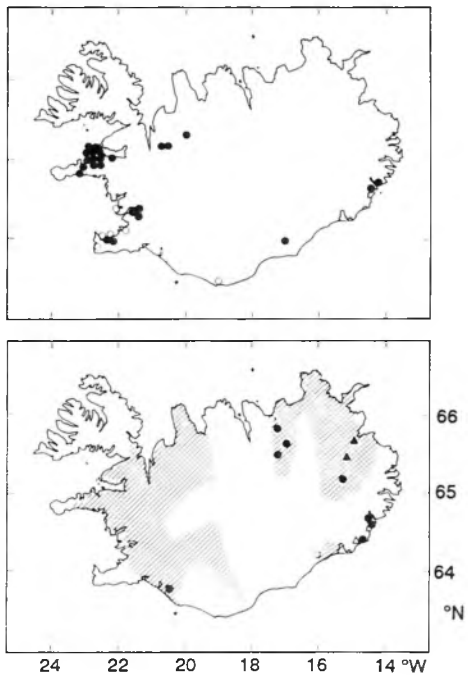

Fig. 3. Distribution within Iceland of all reports of Whooper Swans neckbanded at (a) Vopnafjördur (triangles) and Alftafjördur (dots), E-Iceland, and (b) Snaefellsnes, W-Iceland. Reports in April-October are shown with filled symbols, reports in November-March with unfilled symbols. Shaded: areas where Whooper Swans breed relatively densely. Unshaded: areas where few or no swans breed.

In comparison with some continental populations the migratory route of Icelandic Whooper Swans is relatively short, though it is unusual in being across 800-1200 km of open ocean. Shortly before departure the swans gather on staging grounds spread over Iceland and appear to depart directly from these in mid-October (Gardarsson & Skarphedinsson 1984). The distance from northwest Iceland staging areas to early winter areas in the northwest of the British Isles is about 250 km longer than from staging grounds in southern Iceland. Thus the swans make long direct flights from good feeding areas, rather than staging on the coasts closest to their wintering grounds before making the flight across the ocean. Clearly the swans moved on a broad front, with W-Iceland birds concentrated largely in Ireland and E-Iceland birds further east. As a consequence some birds from E-Iceland, but none from W-Iceland, reached the continent of Europe.

Having crossed the ocean the birds usually stayed in one general area for some months. In December-January about half the swans left the early winter sites and moved, usually south or southwest, often from Scotland and N-Ireland to S-Ireland. It is not easy to see a consistent pattern of swans moving or not moving at this time. Detailed observations are required to show whether mid-winter movements are a response to a change in resources. The long stays of individuals at Caerlaverock and Welney (where grain is provided) suggest, however, that food is important in determining winter movements.

In summer the Icelandic population has two main areas of distribution, separated by a gap in the middle where there is little habitat (Fig. 3). Of the October total of 14,000 about 6,000 have been found in east Iceland and 8,000 in the west. Four of the marked E-Iceland swans reached the continent of Europe, two of these were reported in the British Isles in later years. Assuming that E-Iceland swans are representative of an east Iceland population, as suggested by resightings and recoveries within Iceland, and that 10% of that population winter east of the North Sea, the number wintering on the Eurpoean continent would be about 600. Since 500-1,300 remain in Iceland, about 12,000 should winter in the British Isles, where Salmon & Black (1986) found some 15,000. The difference between an autumn census in Iceland and a mid-winter census must be partly due to early departure of some swans, nevertheless the estimates suggest that many (up to 3,000) Whooper Swans wintering in the British Isles may originate from the European continent.

The low frequency of return in sequential winters (cf. Table 5) may be related to age composition of the marked samples which came from non-breeding moulting flocks. Moulters are at least one and probably at most a few years old when marked (Gardarsson & Skarphedinsson 1984) and perhaps more likely to move between wintering grounds than breeding adults. Such exploratory movements (cf. Baker 1978), may be at a maximum in early life and breeding birds may be expected to show more pronounced site fidelity.

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Arnthor Gardarsson, Institute of Biology, University of Iceland, Grensasvegur 12, IS-108 Reykjavik, Iceland.