Numbers and distribution of Bewick's Swan *Cygnus columbianus bewickii* wintering in Britain and Ireland: results of international censuses, January 1995, 2000 and 2005

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Abstract

The total size of the Northwest European population of Bewick's Swan *Cygnus columbianus bewickii* is monitored at 5-year intervals by a coordinated midwinter census throughout the swans' wintering range. This paper presents the results of three censuses undertaken in Britain and Ireland between 1995 and 2005, with a particular focus on changes in abundance and distribution. A total of 7,563 Bewick's Swans were counted in Britain and Ireland during January 1995, 7,597 in January 2000 and 7,216 in January 2005, representing a 4.6% decrease in numbers between 1995 and 2005. Numbers in both Northern Ireland and the Republic of Ireland decreased dramatically over the period, and declines also occurred in several counties in the west of England. Eastern England consistently held the largest concentrations of Bewick's Swans in Britain and Ireland, increasing by 7% between 1995 and 2005. Southeast England also saw an increase in numbers, supporting the possibility of an eastward contraction of range. The percentage of cygnets recorded in flocks in Britain and Ireland was 11.5% during January 1995, 7.6% in January 2000 and 14.4% in January 2005; mean brood size was similar in these years, ranging between 1.97 and 1.98 cygnets per successful pair. Over 90% of birds were recorded on farmland, most of which were on arable land: 58% in 1995, 87% in 2000 and 86% in 2005. Analysis of data from across Europe is needed to determine whether declining numbers in parts of Britain and Ireland reflect a shift in winter distribution or a decrease in total population size for Bewick's Swans in Northwest Europe.

Key words: Bewick's Swan, wintering population, census, Britain, Ireland.

The Tundra Swan *Cygnus columbianus* has a widespread breeding distribution extending across Alaska, northern Canada and Arctic Russia. Three populations of the *Cygnus c. bewickii* sub-species (known as Bewick's Swan) exist: an eastern population of 86,000 individuals that winters in Japan, China and Korea; a much smaller population, estimated at 500 to 1,000+ individuals, that winters in the Caspian Sea region; and a population breeding west of the Ural mountains in northern Russia that winters in Northwest Europe (Syroechkovski 2002; Wetlands International 2002). The largest wintering concentrations of this third population occur in the Netherlands and Britain, with smaller numbers regularly occurring in Germany, Denmark, Belgium, Ireland and France (Beekman *et al.* 1985; Rees *et al.* 1997a).

The Northwest European population has a restricted winter distribution with up to 90% of birds occurring at fewer than 15 sites (Beekman *et al.* 1994). In harsh winters, cold weather encourages movements of swans from the continent to Britain and Ireland, but these movements are usually to established sites. Although local changes in feeding distribution occur, there are few major shifts in distribution within Britain and Ireland during the winter (Rees *et al.* 1997b). High site fidelity has been observed: for example, up to 60.3% of adults and yearlings recorded at Slimbridge, Gloucestershire, have been seen at this site in previous years (Rees 1988, 2006). Families and pairs show greater site fidelity than do single swans (Evans 1979), the latter being recorded at more sites within a winter than paired swans or those with offspring (Rees & Bacon 1996). The tendency for the swans to congregate at relatively few sites, combined with their site fidelity, makes the population particularly vulnerable to changing habitat conditions at these locations.

During the breeding season the swans are dispersed across the Russian Arctic, a vast area where it is both difficult and extremely costly to attempt a comprehensive and coordinated census. Coverage might theoretically be possible by aerial survey, but risk of misidentification of Bewick's and Whooper Swans when seen from the air, and uncertainty about the population being covered, because it is not known whether swans from the three main flyways overlap in the breeding range, pose potential problems. Population size is therefore monitored most effectively during the non-breeding season, when the birds gather at traditional wintering sites (Robinson *et al.* 2004).

Long-term monitoring data and annual indices derived from the Wetland Bird Survey (WeBS) indicate that numbers of Bewick's Swans in Britain and Ireland increased substantially throughout the 1960s and 1970s, peaking through the mid-1980s and early 1990s, but have subsequently remained below those of the 1991/92 level (Pollitt *et al.* 2003). Although WeBS and the Irish Wetland Bird Survey (I-WeBS) provide comprehensive coverage of wetland sites across Britain and Ireland, many sites used by Bewick's Swans are non-wetland areas or temporarily flooded sites not routinely surveyed by these schemes. Full, coordinated censuses specifically targeted at Bewick's Swans are therefore required in order to achieve adequate coverage to verify estimates of population size and range.

Recently, concern has been raised over declining numbers of Bewick's Swans in Ireland, some parts of Britain and in western parts of the Netherlands since the mid-1990s (Pollitt *et al.* 2003; van Roomen *et al.* 2004; Crowe *et al.* in press). Full results of four international censuses undertaken between 1990 and 2005 have not yet been published, although preliminary data from the 1990 and 1995 censuses have been made available (Beekman 1997). These will determine whether the perceived decline in some regions of the Netherlands, Britain and Ireland are indeed cause for concern in relation to the status of the entire Northwest European population. Here we report on the results of the three most recent censuses made within Britain and Ireland to provide an update on the numbers and distribution of swans using the western part of the wintering range. Abundance, distribution, habitat use and productivity in January 2005 are discussed in relation to the results of previous Bewick's Swan censuses in Britain and Ireland, particularly the 1995 and 2000 censuses, the full results of which are reported here in detail for the first time.

Methods

Censuses of Bewick's Swan in Britain and Ireland were undertaken in mid-January by an extensive network of mainly volunteer observers, and aimed to cover all known and potential Bewick's Swan sites. Coordinated counts were organised for 22 January 1995, 15/16 January 2000 and 15/16 January 2005, the dates being chosen to coincide with WeBS counts in Britain and Northern Ireland, I-WeBS counts in the Republic of Ireland, and the annual International Waterbird Census (see Gilissen *et al.* 2002) throughout Europe.

In addition to WeBS and I-WeBS sites, counters were asked to cover areas where swans had been recorded in earlier censuses, sites where swans had been sighted in recent winters, and those with habitats considered likely to attract swans. Sites were identified from previous census data, the WeBS and I-WeBS databases, the Irish Whooper Swan Study Group database, and local information provided by birdwatchers and professional conservation staff.

Census forms were provided and the following information was recorded: number of Bewick's Swans present, location, date, time, method of count (daytime or dusk/dawn roost count) and the accuracy of the count (i.e. whether the count was considered to be accurate by the counter, with low accuracy being attributed to disturbance, poor visibility or partial obstruction of the count area). Counts were coordinated locally to minimise double counting and ensure maximum coverage of Bewick's Swan sites. Participants were also asked to collect information on the number of young in each flock and brood size. Information regarding site use (e.g. feeding or roost site) and habitat type was also recorded.

In order to obtain counts from areas with limited accessibility in Ireland, aerial surveys were conducted on 16 January 1995, 25 January 2000 and 21 January 2005. These covered the Rivers Suck and Brosna and the Shannon Callows (south of Athlone), Lough Derg and the Shannon and Fergus Estuary.

Submitted data were assessed to identify duplicate counts resulting from the same site being counted more than once or to movements of birds between adjacent sites. Those counts deemed to be duplicate counts were omitted from the census total. Counts of low accuracy were included only if no other count was available for that particular site. For those sites where no data were available for the census weekend, counts conducted up to one week either side of the census weekend were used if movement of birds from nearby sites was deemed unlikely (determined from information provided by the counter). In exceptional circumstances counts made outside this time period were included, but only if the risk of double counting was considered to be minimal.

Counts were grouped at various levels (country, region, county and site) for the purpose of analysis, and statistical tests (Chi-squared, Mann-Whitney U and Kruskal-Wallis tests) were undertaken using Minitab and SPSS statistical software. Definitions of regions are given in Appendix I. Analysis of habitat use was limited as habitat categories used during the 1995 census differed from those used in 2000 and 2005. Four main categories were therefore used: permanent water, coastal (including tidal river/estuary, saltmarsh, brackish lake and open coast), pasture and arable (the latter further categorised by crop type).

Results

Coverage

Coverage was similar during the censuses in 1995, 2000 and 2005, with no major omissions of known sites of importance for Bewick's Swans. In 1995 and 2000, 72% and 78% of counts conducted in Britain and Ireland, respectively, were carried out on the census date(s) or one day before or after it, although only 36% of counts were actually made on the single census day in 1995 and 59% over the two days in 2000. As a result of wet conditions over the census weekend in January 2005, many areas experienced flooding and birds were widely dispersed. A total of 87% of sites, however, were visited during the period one day either side of the census weekend. A total of 62% of counts conducted in Britain and Ireland in January 2005 were carried out on the census dates, and all but one count were carried out within a 2-week period, one week preceding and one week following the census weekend.

Numbers and flock sizes

A total of 7,563 Bewick's Swans were counted in Britain and Ireland during January 1995, 7,597 in January 2000, and 7,216 in January 2005 (Tables 1 and 2). This represents a 5.0% decline in numbers between 2000 and 2005 and a 4.6% decrease since 1995. Between 1995 and 2000, however, numbers were relatively stable. Figs. 1 and 2 present the results of the 1995, 2000 and 2005 censuses in the context of the previous census totals for Britain and Ireland and the Northwest European population as a whole.

Table 1. Total numbers of Bewick's Swans counted in Britain and Ireland during the international censuses in 1995, 2000 and 2005. The numbers of flocks recorded are given in parentheses.

	Numbers of swans		
	1995	**2000**	**2005**
Northern Ireland			
Down	23 (2)		
Antrim	33 (6)	13 (2)	
Armagh	40 (2)	8 (2)	9 (2)
Londonderry	37 (1)	11 (3)	4 (1)
Tyrone	12 (1)	3 (1)	
Fermanagh			
Total	**145 (12)**	**35 (8)**	**13 (3)**
Republic of Ireland			
Donegal	3 (1)		
Sligo			7 (1)
Mayo	8 (1)	22 (3)	
Roscommon	45 (5)	3 (1)	8 (1)
Galway	25 (3)	17 (2)	3 (1)
Clare	6 (1)		
Kerry		3 (2)	
Cork	61 (2)	6 (2)	
Waterford		13 (1)	
Wexford	282 (3)	250 (2)	193 (2)
Kilkenny		10 (1)	
Laios		9 (1)	
Offaly		3 (1)	
Wicklow		1 (1)	
Meath		10 (1)	
Cavan	2 (1)		
Monaghan	2 (1)		
Louth	1 (1)		
Total	**435 (19)**	**347 (18)**	**211 (5)**
England			
Dorset	40 (3)		
Somerset	121 (8)	117 (4)	21 (4)
Gloucestershire	279 (2)	243 (3)	198 (1)
Oxfordshire			4 (1)
Hampshire	77 (2)	17 (1)	10 (1)
Buckingham-shire			2 (1)
West Sussex		91 (5)	38 (1)
East Sussex		5 (1)	
Kent	68 (3)	206 (3)	151 (3)
Suffolk			17 (2)
Cambridgeshire	1,913 (3)	327 (2)	237 (2)
Norfolk	3,952 (10)	5,948 (9)	6,095 (7)
Lincolnshire	14 (1)	2 (1)	
Nottingham-shire	68 (1)		13 (1)
Hereford & Worcester	6 (1)		
Warwickshire	1 (1)		
Staffordshire	4 (1)		
Cheshire	11 (1)	58 (2)	93 (3)
Derbyshire	4 (1)		
Humberside		3 (1)	
Northumber-land		9 (2)	11 (2)
Lancashire	398 (8)	163 (2)	90 (5)
North Cumbria		1 (1)	
Total	**6,956 (46)**	**7,190 (37)**	**6,980 (34)**
Scotland			
Dumfries & Galloway	11 (3)		
Borders		3 (1)	
Fife	10 (1)	6 (1)	
Perth & Kinross		16 (1)	
Total	**21 (4)**	**25 (3)**	**0**
Wales			
Clwyd			12 (1)
Gwynedd	6 (1)		
Total	**6 (1)**	**0**	**12 (1)**
Grand Total	**7,563 (82)**	**7,597 (66)**	**7,216 (43)**

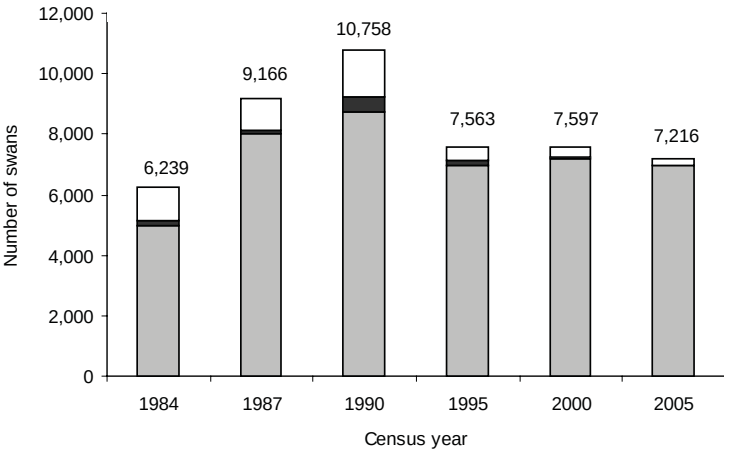

Figure 1. Numbers of Bewick's Swans counted during international censuses in Northern Ireland (black bar), the Republic of Ireland (white bar) and England, Scotland and Wales (grey bar), 1984–2005. Census totals for Britain and Ireland are shown above columns (census totals for 1984, 1987 and 1990 are taken from Beekman *et al.* 1985, Dirksen & Beekman 1991 and Beekman 1997, respectively).

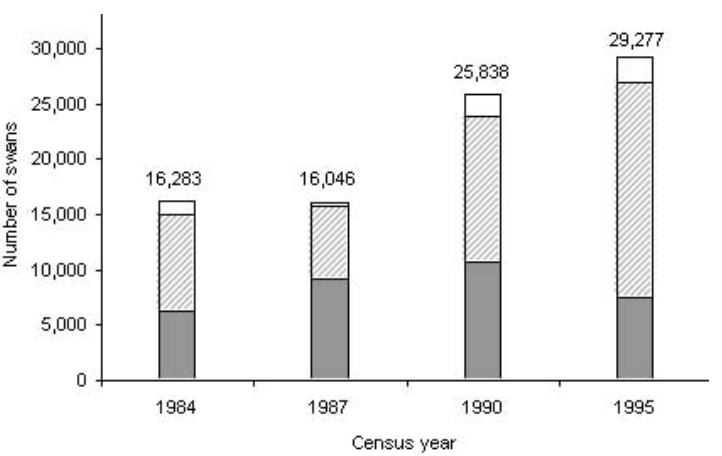

Figure 2. Numbers of Bewick's Swans counted during international censuses in Northwest Europe, 1984–1995, showing proportion of birds in Britain and Ireland (grey bar), the Netherlands (hatched bar) and other regions of Northwest Europe (white bar). Census totals for Northwest Europe are shown above columns (European data taken from Beekman *et al.* 1985, Dirksen & Beekman 1991 and Beekman 1997).

Table 2. Numbers of Bewick's Swans counted in Britain and Ireland between 1995 and 2005.

	1995	2000	2005	% change 1995-2005
Northern Ireland	145	35	13	-91.0
Republic of Ireland	435	347	211	-51.5
All Ireland	**580**	**382**	**224**	**-61.4**
East Central England	5,952	6,277	6,362	6.9
Britain excl. EC England	1031	938	630	-38.9
All Britain	**6,983**	**7,215**	**6,992**	**0.1**
Total	**7,563**	**7,597**	**7,216**	**-4.6**

Although the number of Bewick's Swans in Britain and Ireland declined by less than 5% between 1995 and 2005, the number of flocks recorded decreased by almost 48% (Table 1). Mean flock size increased from 92.2 (± 39.9 s.e.) in 1995, to 110.1 (± 68.9 s.e.) in 2000, and 171.6 (± 80.8 s.e.) in 2005, although differences were not significant over this 10-year period (Mann-Whitney U test, $Z = -0.201$, $P = 0.841$, n.s.). The median flock size in each census year was substantially lower than the mean (11, 8 and 9 for 1995, 2000 and 2005 respectively), indicating that mean flock size is heavily influenced by a small number of large flocks congregating at relatively few sites.

In 1995, around 8% of the British and Irish wintering Bewick's Swans were recorded in Ireland; however, this figure decreased to 5% in 2000, and 3% in 2005 (Table 2). The decline in the proportion of birds recorded in Ireland when compared to numbers recorded in Britain in 1995, 2000 and 2005 was statistically significant ($\chi^2_2 = 154.99$, $P = 0.005$). The decline was evident in both Northern Ireland and the Republic of Ireland, and there was a corresponding decline in the number of flocks recorded (of 75% and 74%, respectively). Proportionally fewer flocks were recorded in Ireland compared with Britain between 1995, 2000 and 2005 ($\chi^2_2 = 5.924$, $P = 0.05$).

Flock numbers also declined by 31% in Britain between 1995 and 2005, with 51 recorded in 1995, 40 in 2000 and 35 in 2005 (Table 1), although here the total number of birds remained relatively stable, with an increase of 0.1% between 1995 and 2005 (Table 2).

Distribution

Figure 3 shows the distribution of Bewick's Swans in 1995, 2000 and 2005 in Britain and Ireland. The species shows a southerly bias, with the largest concentrations located in Eastern England.

In Northern Ireland, birds were recorded in all counties, with the exception of Fermanagh, in January 1995, in four out of six counties in 2000, but only in Armagh and Londonderry in January 2005 (Table 1). Swans were found in 10 counties in the Republic of Ireland in 1995, and 12 in January 2000. The most recent census, however, recorded birds in only three counties in the west (Sligo, Roscommon and Galway) and one in the south (Wexford). In contrast, the number of counties where birds have been recorded in England has remained constant: 15 in 1995 and 14 in both 2000 and 2005. Scotland held small numbers of birds in 1995 and 2000 but none in 2005, and only one flock was recorded in Wales (in 1995 and 2005).

Overall, 33 sites were found to hold Bewick's Swans in 2005; 26 of these were located in Britain, and only seven in Ireland. This represents a 37% decrease in sites supporting Bewick's Swans since 2000, when 30 sites in Britain and 22 in Ireland were identified, and a 40% decrease since 1995 when swans were recorded at 36 sites in Britain and 19 in Ireland.

Sites of national and international importance

Of all the Bewick's Swan sites surveyed in Britain and Ireland in January 2005, only the Ouse Washes held numbers exceeding 1% of the flyway population (290 birds; Wetlands International 2002). The lower population size and corresponding 1% thresholds adopted for earlier censuses (170 birds) resulted in four sites (three in Britain and one in Ireland) exceeding the threshold for international importance in 2000, and six sites in 1995 (five in Britain and one in Ireland) (Appendix II). The number of sites with counts exceeding 1% of the British and All-Ireland (i.e. Northern Ireland and the Republic of Ireland) population (70 and 25 in 1995–2000, and 81 and 25 in 2005 for Britain and All-Ireland, respectively) has also declined, with 15 sites exceeding national threshold levels in 1995 (10 in Britain and five in Ireland), 10 sites in 2000 (nine in Britain and one in Ireland), and 10 in 2005 (nine in Britain and one in Ireland).

Changes in abundance and distribution

The distribution of Bewick's Swans across Britain and Ireland was found to be significantly different between 1995, 2000 and 2005 when compared at a country level ($\chi^2_4 = 225.9$, $p < 0.01$). This was attributable mainly to fewer birds wintering in Northern Ireland and the Republic of Ireland in 2005. In Ireland, numbers fell by 61%, whereas in Britain numbers remained stable with an overall increase of 0.1% over the same time period (Table 2, Fig. 1).

The overall increase in Britain masks the regional trends, however. Most regions in Britain saw a downturn in numbers between 1995 and 2005, with the only consistent increase occurring in East Central England (Figure 4). This region holds the greatest concentration of Bewick's Swans (with most birds frequenting the Ouse Washes), accounting for 77% of all Bewick's Swans recorded in Britain and Ireland during the January 2005 census. Numbers in East Central England increased by 7% between

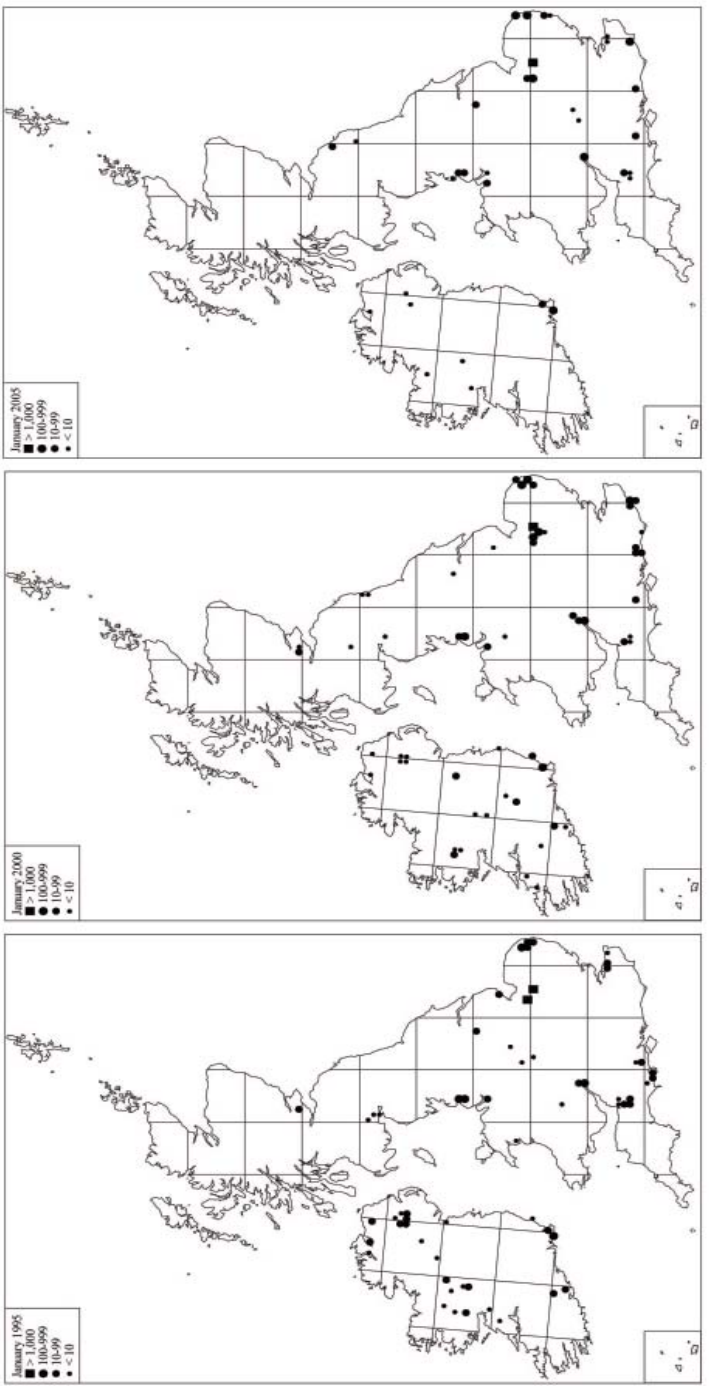

Figure 3. Distribution of Bewick's Swans in Britain and Ireland in January 1995, 2000 and 2005.

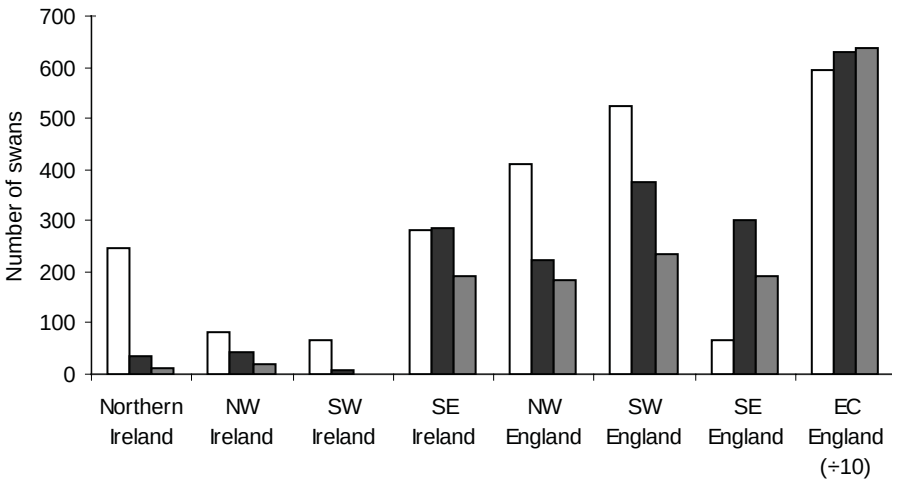

Figure 4. Regional changes in Bewick's Swan numbers, 1995–2005: 1995 (white bar); 2000 (black bar); 2005 (grey bar). Note that owing to large numbers in East Central England, the totals for this region are divided by 10 for illustration purposes. Regional definitions are given in Appendix I.

1995 and 2005, whereas in the rest of Britain the combined counts fell by 39%; the difference in counts for East Central England and the rest of Britain between 1995 and 2005 proved to be statistically significant ($\chi^2_1 = 110.5$, $P < 0.001$). Similar patterns were recorded at the county level: numbers decreased in all counties that regularly recorded Bewick's Swans, except for four counties in England (Norfolk, Cheshire, Kent and Northumberland) where numbers have fluctuated or increased (Table 1). The large drop in numbers in Cambridgeshire is a result of fluctuating numbers at the Nene Washes, rather than a true decline. Numbers recorded by WeBS in January 2003, for example, were in excess of 1,000 birds (Cranswick *et al.* 2005).

Productivity

In total, 2,211 birds were aged at 64 sites in January 1995, 3,347 at 50 sites in January 2000 and 3,116 at 26 sites in January 2005. The overall percentage of young found in flocks across Britain and Ireland was 11.5%, 7.6% and 14.4% in 1995, 2000 and 2005, respectively (Table 3). The proportion of young was higher in Ireland in 2000 and 2005 than in Britain, although differences were not significant ($H_1 = 0.23$, $P = 0.63$ and $H_1 = 0.03$, $P = 0.86$, respectively). The percentage of young in January 2005 is the highest recorded in a census year since 1991 (range 7.6%–16.6%), following a particularly low figure recorded in January 2000, indicating a poor breeding season in summer 1999. The mean brood size was 1.97 in January 1995,

Table 3. Percentage of young in flocks of Bewick's Swans in Britain and Ireland during international censuses from 1984 to 2005. Mean brood size is shown where data are available. Figures in parentheses indicate sample size. [a]from Bewick's Swan monitoring undertaken in conjunction with the January 1991 international Whooper Swan census (Rees *et al.* 1997b). Productivity data were not available for the 1990 Bewick's Swan census.

		Overall	Britain	Ireland
1984	% young	**9.3 (5,094)**	9.5 (4,187)	8.4 (907)
	Brood size	**1.72**	1.52	1.95
1987	% young	**8.6 (7,272)**	8.7 (6,519)	7.6 (753)
1991[a]	% young	**16.6 (3,928)**	n/a	n/a
1995	% young	**11.5 (2,211)**	12.4 (1,631)	9.0 (580)
	Brood size	**1.97**	1.97	1.94
2000	% young	**7.6 (3,347)**	7.2 (3,239)	18.5 (108)
	Brood size	**1.97**	1.89	2.7
2005	% young	**14.4 (3,116)**	14.2 (2,915)	16.9 (201)
	Brood size	**1.98**	2.04	1.89

1.97 in January 2000 and 1.98 in January 2005, with a range of 1.94–2.7 in Ireland and 1.89–2.04 in Britain (Table 3). There was no significant difference in brood size between Britain and Ireland in 1995, 2000 and 2005 ($H_1 = 0.34$, $P = 0.56$, $H_1 = 2.85$, $P = 0.09$ and $H_1 = 0.35$, $P = 0.55$, respectively).

Habitat use

The habitat type of feeding locations was recorded for 42% of all birds counted in January 1995, 54% in January 2000 but only 21% in January 2005. Birds at the Ouse and Nene Washes in 2005 (which combined held 79% of the British and Irish total) disperse over a wide area of farmland and washes during the day, and few observations of habitat use were made in this area.

Since habitat was recorded for only a sample of those birds counted during the census (the proportion of which varied between census years), these data should be interpreted with some caution. For those birds for which habitat was recorded, the majority were found on arable land in all three census years (Figure 5). A greater proportion of birds was recorded on arable habitats in January 2000 and 2005 (87% and 86%, respectively) compared with 1995, when fewer than 58% were recorded using this habitat. Of those birds found on arable habitats the largest proportion was recorded on sugar beet and winter cereals, although use of crop type varied widely between years (Table 4). Use of all other habitats was infrequently recorded, with less than 8% of birds found on permanent water, coastal and river habitats in all three census years.

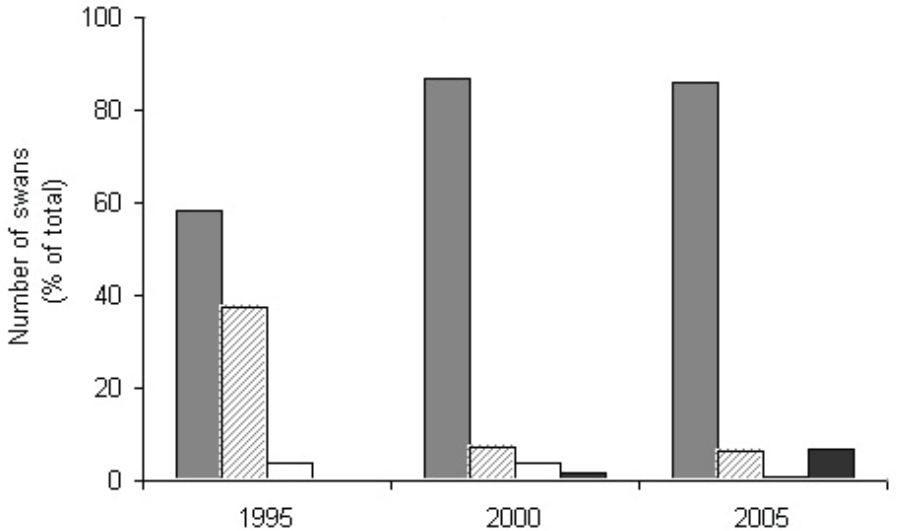

Figure 5. Proportion of Bewick's Swans recorded on different habitats during international censuses, 1995 (n = 3,153), 2000 (n = 4,083) and 2005 (n = 1,518): arable (grey bar), pasture (hatched bar), permanent water (white bar) and coastal (black bar).

Discussion

The total of 7,216 Bewick's Swans counted in Britain and Ireland during January 2005 represents an increase of 16% on the 6,239 recorded in these countries during the first international Bewick's Swan census in 1984 (Beekman *et al.* 1985). Numbers, however, are lower than those found during the 1995 and 2000 censuses, with a 4.6% decline since 1995.

Data have been presented here at a number of levels: by site, county, region and country. Reporting at the country level is important to inform conservation decisions and action in individual countries. Whilst accepting that sub-division of countries into regions and counties reduces their biological relevance, such analyses may help to reveal trends and potential factors operating at different scales. It should be noted, however, that owing to the often highly localised nature of Bewick's Swan distribution, and the fact that population censuses are made only at 5-year intervals, analysis of such data in an attempt to clarify trends have limited value. Regular monitoring at a site level and further directed research are essential in order to determine whether change is driven by site-dependent factors (such as deterioration of feeding habitat), or those affecting the population at a larger scale (such as climate change).

Numbers of Bewick's Swans in both Northern Ireland and the Republic of Ireland have decreased dramatically, from 1,244 birds recorded in 1984 to just 224

birds in January 2005. This downturn in numbers appears to be part of a long-term trend; declines in the numbers of Bewick's Swans visiting Ireland were reported as far back as the 1950s (Kennedy *et al.* 1954; Ruttledge 1966). Declines have also occurred in many regions of England, with notable decreases in many counties, whilst the species no longer winters regularly in Scotland. A decrease in the overall number of birds has been coincident with a decline in the number of flocks recorded.

Table 4. Crop type use by Bewick's Swans in Britain and Ireland during international censuses from 1995-2005 (expressed as a percentage of the total number of birds recorded on arable land). Sample sizes were: 1,841 swans in 1995, 3,550 swans in 2000 and 1,304 swans in 2005.

	1995	2000	2005
Winter cereals	55.1	5.9	53.0
Oil seed rape	0.2	0.2	11.2
Sugar beet	34.4	84.8	10.7
Potatoes	9.5	0.2	16.3
Other root crop	0.8	5.9	0.0
Other	0.0	3.0	8.8

Britain and Ireland are located along the western edge of this population's wintering range, and declines in the westernmost regions such as Ireland, Southwest England and Northwest England may suggest a contraction of the wintering range. Long-term changes in climate, resulting in generally milder winters in recent years, may reduce the birds' need for extreme movements to the west in order to find suitable wintering conditions, resulting in more birds wintering closer to their breeding grounds. It is interesting to note that declining numbers of Bewick's Swans at Loughs Neagh and Beg in Northern Ireland have been coincident with decreases in numbers of Pochard *Aythya ferina* and Goldeneye *Bucephala clangula*; two species that also breed in Northeast Europe (Allen *et al.* 2004). The authors suggested that these species are increasingly attracted to other, more easterly wintering sites on migration from their breeding grounds before reaching Ireland.

Eastern England continues to hold the largest concentrations of Bewick's Swans in Britain and Ireland, with the Ouse Washes regularly holding internationally important numbers of birds (Collier *et al.* 2005). Although annual fluctuations occur at the Ouse Washes, numbers show a rising trend, with a 7% increase between January 1995 and January 2005. Southeast England has also seen an increase in Bewick's Swan records (Figure 4), supporting the notion that an eastward retraction of range may be occurring. However, in the southwest of the country one site, Slimbridge, in Gloucestershire, still regularly attracts sizeable numbers. Numbers here have remained relatively stable during the three

most recent censuses, although numbers recorded by WeBS fluctuate annually (Collier *et al.* 2005). Particularly high site fidelity has been demonstrated at Slimbridge by the proportion of marked individuals returning to the site year after year (Rees 1988), which suggests that traditional use of this site may be a key factor in retaining this flock, contrary to the regional pattern.

Supplementary feeding at Slimbridge and also at Martin Mere, Lancashire, has previously been suggested as a contributing factor in the decline of birds further west in the range (Colhoun *et al.* 2000; Crowe *et al.* in press). However, Martin Mere has seen a dramatic decrease in the number of Bewick's Swans using the reserve and the surrounding area, despite supplementary feeding and apparently suitable natural feeding habitat in the locality. This decrease has been coincident with a continued rise in numbers of Whooper Swan *Cygnus cygnus* in the area (Rees & Bowler 1997). The Ouse Washes have also seen a similar increase in Whooper Swan numbers since 1984 but, unlike in Northwest England, numbers have remained below those of Bewick's Swans. Although it is unknown whether the decline in Bewick's Swan numbers at Martin Mere is a result of competitive displacement by Whooper Swans, it is unlikely that interspecific competition is a factor in East Central England, where intensive agriculture may provide sufficient food resources to support growing numbers of both Whooper and Bewick's Swans.

Numbers recorded each winter by WeBS show that considerable fluctuations in British and Irish totals occur between years, and are most likely heavily influenced by weather conditions on the continent. Elevated numbers of birds were recorded in Britain and Ireland in January 1987 and 1990, with an increase of 47% between 1984 and 1987, and a further increase of 17% between 1987 and 1990 (Beekman *et al.* 1985; Dirksen & Beekman 1991; Beekman 1997). In January 1987, exceptionally cold conditions were experienced across the whole of Western Europe at the time of the census, with the exception of the UK, and may have been responsible for the inflated numbers of birds seen in Britain and Ireland at that time. Indeed, nearly all swans counted during the 1987 census were located in the western part of the wintering range, with as few as 22 birds counted in Germany, Denmark and Poland compared with over 1,000 present there during the previous census (Dirksen & Beekman 1991).

The census totals for the entire Northwest European population show that although a large increase in the British and Irish totals occurred between 1984 and 1987 the overall population size in Northwest Europe actually underwent a 2% decline, with a 32% decrease in numbers recorded on the continent (Beekman 1997). To what extent the overall census total was affected by the considerable cold weather shifts in distribution across Europe is unknown, but it was considered likely to have resulted in an underestimate (Dirksen & Beekman 1991). Subsequent censuses showed a substantial increase in the Northwest European population between 1987 and 1990, from 16,046 to 25,838 individuals, with the greatest increase in the Netherlands (Beekman 1997). Although further rises, of 48% within the Netherlands and 45% overall, occurred between 1990 and 1995, numbers in Britain and Ireland fell by

30% over the same period and accounted for 26% of the Northwest European population, compared with 42% during the previous census in 1990 (Beekman 1997). Annual monitoring in the Netherlands shows stable numbers in the north of the country but a downward trend in the west since 1995 (van Roomen *et al.* 2004). Index values generated from monitoring data from 1992/93 to 2002/03 suggest a downward trend for the country as a whole (van Roomen *et al.* 2004). Results from the 2000 and 2005 censuses for the whole of Europe will help clarify potential changes in total numbers and distribution within Northwest Europe.

The number of young recorded in flocks in Britain and Ireland has varied from 7.6% to 16.6% over the six censuses made between 1984 and 2005. Productivity estimates in January 2005 were comparatively high, with an overall figure of 14.4% (the highest in a census year since 1991, when 16.6 % young were recorded) and mean brood size comparable to that of previous years (1.98). The small sample size of birds aged outside the Ouse Washes makes regional comparisons limited. The proportion of young recorded at Slimbridge in January 2005 was, however, higher than that at the Ouse Washes (15.2% and 13.5%, respectively), consistent with previous years (Rees *et al.* 1997b). Supplementary winter feeding at Slimbridge combined with protection from disturbance may afford a higher degree of breeding success in the following season (Rees *et al.* 1997b). This combined with the high degree of site fidelity shown by many returning families at Slimbridge may explain the higher proportion of young at this site.

Changes in feeding behaviour have been documented, with increasing use of flooded pastures and arable land in recent years in addition to traditional feeding habitats such as shallow lakes and marshes. Feeding on winter wheat was first reported in 1968 (MacMillan 1969) and use of oil seed rape, sugar beet, waste potatoes and other root crops has since been recorded (Merne 1972; Rees *et al.* 1997b; Bowler 2005). Over 90% of birds were recorded on farmland during January 1995, 2000 and 2005, the majority of which were found on arable habitats. Most birds were recorded feeding on winter cereals and sugar beet, although proportions varied considerably between years, presumably due to availability of crop type rather than a change in feeding preference. The proportion recorded feeding on growing crops varied between censuses, with 55% using winter cereals and oil seed rape in January 1995, only 6% in January 2000 and 64% in January 2005. Contrasting results from the International Whooper Swan Census in January 2005 showed that fewer than 5% of Whooper Swans recorded on arable land were feeding on growing crops (J. Worden, unpubl. data). However, any potential widespread agricultural conflict is likely to be limited, owing to the comparatively small numbers of Bewick's Swans wintering in Britain and Ireland, as well as their tendency to concentrate at relatively few sites. Habitat use is undoubtedly influenced by time of year and availability of resources, land-use changes, choice of crop and abundance of each particular type of arable habitat. Increased use of pasture as winter progresses has been previously documented, as has greater use of stubble

and waste potatoes on first arrival on the wintering grounds (Rees *et al.* 1997b).

The results of the most recent three censuses have demonstrated substantial changes in the numbers and distribution of the Northwest European population of Bewick's Swan in Britain and Ireland since the mid-1990s. Continued monitoring of this population, as well as analysis of results from across Europe, is essential to clarify trends in population size and distribution to afford a greater understanding of the status of this population throughout Northwest Europe.

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Appendix I

Regional definitions, by country, used during the 2005 international Bewick's Swan census

Northern Ireland
Down, Antrim, Armagh, Londonderry, Tyrone, Fermanagh

Republic of Ireland
Northwest: Donegal, Leitrim, Sligo, Mayo, Roscommon, Galway
Northeast: Longford, Westmeath, Cavan, Monaghan, Louth, Meath, Dublin
Southwest: Clare, Limerick, Kerry, Cork
Southeast: Tipperary, Offaly, Laois, Kildare, Wicklow, Wexford, Carlow, Kilkenny, Waterford

England
Northwest: Cheshire, Merseyside, Greater Manchester, Isle of Man, Lancashire, Cumbria
Northeast: Cleveland, Durham, Tyne & Wear, Northumberland
East Central: Northamptonshire, Bedfordshire, Cambridgeshire, Suffolk, Norfolk, Lincolnshire, Leicestershire, Nottinghamshire, Humberside, Warwickshire, West Midlands, Staffordshire, Shropshire, Derbyshire, South Yorkshire, West Yorkshire, North Yorkshire
Southwest: Cornwall, Devon, Dorset, Somerset, Avon, Gloucestershire, Wiltshire, Hampshire, Isle of Wight, Oxfordshire, Hereford & Worcester
Southeast: West Sussex, East Sussex, Kent, Surrey, Greater London, Essex, Hertfordshire, Buckinghamshire, Berkshire

Wales: Gwent, Mid Glamorgan, South Glamorgan, West Glamorgan, Dyfed, Powys, Gwynedd, Clwyd

Scotland: Dumfries & Galloway, Strathclyde, Borders, Lothians, Central, Fife, Tayside, Perth & Kinross, Grampian, Highland North, Highland South East, Highland South West, Western Isles

Note that Britain comprises Scotland, Wales and England. The United Kingdom comprises Britain and Northern Ireland.

Appendix II

Sites with counts exceeding international and national thresholds for Bewick's Swans during the 1995, 2000 and 2005 censuses. The threshold for international importance was 170 individuals for 1995-2000, and 290 for 2005. The Great Britain threshold for national importance was 70 for 1995-2000 and 81 for 2005. The All-Ireland threshold was 25 for all years. Counts made during the January censuses are given in parentheses.

1995	2000	2005
Counts exceeding internationally important threshold		
Ouse Washes, Norfolk/Cambs. (3,480)	Ouse Washes, Norfolk/Cambs. (5,643)	Ouse Washes, Norfolk/Cambs. (5,576)
Nene Washes, Cambs. (1,913)	Nene Washes, Cambs. (327)	
Martin Mere & Ribble Estuary, Lancs. (398)	Wexford Harbour & Slobs, Co. Wexford (234)	
The Cull & Killag, Co. Wexford (266)	WWT Slimbridge, Glos. (191)	
St. Benet's Levels, Norfolk (265)		
WWT Slimbridge, Glos. (204)		
Counts exceeding Great Britain threshold		
Somerset Levels, Somerset (121)	Old Romney Marshes, Kent (158)	Hickling Broad, Norfolk (282)
Breydon Water & Berney Marshes, Norfolk (83)	Martin Mere & Ribble Estuary (163)	Breydon Water & Berney Marshes, Norfolk (237)
Walmore Common, Glos. (75)	St. Benet's Levels, Norfolk (128)	Nene Washes, Cambs. (237)
River Avon: Blashford to Bickton, Hampshire (74)	Somerset Levels, Somerset (117)	WWT Slimbridge, Glos. (198)
Haddiscoe Marshes, Norfolk (72)	Breydon Water & Berney Marshes, Norfolk (115)	Walland Marsh, Kent (140)
	Arun Valley, West Sussex (78)	Martin Mere & Ribble Estuary, Lancs. (90)
		Dee Estuary, Cheshire (89)
		Willow Hall Lane, Cambs. (86)
Counts exceeding All-Ireland threshold		
Loughs Neagh & Beg, Co. Armagh, Londonderry, Tyrone, Down, Antrim (69)		The Cull & Killag, Co. Wexford (170)
Lough Foyle, Co. Londonderry (37)		
Blackwater Callows, Co. Cork (33)		
Ballybutler Lake, Co. Cork (28)		