Winter distribution of Whooper Swans *Cygnus cygnus* ringed in four geographically discrete regions in Iceland between 1988 and 2006: an update

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Abstract

Between 1988 and 2006, a total of 5,110 Whooper Swans *Cygnus cygnus* were caught and marked with plastic leg-rings in four geographically discrete parts of Iceland. Of these, 53.6% were subsequently sighted at wintering sites, mainly in Britain and Ireland but with small numbers seen wintering in Iceland and elsewhere in Europe. Overall, the swans migrated on a broad front, had a predominantly northerly distribution in Britain and were widespread throughout many areas of Ireland, particularly in a belt stretching from the northeast to the southwest. Birds were distributed rather more evenly throughout Scotland. In England/Wales they were concentrated at relatively few sites, notably the Ouse Washes, Norfolk and Martin Mere/Ribble Estuary, Lancashire. Birds ringed in the more western parts of Iceland (in Skagafjörður) concentrated largely in more western parts of the wintering range (Ireland), whereas those ringed in east Iceland (Norður-Múlasýsla) were more likely to occur in Scotland and in continental Europe. An overall southerly shift in distribution as the winter progressed was also detected.

Key words: Britain, Cygnus cygnus, distribution, Iceland, Ireland, Whooper Swan.

The Icelandic Whooper Swan Cygnus cygnus population is geographically isolated and may be expected to remain relatively separate from the four other Whooper Swan populations (Gardarsson 1991; Delany & Scott 2002). Sightings of swans marked with neck-bands or with plastic leg-rings have shown that birds from the Icelandic population winter mainly in Britain and Ireland (Gardarsson 1991; McElwaine et al. 1995; Rees et al. 2002). Co-ordinated international censuses in Britain, Ireland and Iceland have also shown that up to 1,200 swans in the population, estimated at 20,856 birds in January 2000, remain in Iceland over winter (Cranswick et al. 2002). The population is not entirely discrete, however; observations in Norway, Denmark, Spain, France and the Netherlands of swans marked in Britain or Iceland indicate that up to 600 of the Icelandic-breeding birds may winter on mainland Europe (Gardarsson 1991; Cranswick et al. 1997). Conversely, it is estimated that at least 200 Finnish-breeding birds winter in southern Britain each year (Laubek et al. 1998).

The ringing of Whooper Swans in Iceland commenced in the 1960s when 400–500 birds were marked with metal rings (Kinlen 1963; Rees *et al.* 2002). Several hundred birds from moulting flocks at Mývatn, Snæfellsnes, Vopnafjörður and Álftafjörður were marked with neckbands in the early to mid 1980s (Brazil 1983; Gardarsson 1991) and, in a study of 197 of the neck-banded Whooper Swans, Gardarsson (1991) found that the birds migrated from Iceland on a broad front. Swans ringed in western Iceland migrated mainly to Ireland, whilst birds from eastern parts of Iceland wintered further east, and only eastern Icelandic birds were reported in mainland Europe. Following the overseas crossing in autumn, the birds tended to stay in their first main wintering area for the first few months of the winter (Oct–Dec), with around half moving south or southwest thereafter (Gardarsson 1991).

One of us (ST) had been ringing Whooper Swans in Suður & Norður-Þingeyjarsýsla, northeast Iceland, since 1981 fitting the birds with metal rings issued by the Icelandic Institute for Natural History, but also using plastic ("darvic") rings from 1988 onwards. Twenty individuals caught opportunistically in Jökuldalsheiði, east Iceland, by WWT in 1987 were also fitted with metal rings. Additionally, small numbers were ringed with metal rings by Pelle Andersen-Harild in 1982 at Akrar, west Iceland, and a further 38 birds were metalringed by Kristlaug Pálsdóttir in Suður-Þingeyjarsýsla, northeast Iceland, between 1988 and 1997.

Regular colour-ringing of Whooper Swans in Britain commenced during the 1979/80 winter, following the building of swan-pipes for catching birds wintering at the WWT reserves at Caerlaverock, Dumfriesshire, and at Welney, Norfolk. Relatively few swans were caught at Welney because the swan-pipe fell into disrepair and has only recently been replaced, but hundreds of Whooper Swans have been caught and ringed at Martin Mere, Lancashire, following the construction of a new swan-pipe there in 1990 (Rees et al. 2002). Resightings of the colour-ringed birds has since provided detailed information on the distribution and movements of individuals

throughout their migratory range. In 1988, WWT and Icelandic colleagues extended the colour-ringing programme to the swans' breeding grounds as part of a collaborative and ongoing study of Whooper Swan breeding biology, which includes catching and ringing both breeding and non-breeding birds in Iceland on a near-annual basis to study site fidelity, natal dispersal, cygnet survival rates and recruitment to the breeding population. Preliminary analysis of ring sightings for Whooper Swans marked at Caerlaverock indicated a high level of winter site fidelity, with 78% of ringed swans returning for at least one winter (Black & Rees 1984). Individuals also move readily between Britain and Ireland within a winter season, however, with northern areas of Ireland, in particular, being used as staging sites by swans wintering in Britain, as well as by those wintering elsewhere in Ireland (McElwaine et al. 1995; Rees et al. 2002).

This paper compares the winter distribution and seasonal movements of Whooper Swans colour-ringed in four geographically separate regions in Iceland between 1988 and 2006 and investigates whether there is an association between the swans' summer and winter locations. Monthly changes in the distribution of ringed birds during the autumn, winter and spring are used to determine possible seasonal movements by Whooper Swans in Britain and Ireland and the results compared with Gardarsson's (1991) earlier study. Overall, this paper aims to provide a preliminary overview of the ringing and resightings of Whooper Swans marked with leg-rings in Iceland since 1988 pending more detailed analysis of the data.

Study Area and Methods

An annual programme of catching Whooper Swans at sites in Iceland commenced in 1988 when birds were caught and colourringed at three of the four ringing areas included in this study, at: (1) Skagafjörður, northwestern Iceland (2) Suður & Norður-Þingeyjarsýsla, northeast Iceland, and (3) Norður-Múlasýsla, east Iceland (Fig. 1). The ringing programme extended to the fourth ringing area, Kjósarsýsla in southwestern Iceland in 1993 (Fig. 1). Swans at all sites were caught whilst the swans are flightless during their annual moult, with most being ringed in August each year.

The first of the ringing sites, Skagafjörður in northwest Iceland (Fig. 1) (65°40'N 19°30'W), is a lowland coastal site of approximately 250 km², consisting of marshes and grazed pasture in and around the Héraðsvötn river delta (Einarsson & Rees 2002). Here ringing has been undertaken annually since 1988 except for the years 1993 and 1997, with 1,482 swans caught and ringed up to and including 2006. Although most of the ringing was undertaken in the Skagafjörður floodplain or at Vatnshlíðarvatn, a lake about 15 km to the southwest of the Skagafjörður valley, small numbers were caught occasionally at Ölvesvatn (12 birds) to the northwest of the main Skagafjörður ringing area and at Slettuhlíðarvatn (2 birds) to the northeast. Sightings of birds ringed at these two sites were grouped with those of birds ringed at Skagafjörður in the analysis.

Ringing efforts in Suður-Þingeyjarsýsla, in northeast Iceland (Fig. 1) have been concentrated at Mývatnsheiði (65°30'N 17°20'W), Fljótsheiði (65°35'N 17°25'W), Aðaldalur (65°48'N 17°24'W) and Fnjóskadalur (65°37'N 17°50'W), upland areas of valleys and rocky terrain where numerous water sources and courses supply many lakes. Sightings of birds ringed at sites in this region were grouped with those of birds ringed in Norður-Þingeyjarsýsla in the analysis, where ringing effort was concentrated at Skjálftavatn in the years 1989–2004. Overall, 2,582 swans caught and ringed in Suður & Norður-Þingeyjarsýsla from 1988–2006 (inclusive), were included in the analysis.

Fieldwork in Norður-Múlasýsla, east Iceland (Fig. 1), has been concentrated at Jökuldalsheiði (65°15´N 15°31´W) and Möðrudalur (65°22'N 15°52'W). This is a sparsely vegetated highland region, characterised by mountain ranges with upland lakes and marshes. From 1988–2006 inclusive, 1,027 swans were caught and ringed in Norður-Múlasýsla, with ringing undertaken each year except for 2002.

A total of 19 Whooper Swans were caught and ringed at Álftanes in Kjósarsýsla, southwest Iceland, in August 1993 (Fig. 1). A further 100 birds were caught in Gullbringusýsla, also in southwest Iceland, from 1990–2005 inclusive, except in 1995, 1999, 2000–2001 and 2003–2004, of which 97% were caught at Tjörnin, Reykjavík. The swans ringed in Gullbringusýsla were not included in the analysis, however, as they



Figure 1. Sites in Iceland where Whooper Swans were ringed in summer, 1988–2006.

were caught during the winter months. Since Whooper Swans tend to return to traditional wintering sites each year (Black & Rees 1984), inclusion of a site where the birds had been caught in winter would have influenced the results obtained for those ringed during the summer, which mostly migrate to wintering sites elsewhere.

Breeding birds occupy diverse nesting habitats which range from low lying marshes in river deltas to upland lakes at altitudes of up to 700 m. Non-breeding flocks tend to use pools, marshes and sometimes farmland until the moulting period, when they move on to more expansive open water, mostly freshwater lakes, brackish coastal lagoons and shallow coastal areas, with rich bottom vegetation which can be accessed by headdipping and up-ending (Rees et al. 1997a). The nature of the Icelandic landscape and the different types of habitat used by the birds has influenced catching techniques. Most birds are caught during the annual moult (in July/August) since the swans are flightless at this time. Birds occupying areas of open water more than 1.2 m deep (all regions) can then be caught from a boat, using a "swan hook" (similar to a shepherd's crook). Those inhabiting marshland or shallow pools (mainly the breeding birds at Skagafjörður) are caught on foot. Since 1988, the sex of most unringed birds has been determined by cloacal examination and a record made of its age prior to ringing. Many of the swans caught were weighed, their body size measured (skull length, tarsus length and primary feather length), and the black and yellow bill patterns of the adult swans photographed to assist subsequent identification. Each bird was fitted with a

plastic darvic ring engraved with a unique code on one leg and a more durable metal ring issued by the Icelandic Institute of Natural History on the other.

Whooper Swan ring codes are read by amateur and professional ornithologists from across Britain and Ireland during the winter months. Sightings within Ireland have been collated by the Irish Whooper Swan Study Group since the early 1990s. Recoveries of dead birds are also noted and are reported to the Icelandic Bird Ringing Scheme at the Icelandic Institute for Natural History in Reykjavík. Ring-reading effort is particularly intensive at WWT centres: Caerlaverock, Martin Mere and Welney, where there has been near-daily reading of Whooper Swan rings since the colourringing scheme commenced in Britain in 1980. In Ireland, the development of the ring reading effort from winter 1988/89 onwards resulted in a major improvement in the coverage of Whooper Swan flocks throughout Ireland, but particularly in Northern Ireland (McElwaine et al. 1995). Ring reading at other wintering sites varies from regular to intermittent coverage, and is not necessarily consistent from year to year. Nevertheless, the ratio of ringed birds from the different ringing areas would still be recorded at these sites.

To assess the winter distribution of the Whooper Swans ringed in Iceland, the wintering sites at which ringed birds were recorded were mapped using ArcGIS (ESRI 2006). The number of ringed individuals identified between the winter months of November and February inclusive was summed for each site, to reduce any bias due to multiple observations of the same bird at

the same location, though some individuals were seen at more than one location during this mid-winter period. Sightings for each month (October-March inclusive) were also considered separately, to describe the swans' use of migratory sites and any shifts in the mid-winter distribution of marked birds. Sites within seven catchments where detailed monitoring was being undertaken were grouped for the purpose of analysis. These were the Ouse Washes (England), Martin Mere/Ribble Estuary (England), Caerlaverock/Islesteps (Scotland), Loughs Neagh/Beg (Northern Ireland), Upper Loughs Erne/Oughter (Northern Ireland/ Republic of Ireland), Lough Foyle/River Foyle (Northern Ireland/Republic of Ireland) and Lough Swilly (Republic of Ireland). Only sightings of live birds marked with plastic leg-rings were included; those with neck-bands or with metal rings only were omitted from the analysis, as were recoveries of birds found dead. Limiting the analysis to colour-ring sightings, rather than including resightings of neck-bands, made it possible to compare the results with the earlier study of the winter distribution of Whooper Swans marked with neck-bands in Iceland (Gardarsson 1991), and thus to determine whether the two marking methods gave similar results. Metal rings can only occasionally be read in the field so, since there is variation between the different ringing sites in the number of birds fitted with metal rings only (16 individuals at Skagafjörður, 49 at Norður-Múlasýsla and 181 at Suður & Norður-Þingeyjarsýsla since 1988), inclusion of these data would have caused a bias in the resightings rates for each site. Thirty-seven individuals that had been

caught in more than one part of Iceland were also omitted.

Chi-squared tests were used to test for significant differences in the winter distribution of Whooper Swans from the different ringing areas. Where swans were seen in more than one country, these were treated as a separate group in the chisquared analyses. For instance, if testing whether swans ringed in northwest Iceland were more likely than those ringed elsewhere to be seen in the Republic of Ireland, the winter resightings were divided into three groups: those seen in the Republic of Ireland only, those seen elsewhere and also in the Republic of Ireland, and those not seen in the Republic of Ireland.

Results

Overall distribution in winter

A total of 5,110 Whooper Swans was caught and ringed in Iceland between 1988 and 2006, of which 2,740 (53.6%) were resighted on the wintering grounds. The percentage of birds resighted in winter varied slightly between ringing regions: 59.4% for birds ringed in Skagafjörður (1,482), 49.5% for birds ringed in Suður & Norður-Þingeyjarsýsla (2,582), 54.9% for birds ringed in Norður-Múlasýsla (1,027) and 63.2% for those ringed in Kjósarsýsla (19). Of all individuals resighted, 2,672 (98.0%) were seen at sites in either Britain or Ireland in at least one winter. A total of 1,718 birds were recorded in Britain, 969 in the Republic of Ireland and 850 in Northern Ireland (Table 1), including 794 birds seen wintering in more than one country. These were included for each

Table 1. The winter distribution of Icelandic-ringed Whooper Swans recorded in different parts of the range during winters 1988/89–2006/07.

	No. of	% of
	individuals	individuals ¹
Britain	1,718	63.0
Republic of Ireland	969	35.4
Northern Ireland	850	31.0
Iceland	78	2.8
Denmark	33	1.2
Germany	2	0.07
Netherlands	5	0.18
France	2	0.07
Spain	1	0.04
Norway	6	0.2

¹ The percentage of individuals recorded for each country was calculated using the total number of individual birds resigned in the wintering grounds (2,740). Individuals seen in more than one country were included once for each country.

country in which the bird was sighted. Icelandic-wintering birds represented only 2.8% (78 birds) of the total number sighted (Table 1).

In addition to the swans wintering in Britain, Ireland and Iceland, much smaller numbers were seen wintering in Europe (Table 1, Fig. 2). These accounted for only 1.7% (47 birds) of all Icelandic-ringed birds seen in winter. Most were recorded in Denmark (33 birds; 67.3% of the European-wintering birds) with ringed birds also found in the Netherlands, Germany, France, Spain and Norway (Table 1, Fig. 2). Ringed individuals were reported from across Britain and Ireland, though relatively few birds were identified in southwest England and in Wales (Fig. 2). In Ireland, birds were particularly concentrated in a belt that stretched from the northeast to the southwest (Fig. 2).

Overall, ringed Whooper Swans were seen at 967 sites throughout the wintering range. Even at Caerlaverock and at Martin Mere/Ribble Estuary, where the swans are monitored on a near daily basis during the winter, only 180 and 331 Icelandicringed individuals were identified during the study (6.6% and 12.1% of all birds resighted respectively). Three sites received substantially larger (>400) numbers of Icelandic-ringed individuals: the Ouse Washes (563 birds, 20.6%), Lough Swilly (431 birds, 15.8%) and Lough Foyle/River Foyle (405 birds, 14.8%) (Fig. 2).

Distribution in relation to ringing site

Of the 880 birds ringed in Skagafjörður that were resighted, most were recorded in the Republic of Ireland (42.7%) and Northern Ireland (37.6%) (Table 2). Birds ringed in Skagafjörður were more likely to be resighted in Ireland (than elsewhere) than birds ringed in the three other regions (χ^2_2 = 14.9, P < 0.05 and $\chi^2_2 = 18.3$, P < 0.05 for the Republic of Ireland and Northern Ireland respectively). Although a relatively high proportion of birds ringed in this region were recorded in England/Wales (33.8%), they were concentrated at just two key sites (the Ouse Washes and Martin Mere/Ribble Estuary); the highest number of birds ringed in Skagafjörður were found at Loughs Neagh/Beg in Northern Ireland

Table 2.	The	percentage	of	Icelandic-ringed	birds	resighted	in	different	parts	of	the
wintering	range	e in 1988/89	-20	06/07. Sample siz	zes (n	values) are	giv	en in pare	nthese	s.	

Resighting	Percentage of ringed individuals resighted ¹ (n)								
location	Skagafjörður (NW Iceland)	Suður & Norður-	Norður- Múlasýsla	Kjósarsýsla (SW Iceland)					
		(NE Iceland)	(E Iceland)						
England/Wales	33.8 (297)	38.3 (490)	36.3 (205)	8.3 (1)					
Scotland	29.3 (258)	36.4 (465)	43.4 (245)	33.3 (4)					
Republic of Ireland	42.7 (376)	31.8 (406)	32.1 (181)	33.3 (4)					
Northern Ireland	37.6 (331)	30.8 (393)	22.2 (125)	8.3 (1)					
Iceland	1.6 (14)	4.3 (55)	0.2 (1)	33.3 (4)					
Continental Europe ²	0.5 (4)	1.5 (19)	4.3 (24)	0 (0)					

¹The percentage of individuals seen wintering in each country was calculated from the number of birds from each ringing region that were resighted: overall, 880 birds from Skagafjörður, 1,278 from Suður & Norður-Þingeyjarsýsla, 564 from Norður-Múlasýsla and 12 from Kjósarsýsla.

²Continental Europe includes sightings in Denmark, Germany, the Netherlands, France, Spain and Norway.



Figure 2. Winter distribution of Whooper Swans ringed in all four regions of Iceland between 1988 and 2006.

Table 3: Main wintering sites used by birds ringed in different parts of Iceland ¹ . Numbers of
Icelandic-ringed individuals identified at each site (n values) are given in parentheses.

Wintering site	% birds ringed at Skagafjörður (n)		% birds at Suð Norð Þingeyja	% bi ringe Nord Múla	irds ed at ður- sýsla	% birds ringed at Kjósarsýsla (n)	
Loughs Neagh/Beg	21.3	(187)	12.4) (159)	9.2	(52)	8 3 (1)
Northern Ireland	21.5	(107)	12.1	(157)	.2	(32)	0.5 (1)
Lough Swilly, Republic of Ireland	20.0	(176)	14.4	(184)	12.1	(68)	8.3 (1)
Ouse Washes, England	16.5	(145)	23.8	(304)	20.0	(113)	8.3 (1)
Lough Foyle/River Foyle Northern Ireland/ROI	, 16.3	(143)	15.1	(193)	12.1	(68)	8.3 (1)
Martin Mere/Ribble Estuary, England	13.8	(121)	11.1	(142)	11.3	(64)	0 (0)
Caerlaverock/Islesteps, Scotland	9.8	(86)	5.2	(66)	4.8	(27)	8.3 (1)
Upper Loughs Erne/ Oughter, Northern Ireland/ROI	3.6	(32)	5.9	(76)	3.5	(20)	0 (0)
Ballingarry, Republic of Ireland	0	(0)	0.2	(2)	0	(0)	0 (0)
Tjörnin, Iceland	0	(0)	0.1	(1)	0	(0)	25.0 (3)
Rostellan Lake, Cork Harbour, ROI	0.1	(1)	0.1	(1)	0	(0)	16.7 (2)
Inchinnan, Renfrewshire, Scotland	0.3	(3)	0.4	(5)	0.5	(3)	16.7 (2)

¹ The percentage of individuals seen at each site was calculated using the total number of resighted birds from each ringing region. These were as follows: overall, 880 birds from Skagafjörður, 1,278 from Suður & Norður-Dingeyjarsýsla, 564 from Norður-Múlasýsla and 12 birds from Kjósarsýsla.



Figure 3. Winter distribution of Whooper Swans ringed in different parts of Iceland: (a) northwest Iceland (Skagafjörður) (b) northeast Iceland (Suður & Norður-Þingeyjarsýsla) (c) east Iceland (Norður-Múlasýsla), and (d) southwest Iceland (Kjósarsýsla).



Figure 3 (cont.)

(187 birds, 21.3% of all resighted birds from Skagafjörður) (Table 3, Fig. 3a). Birds from this region were recorded in eight different countries including the Netherlands and Denmark (Fig. 3a).

Birds ringed in Suður & Norður-Þingeyjarsýsla and subsequently resighted (1,278 birds), were mostly recorded in England/Wales (38.3%, Table 2), with highest numbers found on the Ouse Washes (304 birds, 23.8% of all resighted birds, Table 3). Birds from this region were recorded in nine different countries including Norway, Denmark and France (Table 2, Fig. 3b).

Those ringed in Norður-Múlasýsla and resighted (564 birds) were mostly found wintering in Scotland (43.4%, Table 2), and were more likely to do so than birds ringed in the other regions ($\chi^2_2 = 15.0$, P < 0.05). Nevertheless, most ringed birds were again found concentrated on the Ouse Washes (113 birds, 20.0%, Table 3). Birds from this region were recorded in ten different countries, including the



Figure 4. The number of Icelandic-ringed Whooper Swans recorded each month during the winter.

Netherlands, Denmark, Germany and Spain (Fig. 3c).

High proportions of birds ringed in Kjósarsýsla were subsequently seen wintering in Scotland, the Republic of Ireland and Iceland (each accounting for 33.3% of birds resighted from this region) (Table 2). No birds were recorded in continental Europe (Table 2, Fig. 3d).

Birds recorded wintering in continental Europe were mostly ringed in Norður-Múlasýsla and were more likely to be from this region than the other regions ($\chi^2_2 = 26.8$, P < 0.05), whereas birds ringed in Kjósarsýsla were least likely to be seen in continental Europe (Table 2).

Changes in the distribution of ringed birds during the autumn, winter and spring

Although Icelandic-ringed Whooper Swans were recorded from October to March, numbers identified increased from 1,022 in October (20.0% of the total ringed) to

> a peak of 1,713 in November (33.5%). Thereafter, numbers identified each month remained relatively steady as the winter progressed (Fig. 4).

Most birds were identified in Ireland in October, with the Republic of Ireland and Northern Ireland accounting for 39.1% and 25.5% of ring sightings for that month (Table 4, Fig. 5). The highest concentrations of ringed birds were found at Lough Swilly (326 birds, 31.9% of all birds recorded in October)

	Oct	Nov	Dec	Jan	Feb	Mar
England/ Wales	23.2 (237)	35.0 (600)	40.4 (599)	39.5 (643)	34.1 (506)	23.3 (351)
Scotland	23.2 (237)	31.9 (546)	27.4 (407)	25.9 (421)	23.6 (350)	30.0 (448)
Republic of Ireland	39.1 (400)	30.5 (522)	21.6 (321)	26.0 (423)	24.9 (369)	28.0 (418)
Northern Ireland	25.5 (261)	24.6 (421)	26.2 (389)	23.2 (377)	26.3 (391)	34.2 (514)
Iceland	7.4 (76)	0.6 (10)	0.4 (6)	1.0 (17)	3.5 (52)	4.8 (72)
Continental Europe	0.1 (1)	1.6 (27)	1.2 (18)	1.3 (21)	1.2 (18)	2.1 (32)

Table 4: The percentage of individual Icelandic-ringed birds resighted in each country in the months October-March, 1988–2006¹. Sample sizes (*n* values) are given in parentheses.

¹The percentage of birds seen in each region was calculated using the total number of individual birds resighted in each month 1988–2006. These totals were as follows: overall, 1,022 birds in October, 1,713 in November, 1,483 in December, 1,627 in January, 1,484 in February and 1,505 birds in March.



Figure 5. The number of Icelandic-ringed Whooper Swans recorded in each region during months October–March.

Wintering site	Oct	Nov	Dec	Jan	Feb	Mar
Ouse Washes, England	10.8	18.9	23.1	24.0	19.1	12.2
	(110)	(323)	(343)	(391)	(284)	(184)
Martin Mere/Ribble	12.0	14.3	13.0	11.2	10.6	8.8
Estuary, England	(123)	(245)	(193)	(182)	(157)	(133)
Caerlaverock/Islesteps,	6.8	6.9	6.5	5.5	4.9	6.1
Scotland	(70)	(119)	(96)	(90)	(73)	(92)
Lough Foyle/River Foyle,	24.3	15.5	7.8	7.3	6.1	11.5
Northern Ireland/ROI	(248)	(265)	(116)	(118)	(91)	(173)
Lough Swilly,	31.9	19.7	8.9	6.8	3.5	9.4
Republic of Ireland	(326)	(337)	(132)	(111)	(52)	(142)
Upper Loughs Erne/Oughter, Northern Ireland/ROI	0 (0)	1.3 (23)	2.9 (43)	3.5 (57)	4.4 (66)	6.3 (95)
Loughs Neagh/Beg,	3.4	8.1	14.2	12.3	13.9	16.3
Northern Ireland	(35)	(139)	(211)	(200)	(206)	(245)

Table 5: The percentage of Icelandic-ringed Whooper Swans seen at the main wintering sites each month (October to March inclusive) during the winter¹. Numbers of Icelandic-ringed individuals identified at each site (*n* values) are given in parentheses.

¹The percentage of birds seen at each site was calculated using the total number of individual birds resighted in each month 1988–2006. These totals were as follows: overall, 1,022 birds in October, 1,713 in November, 1,483 in December, 1,627 in January, 1,484 in February and 1,505 birds in March.

and Lough Foyle/River Foyle (248 birds, 24.3% – Table 5, Fig. 6a), indicating that the birds were mainly in the northern part of Ireland. Birds were still recorded across Iceland in October, with particularly high concentrations found at Lónsfjörður in the southeast (34 birds – many of which were recorded in early October by the Irish Whooper Swan Study Group) (Fig. 6a). One ringed individual had reached Denmark during this month (Fig. 6a).

Whooper Swan sightings increased in all regions in November, except for Iceland

where the number of ringed birds fell by 86.8% (Table 4, Fig. 5). Most birds were recorded in England/Wales (600 birds, 35.0%) and Scotland (546 birds, 31.9%, Table 4). Ringed birds were found mainly at Lough Swilly (337 birds, 19.7%), Lough Foyle/River Foyle (265 birds, 15.5%), Martin Mere/Ribble Estuary (245 birds, 14.3%) and the Ouse Washes (323 birds, 18.9%) (Table 5, Fig. 6b). Twenty-seven ringed birds were also recorded in four countries in continental Europe (Norway, Denmark, France and Spain) during November





Figure 6. Distribution of Icelandic-ringed Whooper Swans in each month of the winter: (a) October, (b) November, (c) December, (d) January, (e) February, (f) March.

(a)

No of birds • 1-99 • 100-399 • 400-699



Figure 6 (cont.)





Figure 6 (cont.)

(Fig. 6b). All 10 ringed birds resighted in Iceland in November were found in the south of the country (Fig. 6b).

Fewer individuals were recorded in December than in November for all regions. In England/Wales, the number of ringed swans recorded remained stable for both months (Table 4, Fig. 5). During the mid-winter months of December and January, most birds were recorded in England/Wales, accounting for 40.4% and 39.5% of all resightings in these two months (Table 5, Fig. 5). Birds identified in midwinter were seen mainly on the Ouse Washes (343 birds in December and 391 birds in January; 23.1% and 24.0% of all birds recorded in each month) and at Loughs Neagh/Beg (211 birds in December and 200 birds in January; 14.2% and 12.3% of all birds recorded in each month) (Table 5, Figs. 6c, d). Birds were also recorded in five countries across Europe in December and January, in Denmark, the Netherlands, Norway, France and Spain (Figs. 6c, d).

Sites where Icelandic-ringed birds were recorded in numbers in February included the Ouse Washes (284 birds, 19.1% of all birds recorded in February), Martin Mere/Ribble Estuary (157 birds, 10.6%) and Loughs Neagh/Beg (206 birds, 13.9%) (Table 5, Fig. 6e).

From February to March, the number of ringed birds recorded in England/Wales declined sharply by 30.6%, whilst the numbers identified in all other regions increased (Table 4, Fig. 5). The increase was particularly evident in Northern Ireland, where the number of swans identified rose by 23.9% and accounted for 34.2% of all birds recorded in March (Table 4, Fig. 5). A

high proportion of ringed birds was also recorded in Scotland in March (448 birds, 30.0% of swans identified, Table 4). Correspondingly, key sites in England had fewer rings read in March than in February, whilst those in Ireland increased. For example, the number of ringed individuals using the Ouse Washes and Martin Mere/Ribble Estuary declined by 35.2% and 15.3%, respectively whilst 15.9% and 47.4% more birds were recorded at Loughs Neagh/Beg and Lough Foyle/River Foyle (Table 5, Figs. 6e, f).

No birds were recorded in France or Spain in February, although 18 individuals were still recorded at sites in the Netherlands, Denmark, Germany and Norway (Fig. 6e). Those seen in Iceland in February were predominantly found in Suður & Norður-Þingeyjarsýsla, northeast Iceland (Fig. 6e). There was greater dispersal of birds across Iceland in March with most ringed birds again recorded in Suður & Norður-Þingeyjarsýsla (Fig. 6f). Numbers resighted in continental Europe increased in March to 32 birds (Table 4, Fig. 5).

Discussion

Icelandic-ringed Whooper Swans were seen in numbers across a large part of the Icelandic population's wintering range suggesting that samples from the four ringing areas in Iceland gave a fair representation of the winter distribution as a whole. Although the resightings of ringed birds may be biased by the distribution of observer effort, the distribution found corresponds with those found during past censuses (e.g. Cranswick *et al.* 2002). As some birds were ringed as pairs or in family groups, sightings and therefore movements were not entirely independent. Future analysis could investigate the influence of breeding status on migratory patterns and wintering distribution.

Overall, the ringed swans had a predominantly northerly distribution in Britain and were widespread throughout many areas of Ireland, particularly in a belt stretching from the northeast to the southwest. Most birds resighted were seen in Britain and Ireland during at least one winter. Icelandic-ringed birds were distributed rather more evenly throughout Scotland. In England/Wales they were concentrated at relatively few sites, notably at the Ouse Washes, Norfolk and at Martin Mere/Ribble Estuary, Lancashire. These two sites, together with Loughs Neagh/Beg, Lough Foyle/River Foyle and Lough Swilly in Ireland, proved to be the key resighting areas for the Icelandic-ringed swans. Lough Swilly and Lough Foyle/River Foyle were also main staging areas for the birds in October. All five sites were confirmed as being sites of international importance for the species during the international Whooper Swan census in 2000 (Cranswick et al. 2002). The lowest numbers of wintering ringed birds were found in Iceland and in European countries further from Icelandic breeding grounds.

There was some evidence of an association between ringing location and wintering site. Birds ringed in the more western parts of Iceland concentrated largely in more western parts of the wintering range. This agrees with Gardarsson (1991), who found that birds from the western parts of Iceland tended to winter in Ireland while those further east were more likely to spend their winters in Scotland and England. Whooper Swans ringed in the northwest of Iceland (Skagafjörður), for instance, were mostly recorded in the Republic of Ireland and Northern Ireland and were more likely to be seen in these countries than those ringed in the other three regions. This concurs with McElwaine et al. (1995), who found that swans seen in Ireland were significantly more likely to come from Skagafjörður than from the two more easterly ringing sites. Birds ringed in eastern Iceland (Norður-Múlasýsla), on the other hand, were more likely to winter in Scotland than swans ringed in the other three regions. The east Iceland birds were also more likely to winter in continental Europe, thus supporting Gardarsson's study (1991) which found that birds from more easterly parts of Iceland tend to winter further east, though a small number of birds from the other three Icelandic ringing sites also reached the continental mainland.

The main influx of birds into the wintering range occurs from late September, and continues through October and November (Brazil 2003). Therefore, only 20.0% of the total ringed were recorded in the wintering grounds in October. The swans are still dispersed across Iceland in suitable habitat during October, though particularly high concentrations are found at Lónsfjörður in the southeast, a major staging site used prior to departure to wintering grounds in Britain and Ireland (Einarsson 2000).

The importance of sites in northern parts of Ireland as staging areas during October, described by McElwaine et al. (1995), was reiterated here. Interestingly, they also found that few of the birds seen in October remained in Ireland for longer than two weeks, with 28% subsequently recorded at sites in England, Scotland and Wales (McElwaine et al. 1995). These movements may explain the decline in the number of ringed swans recorded in the Republic of Ireland and Northern Ireland in December, following peak numbers identified there in November. An onward movement of swans from Ireland to England/Wales seems a likely explanation given that ringed swans were more likely to be recorded in England/Wales in December and January. Similarly, the peak number of birds in Scotland occurred in November and was followed by a decline in December, perhaps reflecting a movement south from Scotland as the winter progressed and thus confirming the redistribution described in McElwaine et al. (1995). Half of the ringed birds studied by Gardarsson were also recorded moving south or southwest from sites in December and January. A southerly shift in distribution of sites used by Whooper Swans between October and November, was also discovered by Rees et al. (1997b), and suggests that the birds use regions closest to their Icelandic breeding grounds upon arrival in the U.K. before dispersing southwards. A similar position in Ireland was highlighted in McElwaine et al. (1995).

The tendency of Whooper Swans to regroup into larger flocks at fewer locations for spring migration (Brazil 2003) may partly explain the apparent increase in numbers of ringed birds recorded in March for most regions, as the rings are more likely to be read if the birds congregate at major wellmonitored sites. Therefore, a bias in the ease of ring-reading, and thus in the distribution of the birds, during the winter in association with changes in habitat use should also be considered.

However, increases in Scotland and Northern Ireland may also be attributable to the northwest movement of birds towards Iceland at the start of spring migration, which usually occurs in March and April (Rees *et al.* 1997b). This seems a reasonable explanation given the corresponding decline in numbers sighted in England/Wales during February and March and could be confirmed through more detailed analysis of the movements of individual birds.

During spring migration, many birds stop at important staging areas in the south and southeast of Iceland, particularly at Lónsfjörður (Einarsson 2000; Brazil 2003). The arrival of birds almost certainly explains the increase in numbers and greater dispersal of birds across Iceland in March. Interestingly, higher concentrations of birds were recorded in Suður & Norður-Þingeyjarsýsla in February and March than in the other months. This may be due to an increase in observations of ringed birds over-wintering in the area during these months, rather than an early migration of swans to this part of Iceland in spring.

Further analysis will address staging phenology, and the network of sites used by the birds locally and along the flyway. Variation in winter site fidelity and reasons for changes in winter site selection will also be considered, together with the effects of age and breeding success on migratory strategies. A year-round investigation of Whooper Swan distribution will additionally provide information on the summer distribution of swans ringed in the wintering range.

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