Numbers of Whooper Swans *Cygnus cygnus* in Iceland, Ireland and Britain in January 1995: results of the international Whooper Swan census.

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The third co-ordinated international census of Whooper Swans in Iceland, Ireland and Britain was made in January 1995. Excellent coverage was achieved and 15,842 birds were counted or estimated, suggesting a decrease in the population of 2,193 birds (12.2% overall, or 3.0% per annum) since the previous census in January 1991; 20.1% overall if only adult birds are considered. Average annual mortality was estimated at 19.7%, compared with recruitment of 16.7%, over the four year period. Distribution was similar to 1991, however, with 5,016 (31.7%) recorded in Great Britain and the Isle of Man, 2,783 (17.6%) in Northern Ireland, 7,072 (44.6%) in the Republic of Ireland and 971 (6.1%) in Iceland. Around 400 birds wintered on the continent, whilst an unknown but probably small number from the Scandinavian/Russian population wintered in Britain. It is recommended that the figure of 16,000 is adopted for the Icelandic Whooper Swan population. The 10,156 birds aged included 1,814 (17.9%) juveniles, indicating that 1994 was a good breeding year. Substantial variation in the distribution of juveniles in the wintering range emphasises the difficulty of obtaining accurate estimates of annual productivity from small or localised samples.

Keywords: Whooper Swan, Britain, Ireland, Iceland, Wintering Population, Census

Whooper Swans *Cygnus cygnus* have a widespread breeding distribution in the northern Palaearctic, extending from Iceland and northern Scandinavia, across Russia, to the Pacific coast. Four main breeding populations have been described: Icelandic, northwest European, central Russian and east Russian (Monval & Pirot 1989), but the different migratory routes and level of interchange between populations remain unclear, particularly in the eastern part of the range. Results of ringing programmes indicate that most of the swans wintering in Britain and Ireland are from the Icelandic-breeding population (Brazil 1983; Black & Rees 1984; Gardarsson 1991), with some 500-1,300 birds remaining in Iceland over winter (Gardarsson & Skarphedinsson 1985). Small numbers of swans ringed in Iceland have been sighted in Norway, Denmark and The Netherlands (Gardarsson 1991), and in the 1995-96 winter, swans marked in Finland were recorded in Great Britain for the first time (B. Laubek pers. comm.). The level of interaction between the Icelandic and northwest European populations, and the extent to which this varies between years, is still not known, although individuals move readily in both directions between Britain and Ireland within a winter (Gardarsson 1991, McElwaine *et al.* 1995).

Analysis in the late 1980s of population trends in Great Britain between 1967 and 1986 did not find any evidence for a change in population levels. In Ireland, coverage was too irregular during this period to determine trend indices (Monval & Pirot 1989). More recent indexing techniques applied to data from the annual waterfowl

count scheme in the UK suggest sustained increases from the mid-1960s to 1990-91 with a subsequent decline in Great Britain, and generally stable numbers in Northern Ireland between 1986 and 1995 (Kirby *et al.* 1995; Waters *et al.* 1996). Although a relatively small proportion of the Whooper Swan population is present on sites covered by the scheme, the marked increase in counts and population estimates between the early 1960s and mid-1980s suggests that there may have been a genuine population increase over this period. The British total in the early 1960s was put at not more than 4,000 birds (Boyd & Eltringham 1962), and the numbers wintering in Britain and Ireland at 5,000-7,000 (Boyd 1963). Subsequent estimates remained in this range (Scott 1980; Atkinson-Willes 1981; Brazil & Kirk 1981) until autumn censuses in Iceland recorded 10,000-11,000 birds in October 1982, with improved coverage yielding c.14,000 in 1984 and 1985 (Gardarsson & Skarphedinsson 1984; Gardarsson 1991). Owen *et al.* (1986) suggested that the number in Great Britain increased at a rate of 6% per annum between 1970 and 1979, which they attributed to a decrease in mortality levels. The first co-ordinated censuses of Whooper Swans wintering in Britain, Ireland and Iceland, made in January 1986, found 16,700 swans (Salmon & Black 1986), and an increase to 18,035 swans was recorded during the second international census in January 1991 (Kirby *et al.* 1992). Information on flock size and distribution recorded during both censuses confirmed that Whooper Swans are widely dispersed in scattered flocks, supporting the view of Ruger *et al.* (1986) that it is difficult to achieve comprehensive coverage and to obtain an accurate estimate of population size and trends for this species, except by organising special surveys.

A third international census was undertaken in January 1995, to continue the long-term monitoring of changes in numbers and winter distribution for the Icelandic-breeding population. It was intended that the censuses be held at five-year intervals, and the third census was originally scheduled for January 1996. It was brought forward by one year to coincide with the first co-ordinated survey of Whooper Swans on the continental mainland (described in Laubek 1995a), and thus provide the first total count of Whooper Swans wintering in Europe.

Methods

The census of birds in Great Britain, Ireland and Iceland was organised by The Wildfowl & Wetlands Trust (WWT) in collaboration with IWC Birdwatch Ireland (IWC), the University of Iceland and the Icelandic Institute of Natural History. Counters were asked to record the following details on census forms: the total numbers of Whooper and Bewick's Swans *Cygnus columbianus bewickii*; number of adults and cygnets; number of cygnets in each family; whether the area was used as a roost or feeding site; the habitat which the swans were using; and any leg ring or neck collar details.

The census was combined with existing volunteer waterfowl count schemes: the Wetland Bird Survey (WeBS) in the UK, and the Irish Wetland Bird Survey (I-WeBS) in the Republic of Ireland. Many counters also visited additional areas thought likely to hold swans but not normally covered by the count schemes. The recommended count date was 22 January 1995, although counts from different dates were used where none was available for 22nd and where the possibility of birds being double-counted, having moved between counted sites, was thought to be small. A number of counts from more remote areas made during early January or early February were therefore included where it was felt safe to do so. In view of the known interaction between flocks (McElwaine *et al.* 1995), a small team specifically counted the major sites of Swilly/Foyle, Loughs Neagh and Beg, and Upper Lough Erne in a co-ordination fashion in an attempt to reduce the chances of double-counting. In addition, an aerial survey was undertaken of the Shannon Callows and adjacent areas in Ireland in mid-January. Thus, good coverage was achieved of the vast majority of the range of Whooper

Swans in Britain and Ireland (**Figure 1**). Areas not included in the census were mainly mountainous regions or large conurbations, thought unlikely to hold large numbers of Whooper Swans.

Iceland was covered by a team of 23 observers. Two principal count dates, in early January and early February, were used due to the difficulties of synchronous coverage by such a small team. However, the birds are fairly sedentary at this time and the likelihood of missed or double-counted birds is thought to have been small. Southwest and southeast Iceland were covered from the ground, whilst south and parts of west Iceland were surveyed by air. North Iceland was only partly covered.

Estimates have been included for sites that were not visited but which were suspected to have held significant numbers of birds, based on the nearest available counts or from the previous census. This involved only a handful of sites in Britain and Ireland. An estimate based on counts made during the 1991 census has been used for the areas of northern Iceland not visited in 1995.

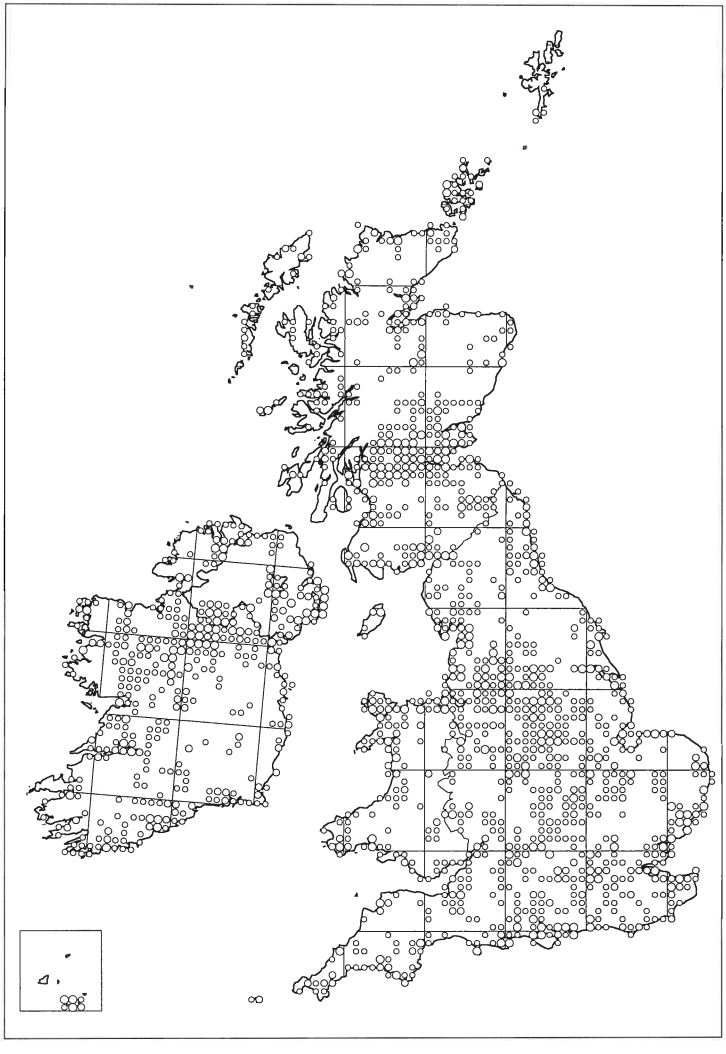

Figure 1. Distribution of count areas visited for the Whooper Swan census in each 10 km square in Britain and Ireland, January 1995. Dots represent the number of count areas visited: small dots = 1-2 count areas, medium dots = 3-4, and large dots = 5 or more. Note that some additional, mainly non-wetland areas, were visited for the census, particularly in Northern Ireland and around the Moray Firth, but are not included in the map where no birds were found.

Results

Numbers and distribution

The total of 15,842 Whooper Swans recorded in January 1995 comprised 14,966 counted and 846 estimated birds (**Table 1**). As in previous censuses, the majority of birds were found in Ireland, with 44.6% in the Republic of Ireland and 17.6% in Northern Ireland, although both figures were slightly lower than in 1991. The total in Great Britain was divided almost equally between Scotland (16.4%) and England (14.3%), with Wales and the Isle of Man each holding less than 1% of the total. Some 6.1% of the population remained in Iceland during the winter.

Table 1. Numbers of Whooper Swans in Britain, Ireland and Iceland, January and February 1995. Includes estimated birds: Republic of Ireland 661; Iceland 174; and England 11. Counties not listed held no Whooper swans.

	Flocks[1]	Birds[2]
ICELAND		
West	2	24
Southwest	15	392
South	20	380
Southeast	2	21
North	16	154
Total	**55**	**971**
NORTHERN IRELAND		
Down	9	184
Antrim	14	505
Armagh	9	43
Londonderry	10	810
Tyrone	7	178
Fermanagh	35	863
Total	**84**	**2,783**
REPUBLIC OF IRELAND		
Donegal	20	659
Leitrim	24	280
Sligo	4	142
Mayo	25	643
Roscommon	25	161
Longford	4	83
Galway	17	919
Clare	17	614
Limerick	3	82
Tipperary	4	108
Kerry	4	200
Cork	9	219
Waterford	2	131
Kilkenny	1	30
Wexford	3	76
Laois	1	100
Offaly	5	2969
Kildare	2	192
Wicklow	1	42
Dublin	2	8
Meath	2	98
Westmeath	4	342
Cavan	31	527
Monaghan	14	336
Louth	2	111
Total	**226**	**7,072**

	Flocks[1]	Birds[2]
SCOTLAND		
Dumfries & Galloway	16	358
Strathclyde	23	270
Borders	5	223
Lothians	6	166
Central	13	100
Fife	3	65
Tayside	12	302
Grampian	3	80
Highland	33	423
Western Isles	16	298
Orkney	30	292
Shetland	2	25
Total	**162**	**2,602**
ISLE OF MAN		
Total	**2**	**36**
WALES		
Dyfed	3	31
Gwynedd	4	76
Clwyd	1	2
Total	**8**	**109**
ENGLAND		
Gloucestershire	1	4
Cambridgeshire	3	97
Suffolk	1	5
Norfolk	4	971
Lincolnshire	1	2
Nottinghamshire	1	15
Humberside	2	31
Greater Manchester	2	20
South Yorkshire	1	18
West Yorkshire	1	4
North Yorkshire	4	5
Tyne & Wear	1	1
Northumberland	7	148
Lancashire	9	724
Cumbria	8	184
Total	**46**	**2,269**
GRAND TOTAL	**583**	**15,842**

[1] At some sites, birds in different flocks were summed to give just one count.
[2] The count for Offaly includes the aerial count of birds on the Shannon Callows, many of which were actually in other counties.

The overall distribution of birds in Britain and Ireland is shown by 10 km squares in **Figure 2**. This closely matches that of previous Whooper Swan censuses and the *Winter Atlas* (Lack 1986). Although presentation by 10 km squares requires careful interpretation when compared with the map showing precise flock locations in Kirby *et al.* (1992), there were seemingly fewer small flocks in England in 1995, whilst very few birds were found in east Grampian and Tayside. There were rather more birds in central Scotland, however. Extensive coverage of north and west Scotland revealed very few birds on the mainland. Distribution in Ireland was also similar to 1986, although swans were less widely distributed in Co. Down, and fewer flocks were found in southeast Ireland, particularly in Counties Waterford and Offaly.

Eight sites each held 1% (160 birds) or more of the total at the time of the survey: Swilly/Foyle (Tyrone/Londonderry/Donegal) 1,149; Ouse Washes (Norfolk/Cambridgeshire) 1,034; Loughs Neagh & Beg (Down/Antrim/Armagh/Londonderry/Tyrone) 955; Shannon Callows (Galway/

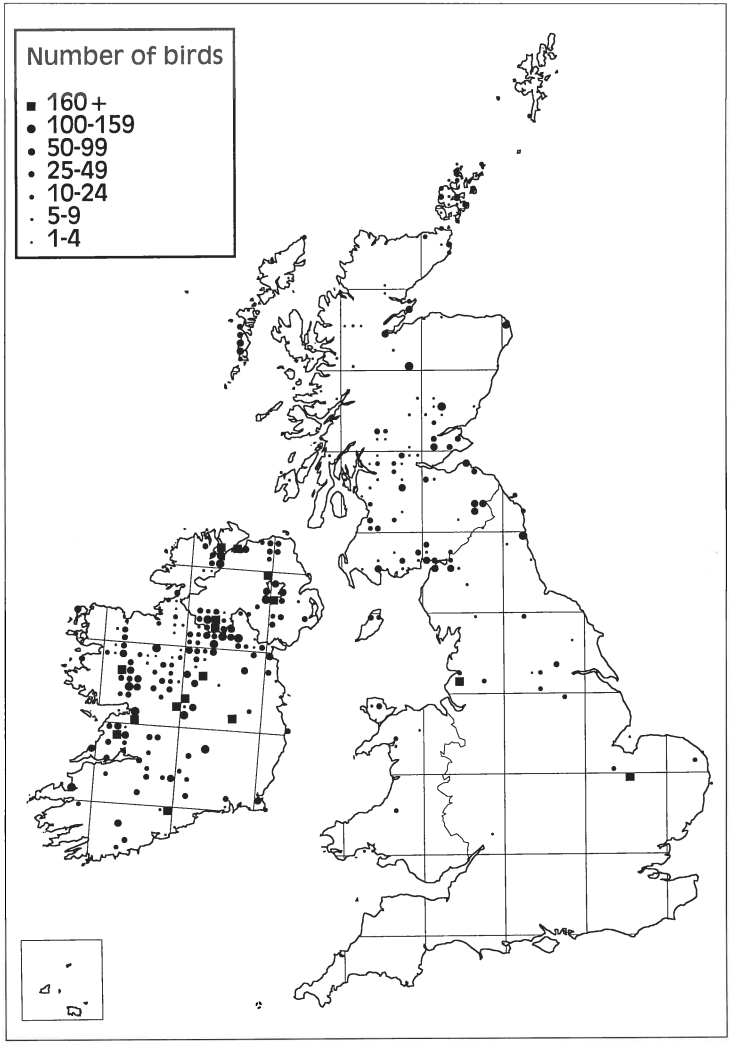

Figure 2. Distribution of Whooper Swans by 10 km squares in Britain and Ireland, January 1995. Both observed and estimated counts of birds are shown.

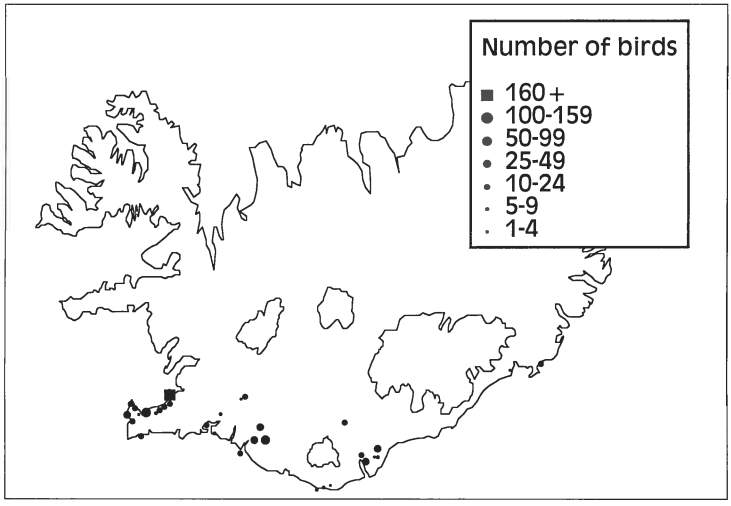

Figure 3 Distribution of Whooper Swans in Iceland, January and February 1995. Only observed birds are displayed; counts of estimated birds are omitted. Some flocks have been summed for clearer presentation. The major glaciers are also shown.

Offaly/Roscommon/Tipperary/Westmeath) 901; Martin Mere (Lancashire) 723; Upper Lough Erne (Fermanagh) 683; Glen Lough (Westmeath) 248; Derry Lea House (Kildare) 180; and Lough Atedaun (Clare) 165.

The majority of birds in Iceland were found in the south and southwest (**Figure 3**), areas that were ice-free during the winter. Birds were found on a number of habitats, including rivers, lakes and coastal habitats, where feeding conditions were suitable. The numbers and distribution of Whooper Swans wintering in Iceland in 1995 were similar to those found in 1991, except for a higher number of birds in the southwest in 1995.

Productivity

Brood sizes and the proportion of cygnets in 1995 are given in **Table 2**. The overall figure of 17.9% cygnets from the 10,156 birds aged represents a reasonably successful breeding season, and compares with around 23% and 9.8% during the 1986 and 1991 censuses, respectively (Salmon & Black 1986; Kirby *et al.* 1992). Variation between regions was, however, considerable, particularly in Great Britain where the proportion of young ranged from 14.7 to 32.1% in regions with reasonable sample sizes. The overall proportion of cygnets in each country was similar, although it was notably lower in Northern Ireland.

The overall mean brood size of 2.32 in 1995 was about average. Despite the difference in the proportion of young between 1995 and 1991, the frequency of different brood sizes was similar, with 30.3% of broods containing two young (cf. 36.2% in 1991) and 83.8% containing one to three young (cf. 86.5%). Mean brood size also varied between regions, from 1.9 in south Iceland to 3.3 in southwest Iceland. Iceland also had the highest overall brood size for any country. The highest value in Britain and Ireland was 2.9 in northwest Scotland, not surprisingly, the region which also held the highest proportion of young. The proportion of juveniles recorded in flocks at WWT reserves was close to the average for the population as a whole: 17.3% at Martin Mere (Lancashire), 20.9 % at Caerlaverock (Dumfries & Galloway) and 17.0% at Welney (Norfolk) (Bowler *et al.* 1995).

Discussion

Census accuracy and sources of error

The most likely sources of error in such a census are: (1) the presence of birds at unknown sites; (2) the absence of data

Table 2. Age structure and brood sizes of Whooper Swans in Britain, Ireland and Iceland, January and February 1995. See Appendix for region definitions.

	%	Brood size							
	n	Young	6	5	4	3	2	1	Total	Mean
Iceland										
W Iceland	4	*0.0	0	0	0	0	0	0	0	-
SW Iceland	366	26.0	0	6	5	6	5	2	24	3.33
S Iceland	373	15.8	0	0	1	6	6	10	23	1.91
SE Iceland	21	*0.0	0	0	0	0	0	0	0	-
N Iceland	0	-	0	0	0	0	0	0	0	-
Total	**764**	**9.1**	**0**	**6**	**6**	**12**	**11**	**12**	**47**	**2.64**
Frequency	(%)		0.0	12.8	12.8	25.5	23.4	25.5		
Northern Ireland										
Total	**2,668**	**15.9**	**0**	**6**	**16**	**48**	**43**	**62**	**175**	**2.21**
Frequency			0.0	3.4	9.1	27.4	24.6	35.4		
Republic of Ireland										
NW Ireland	2,037	17.2	0	2	15	29	37	29	112	2.32
NE Ireland	850	20.8	0	3	6	11	31	25	76	2.09
SW Ireland	497	18.3	1	1	8	10	3	12	35	2.60
SE Ireland	399	16.3	0	0	1	7	8	7	23	2.09
Total	**3,783**	**18.1**	**1**	**6**	**30**	**57**	**79**	**73**	**246**	**2.27**
Frequency (%)			0.4	2.4	12.2	23.2	32.1	29.7		
Britain										
Northern Isles	283	23.0	0	1	4	4	11	3	23	2.52
NW Scotland	196	32.1	0	1	6	6	4	3	20	2.90
NE Scotland	241	24.5	0	0	2	8	9	8	27	2.15
SW Scotland	530	14.7	0	0	3	8	11	14	36	2.00
SE Scotland	443	19.0	0	0	2	7	15	4	28	2.25
Wales	93	20.4	0	1	1	1	2	3	8	*2.38
NW England	954	15.6	0	6	8	11	19	16	60	2.48
NE England	95	23.2	0	0	3	1	1	1	6	*3.00
EC England	102	18.6	0	1	1	2	1	2	7	*2.71
S England	4	*50.0	0	0	0	0	1	0	1	*2.00
Total	**2,941**	**19.0**	**0**	**10**	**30**	**48**	**74**	**54**	**216**	**2.39**
Frequency (%)			0.0	4.6	14.3	22.2	34.3	25.0		
GRAND TOTAL	**10,156**	**17.9**	**1**	**28**	**82**	**165**	**207**	**201**	**684**	**2.32**
Frequency (%)			0.1	4.1	12.0	24.1	30.3	29.4		

* Based on small sample size

from sites known to be used by Whooper Swans; (3) failure to locate birds at known sites, particularly where birds may be inaccessible or spread over large agricultural areas or extensive waterbodies; (4) birds being missed or double-counted where counts were made on different dates, particularly on adjacent sites; and (5) birds from the Icelandic breeding population having migrated further east to winter in continental Europe or, conversely, birds from the continent having migrated west to Great Britain.

Excellent coverage was achieved during the 1995 census by the combined efforts of WeBS and I-WeBS (around 2,000 sites in the UK and 250 in the Republic of Ireland). Additionally, local experts organised coverage of sites not normally visited for the count schemes, including many non-wetland areas, ensuring that the vast majority of known sites and adjacent areas likely to hold Whooper Swans were covered. Further sites were covered in northwest Scotland, an area little visited for waterfowl surveys. Gaps in coverage were generally areas of high ground, few

wetlands, or remote regions, such as parts of Scotland and southwest Ireland, i.e. areas which hold very few Whooper Swans. Nevertheless, more comprehensive coverage was achieved in 1995, particularly in Ireland, than in any of the previous censuses.

All data received were carefully checked and validated, using local experts wherever possible. Several areas of Ireland were visited on more than one occasion, particularly around Swilly/Foyle, Loughs Neagh and Beg and Upper Lough Erne. Comparison of these counts allowed birds missed during either of the counts to be identified and included, although counts were generally closely matched, indicating both good coverage and accurate counting. Local experts also ensured that double counts were removed, particularly where the same birds had used different sites, and allowed estimates to be made for areas known or likely to have held birds but which were not visited during the census. For instance, wet weather and resultant flooding in parts of mid and southern Ireland may have caused swans to disperse more widely than usual, resulting in slight underestimates. This is unlikely to have caused a substantial drop in the numbers recorded, however, since counters would also have been aware of any localised declines associated with the flooding. Thus, it is thought that only a very small proportion of the birds were either double-counted or missed and that the final total is very close to the true number of birds. Further, the similar proportions of the population found in each country in 1991 and 1995 suggests that there was no large undercount in any one area.

Resightings of birds ringed in Iceland in the mid-1980s indicated that about 600 birds from the Iceland population wintered in continental Europe (Gardarsson 1991). Of 196 swans marked with neck-collars in eastern Iceland in 1994, four of the 150 resighted during the 1994-95 winter were recorded in continental Europe (B. Laubek pers. comm.). This gives a very tentative estimate of around 400 birds wintering outside Britain, Ireland and Iceland, and compares reasonably with the earlier estimate. Conversely, at least 22 Finnish breeding birds were recorded in Great Britain in winter 1995-96, involving a minimum of four families fitted with neck-collars the previous summer (B. Laubek pers. comm.). The total number of Scandinavian/Russian birds wintering in Great Britain is unknown but, based on resighting and count information, is thought to be small. Information on the dispersal of this population, involving birds ringed in different parts of the breeding range, is required to establish the true number wintering in Britain and Ireland. Further, a complete census of birds in Iceland in autumn, before migration begins (e.g. Gardarsson & Skarphedinsson 1984), would help clarify these problems. Ideally, this should be made in autumn 1999, directly before the next international census in January 2000.

Despite uncertainties regarding the precise numbers of birds involved in the mixing of populations on the wintering grounds, it seems reasonable to suggest that the Icelandic population of Whooper Swans numbered 16,000 in 1994-95.

Numbers and distribution

The total of 15,842 Whooper Swans recorded during the January 1995 census represents a decrease of 12.2% from the 1991 estimate of 18,035 birds by Kirby *et al.* (1992), indicating, on average, a 3.0% decline per annum over the four year period. Moreover, variation in the percentage of juveniles recorded in these two years (9.8% and 17.9% for 1991 and 1995, respectively) means that the estimated number of adult swans has fallen from 16,268 to 13,006, representing a decline of 20.1% in the adult population since 1991.

There are several possible explanations for the change in population estimates. First, the 1995 census may have been an underestimate due to undercounting, although, as detailed above, the extent of any such error is thought to be small.

A second possibility is that there was some double-counting during the 1991

census, since a separate study of feeding site selection was being undertaken at the same time (Rees *et al.* in press), and birds that changed habitats may have been included twice. A preliminary review of the 1991 database indicates that this certainly occurred in some areas, particularly Cavan and Monaghan and in the Swilly/Foyle area, thought likely to have involved more than 1,000 birds. However, the 1991 total of 18,035 comprises only counted birds; around 1,000 birds were estimated to have been missed due to gaps in coverage (Kirby *et al.* 1992). Given the less extensive coverage in 1991, this figure is likely to be conservative. Despite these shortcomings, the figure of 18,035 birds in 1991 has been used for comparison in this paper, although it should be recognised that this is likely to be an overestimate.

Thirdly, the numbers of birds from the different populations moving between Britain and the continent may have changed. The little information available on the extent of these movements suggests that the number of Icelandic birds on the continent in the mid-1990s was broadly similar to that ten years ago. Given the current increase in the Scandinavian/Russian population (Rose 1995), thought to number 35,000-40,000 (Laubek 1995a), it seems unlikely that the number reaching Britain would have decreased substantially. This movement may be influenced by weather. However, the winter of 1994-95 was generally wet and mild up to the time of the census on the continent and unlikely to have caused an exceptional westerly movement of birds.

The explanation most likely to account for the majority of the changes between the censuses is that there has been a genuine decrease in the Icelandic Whooper Swan population over the last four years, particularly since 1990 and 1992 were poor breeding years. The 1991 census confirmed that the percentage of juveniles recorded following the 1990 season was low for the population as a whole (9.8%, Kirby *et al.* 1992). Since then, the percentage of cygnets, based on observations at WWT Centres in mid-winter, has been rather variable: 20.2% (n=1,143 birds aged at Martin Mere, Welney and Caerlaverock) in the 1991-92 winter; 12.8% (n=1,109) in 1992-93; and 16.0% (n=1,096) in 1993-94 (from Bowler *et al.* 1992, 1993, 1994), giving an average recruitment rate of 16.7% per annum for the years 1991 to 1994 inclusive. The decline of 3.0% per annum recorded between the 1991 and 1995 censuses, combined with productivity of 16.7% over the same period, suggests an annual mortality rate of 19.7% (**Table 3**). This figure is very similar to mortality estimates derived from resightings of ringed birds, which were also thought to be as high as 20% (Einarsson 1996).

The main problem associated with this model is that a mortality rate of 20% seems

Table 3. Estimated changes in Whooper Swan population levels between 1991 and 1995 (based on annual variation in breeding success observed at WWT reserves, and an average annual mortality rate of 20%) and WeBS annual indices for Whooper Swans in Great Britain and Northern Ireland.

	Population	% Juvs	% loss/gain	n loss/gain	WeBS indices GB	NI
1991	18,035	20.2	+0.2	+ 36 birds	270	90
1992	18,071	12.8	-7.2	-1301 birds	187	81
1993	16,770	16.0	-4.0	-671 birds	184	85
1994	16,099	17.9	-2.1	-338 birds	156	74
1995	15,761	(i.e. 0.5% from the census total of 15,842)			186	81

Note: no correction has been made for differences in mortality rates for different age classes because there is no evidence to suggest that juveniles have lower survival levels, between the first and second winter, than adult birds (Einarsson 1995). Population figures given are for the start of each year; % juveniles indicate breeding success in the summer of that year. WeBS indices relate to the months of peak occurrence during the winter, with counts set at 100 in 1970-71 in Great Britain and 1987-88 in Northern Ireland (from Waters *et al.* 1996).

high for a species with such variable breeding success, making it difficult to explain the population growth during the 1960s and 1970s, particularly since the mean proportion of young between 1948 and 1984 was in the region of 19.6% (Salmon & Black 1986). More detailed analysis of changing age structure of the population, and of age differences in survival and breeding success, is needed to clarify this issue. Population trends derived from the Wetland Bird Survey (WeBS) also indicate an overall decline in Whooper Swan numbers since the peak count in 1990-91, both in Great Britain and Northern Ireland (Waters *et al.* 1996). The census figure of 5,000 birds for Great Britain also compares favourably with the estimate of 5,600 by Kirby (1995), based solely on data from the annual waterfowl count schemes for the period 1987-88 to 1991-92, given the decline of around 14% since that time. The estimate of 16,000 Whooper Swans wintering in Britain, Ireland and Iceland therefore seems to be sound, and should be used as the new total for the population.

There were no major changes in distribution of Whoopers in January 1995 compared with that in 1991, with similar proportions of the population recorded in each of the countries. However, birds in England were more concentrated in 1995, with over 250 more birds in Lancashire, mostly at Martin Mere, and around 500 more in Norfolk/Cambridgeshire, mostly at Welney on the Ouse Washes. The presence of a safe roost in a high grade agricultural area has probably been responsible for the increase in numbers at these centres over the last decade (Rees & Bowler 1996). County totals suggest that these increases have been mainly at the expense of surrounding counties, but the proportion of the census total in England (14.3% in 1995 cf. 11.1% in 1991) indicates that the effects may be more widespread.

Although the proportion present in Scotland was very similar during the two censuses (16.4% in 1995 cf. 15.9% in 1991), regional totals varied considerably. In southern Scotland, differences in adjacent regions appear to be compensatory. About 700 fewer birds were recorded in Grampian, Highland, the Western Isles and Orkney. These regions are the main arrival sites for birds in autumn before onward southerly movement as the winter progresses (Rees *et al.* in press), and thus may hold few birds during mid-winter. However, WeBS data show several sites to have declined significantly in importance: Loch Eye (Highland) recorded peak counts of 1,100-1,700 birds in the early 1990s, but less than 100 in 1993-94 and 1994-95; numbers at Loch of Harray (Orkney) fell from 800-900 to less than 50 over the same period; and numbers at Loch of Skene (Grampian) fell from 300-400 birds to none in 1994-95 (Cranswick *et al.* 1995). Some of these changes relate to factors at the particular sites, with high numbers at Loch Eye persisting only during exceptionally good feeding conditions following an increase in pondweed during dry summers.

There were also apparent changes in distribution in Ireland, some of which may have been influenced by the mild, wet weather during 1994-95. However, many of the declines recorded in 1995, notably in Counties Donegal and Londonderry, in Mayo and Roscommon in the west, and in Cavan and Monaghan also, are due, at least in part, to the double counts in 1991 mentioned earlier. Nevertheless, there does appear to have been a genuine decline in Cavan and Monaghan. A further problem in interpreting county totals is that many rivers form the county boundaries and birds may have been attributed to different counties in different censuses, although occurring in the same area in both years. This may have influenced the apparent change in numbers recorded in Counties Waterford and Cork, and those adjoining the River Shannon. A more detailed comparison of results from the censuses, ideally using more meaningful regional definitions, rather than political boundaries, is required to determine the exact nature of any changes in distribution.

Habitat

Provisional analysis of 1995 data showed that over half of the 12,033 birds for which habitat information was recorded were

found on improved or flooded pasture almost four times the number found on the equivalent habitat in 1991 (**Table 4**). In contrast, only one third of the total was recorded on inland waters in 1995, compared with almost three-quarters previously. Thus, there appears to have been a shift of birds from inland waters to fields, presumably a result of the increased flooding in 1995, with the overall proportion of birds on inland waters and pasture (including flooded pasture) remaining the same. Proportions on the remaining habitats were broadly similar in the two censuses, suggesting that the variation between the two years was not due to the difference in sample size. Interestingly, there has not been a large movement of Whooper Swans onto arable crops; the percentage of birds decreasing from 10% in 1991 to 7% in 1995. Conversely, Whooper Swans wintering in Denmark fed mainly on natural habitat two decades ago, changing to over 70% of birds feeding on arable areas in mid-winter by the early 1990s (Laubek 1995b), whilst birds wintering in southern Sweden have recently moved away from the coast to inland areas where they feed on fields (Nilsson 1994).

Table 4. Proportion (%) of Whooper Swans recorded on different habitats.

Habitat	Jan 1995 (n=12,033)		Jan 1991 (n=1,633)	
Improved pasture	38	87	15	87
Flooded pasture	17		-	
Permanent inland water	32		72	
Arable	7		10	
Rough pasture	4		0	
Coastal	1		2	
Bog/fen	<1		1	

Note: slightly different habitat classifications were used in the two censuses, preventing direct comparison with the proportion of birds on flooded areas in 1991.

Brood size

A major problem in assessing the factors underlying changing population levels is to obtain an accurate estimate of annual recruitment to the population. Regional variation in the percentage of juveniles recorded during the 1995 census emphasises the difficulty of recording breeding success from just a few sites. Moreover, there were marked differences in the distribution of cygnets in 1995, compared with 1991. In both years, the proportion of cygnets recorded in Great Britain was higher than in Northern Ireland. The proportion of cygnets in the Irish Republic was similar to the British figure in 1995, but was exceptionally low in 1991. The percentage of juveniles seen in flocks remaining in Iceland over-winter is usually higher than for the migratory birds (Gardarsson & Skarphedinsson 1985), as was the case in 1995. Thus it is difficult to select a few representative sites as reliable indicators of changes in breeding success for the population as a whole, particularly since the percentage of cygnets is associated with flock size and habitat, and the distribution of families changes between regions during the winter season (Rees *et al.* in press).

The percentage of juveniles recorded at WWT reserves in the 1994-95 winter were 17.0% (n=492 birds aged) at Welney, 17.3% (n=723) at Martin Mere and 20.9% (n=153) at Caerlaverock (Bowler et al. 1995), averaging 17.6% (n=1,368), which was very similar to the 17.9% recorded during the census. Although there was a significant correlation in the percentage of juveniles recorded at Martin Mere and Welney each year from 1981-82 to 1991-92 inclusive, annual variation in breeding success recorded for birds wintering at Caerlaverock was not correlated with the success of birds at the other two sites (Einarsson 1996). Ideally, to obtain more accurate information on annual recruitment to the Whooper Swan population, age-checks should be carried out during all swan counts.

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Appendix. Regional Definitions

West Iceland	Vestur-Bardastrandarsysla to Kjosarsysla.
Southwest Iceland	Reykjavik and Reykjanes Peninsula.
South Iceland	Arnessysla, Rangarvallasysla, Vestur-Skaftafellssysla.
Southeast Iceland	Austur-Skaftafellssysla, Sudur-Mulasysla.
North Iceland	Sudur- and Nordur-Thingeyjarsysla.
Northern Ireland	Down, Antrim, Armagh, Londonderry, Tyrone, Fermanagh.
Northwest Ireland	Donegal, Leitrim, Sligo, Mayo, Roscommon, Galway.
Northeast Ireland	Longford, Westmeath, Cavan, Monaghan, Louth, Meath, Dublin.
Southwest Ireland	Clare, Limerick, Kerry, Cork.
Southeast Ireland	Tipperary, Offaly, Laois, Kildare, Wicklow, Wexford, Carlow, Kilkenny, Waterford.
Northern Isles	Orkney, Shetland
Northwest Scotland	Highland South West, Western Isles.
Northeast Scotland	Grampian, Highland South East, Highland North.
Southwest Scotland	Dumfries & Galloway, Strathclyde.
Southeast Scotland	Borders, Lothians, Central, Fife, Tayside.
Wales	Gwent, Mid Glamorgan, South Glamorgan, West Glamorgan, Dyfed, Powys, Gwynedd, Clwyd.
Northwest England	Cheshire, Merseyside, Greater Manchester, Isle of Man, Lancashire, Cumbria.
Northeast England	Cleveland, Durham, Tyne & Wear, Northumberland.
East Central England	Northamptonshire, Bedfordshire, Cambridgeshire, Suffolk, Norfolk, Lincolnshire, Leicestershire, Nottinghamshire, Humberside, Warwickshire, West Midlands, Staffordshire, Shropshire, Derbyshire, South Yorkshire, West Yorkshire, North Yorkshire.
South England	Cornwall, Devon, Dorset, Somerset, Avon, Gloucestershire, Wiltshire, Hampshire, Isle of Wight, West Sussex, East Sussex, Kent, Surrey, Greater London, Essex, Hertfordshire, Buckinghamshire, Berkshire, Oxfordshire, Hereford & Worcester.