

# Bewick's Swan

*Cygnus columbianus bewickii*  
(Northwest Europe population) in Britain and Ireland  
1960/61 – 1999/2000

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## SUMMARY

This review aims to describe changes in the abundance and distribution of the Bewick's Swan *Cygnus columbianus bewickii* in Britain and Ireland since winter 1960/61, to compile available historical information prior to that year, to provide current estimates of population size, to review published data on the ecology and biology of this species, and to describe numbers, trends and site use at the key resorts in Britain and Ireland.

Bewick's Swans breed at high latitudes from the Fenno-Russian border east to the Lena Delta. The Northwest European population migrates through the Baltic Sea to winter primarily in Denmark, the Netherlands, Britain and Ireland.

There were thought to be around 6,000-7,000 Bewick's Swans in the Northwest European population in the early 1970s. This had increased to around 17,000 by the mid 1980s and remained relatively stable through the late 1980s. An international census in January 1995 put the population at around 29,000 individuals. This substantial increase, which was recorded mainly at sites in the Netherlands, was considered to be the result of exceptionally high breeding success in the previous decade.

In Britain and Ireland, it is thought that a higher proportion of Bewick's Swans wintered in Scotland and Ireland in the 19th century, occurring less frequently in England and Wales. The first increases in numbers in England and Wales occurred during the 1920s, and a large influx from wintering grounds in mainland Europe during the cold winter of 1938/39 led to the establishment of a regular wintering site in the fenlands of East Anglia.

The first co-ordinated census of Bewick's Swans in Britain coincided with a cold weather influx in winter 1956/57. Around 1,600 birds were recorded during that winter, with a further 2,700 in Ireland, and numbers remained relatively stable into the late 1960s. Up to 3,000 Bewick's Swans regularly wintered in Britain and 2,000 in Ireland through the 1970s, rising to around 5,000 and 500-1,000, respectively, in January 1984. Over 9,000 were recorded in Britain and Ireland during a census in January 1987, around 10,800 in 1990, and a total of around 7,600 in January 1995. The most recent census, undertaken in January 2000, found 7,360 Bewick's Swans in Britain and Ireland, representing just over 26% of the Northwest European population.

In Britain and Ireland, Bewick's Swans winter on shallow freshwater lakes, marshes or slow-moving rivers, near or adjacent to extensive grasslands liable to flooding. Since the early 1970s, they have taken to foraging on agricultural land, especially on waste root crops, grain stubbles and winter cereals. This switch in diet may be attributed to changes in natural habitat quality imposed by land drainage and land claim and to more extensive planting of arable crops influencing feeding site selection by the birds. Generally, Bewick's Swans in Britain and Ireland switch from arable foods to natural grasses through the winter. Proportionately, however, arable foods remain the most important over the winter period as a whole.

The redistribution of Bewick's Swans onto arable land and increased use of agricultural areas in the southeast of England may result in some conflict with agricultural interests, particularly on re-seeded grasslands and winter cereals.

The winter distribution of the Bewick's Swan in Northwest Europe is highly concentrated. In Britain, the species has a southerly distribution with by far the largest flocks occurring in eastern England, especially the Nene and Ouse Washes. Smaller flocks occur in western England and relatively small numbers in Wales. In Northern Ireland, the only flocks of note occur at Loughs Foyle, Neagh and Beg. In the Republic of Ireland, Tacumshin Lake, Wexford Slobs and The Cull & Killag are the key resorts, all located in the southeast of the country.

Eight sites in Britain and three in Ireland are internationally important for Bewick's Swan, regularly supporting at least 170 individuals; six further sites are nationally important in Britain (holding 70 or more birds), and three are important in an all-Ireland context (supporting 50 or more birds). Information on numbers, trends and site use at these key resorts is provided within this review.

Future monitoring is required to follow distributional changes in the feeding areas of Bewick's Swans around key sites so that adequate protection can be afforded in agricultural habitats. Improved monitoring of key sites throughout the range will be necessary to identify and designate important sites which are currently poorly monitored. New research should focus on understanding population dynamics and predicting the consequences of threats to this population. The impacts of interspecific competition with Whooper Swans also deserves further attention.



# 1 THE BEWICK'S SWAN

## 1.1 Introduction

The Wildfowl & Wetlands Trust (WWT) began a long-term study of the life-histories of individual Bewick's Swans at Slimbridge, Gloucestershire, during the 1960s, and the first comprehensive review of the status of the Bewick's Swan *Cygnus columbianus bewickii* in Britain and Ireland was undertaken in 1969 (Ogilvie 1969), following the early status assessment of Atkinson-Willes (1963). Since then, a vast amount of information regarding the abundance, movements, behavioural ecology and demography of the Bewick's Swan has been collected by amateur and professional enthusiasts throughout northern Europe. The Bewick's Swan is now one of the most intensively studied members of the Anatidae in the world.

Although well studied, much of the information on the species has been published piecemeal, or is hidden in the form of internal reports or unpublished databases. In an attempt to collate information for Britain and Ireland, this report aims to assess changes in the abundance and distribution of Bewick's Swans since winter 1960/61, to provide current estimates of population size and to review our knowledge of the ecology of this swan.

This report is split into two sections and follows the format of other reviews (e.g. Fox *et al.* 1994). The first section reviews current knowledge of the abundance, distribution and ecology of the Bewick's Swan, particularly in Britain and Ireland but also throughout the migratory range. This information puts the site-based count data into a national and international context. In addition, gaps in our knowledge are highlighted together with the conservation threats facing this species. The second section presents numbers on a regional scale collected during the winters of 1960/61 to 1999/2000 inclusive. Spatial and temporal changes in abundance, productivity and distribution are examined. Furthermore, monthly peak counts are illustrated for those sites that regularly support nationally and internationally important numbers during the winter to investigate the phenology of movement to and from individual sites.

## 1.2 Background

*Cygnus columbianus* has a Holarctic breeding distribution, which extends across Alaska, northern Canada and Arctic Russia (Fig. 1). It winters south to

the USA, Northwest Europe, the Caspian Sea, China and Japan (Scott & Rose 1996). Two subspecies have been identified. The nominate form (Whistling Swan) occurs mainly in North America, although small but regular numbers breed in Far Eastern Russia (Syroechkovski 2002). The subspecies *bewickii* (Bewick's Swan) breeds on arctic tundra, across the northern Russian Palearctic, from the Kanin Peninsula to Kolyuchin Bay in the Chukchi Sea (Rees *et al.* 1997a). *C. c. bewickii* which occurs in eastern Asia was previously considered to be a subspecies, *C. c. jankowskii*, but the limited biometric data suggest that there is no justification for this (Rees *et al.* 1997a).

Two populations of the Bewick's Swan have been identified in the Western Palearctic. One of these populations is very small (approximately 500 individuals) and breeds in northwestern Siberia and winters in the Caspian (Rose & Scott 1997, Wetlands International 2002). The other breeds mainly in northeast European Russia and winters primarily in Northwest Europe, including Britain and Ireland. It is estimated to contain 29,000 individuals (Wetlands International 2002). The latter population is the subject of this review. The population that breeds in Central and East Siberia and winters in East Asia contains 86,000 birds (Wetlands International 2002).

## 1.3 Monitoring and population assessment

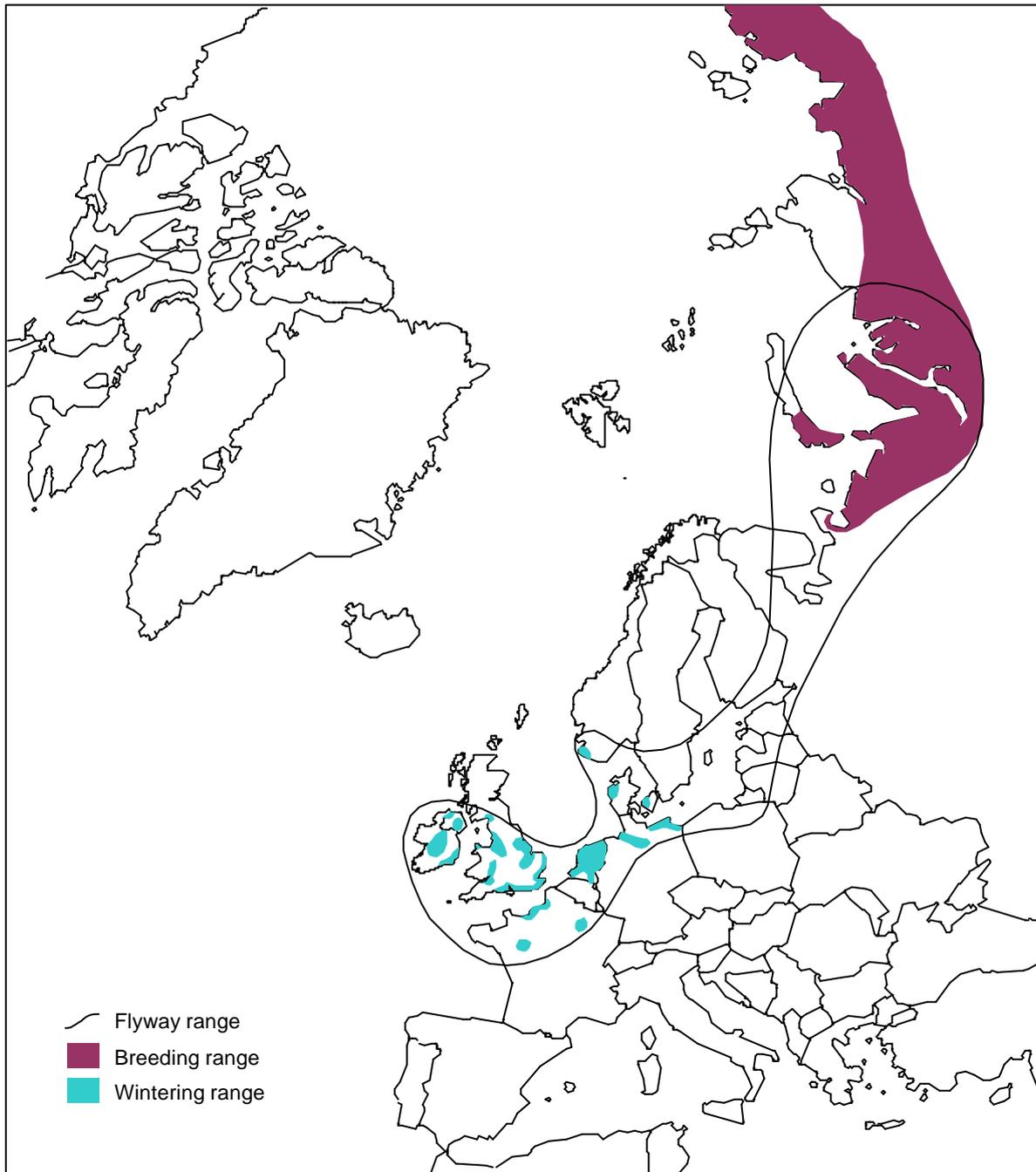
### 1.3.1 Counts

Monitoring is difficult at the breeding grounds because of the highly dispersed distribution of breeding pairs over vast expanses of the Russian arctic. The most accurate and cost-effective time for monitoring population size is during the non-breeding season, when birds congregate at traditional wintering sites.

#### *International censuses*

Coordinated censuses of Bewick's Swans across Europe, which aim to count the whole of the Northwest European population, have been made at intervals since January 1984 (Beekman *et al.* 1985, Beekman 1997). During these international censuses, counters are asked to record the total numbers of Bewick's Swans, the number of adults and cygnets in as large a sample as possible, brood size, whether the area was being used as a roost or feeding site, and the habitat that the birds are using. Leg rings or neck

**Figure 1.** Breeding and wintering ranges of Bewick's Swan *Cygnus columbianus bewickii* and flyway range of NW Europe population (adapted from Lack 1986, Madge & Burn 1988, Scott & Rose 1996 and Snow & Perrins 1998).



collar codes are read and recorded for use in survival analyses and subsequent population models. The censuses now occur every five years, over a predetermined weekend in mid January.

#### *National monitoring*

Annual site-based monitoring in Britain has been ongoing since the late 1940s and is now undertaken primarily through the Wetland Bird Survey (WeBS). The scheme was extended to Northern Ireland from 1986. Since 1947, WeBS counts have been made by volunteer ornithologists at a variety of wetland habitats generally on the middle Sunday of each month, and primarily between September and March (Atkinson-Willes 1963, Owen *et al.* 1986, Cranswick *et al.* 1997). Count dates are co-ordinated nationwide and are chosen to occur on days when high tide occurs during the morning, thus concentrating waterbirds into a small number of roosting areas at coastal sites (Gilbert *et al.* 1998). Counters are encouraged to make their count during the morning to ensure co-ordination across sites.

Before the mid 1960s, the counting of Bewick's Swans in Ireland was sporadic, localised and the results were largely unpublished (Colhoun 2001). The first comprehensive waterbird monitoring project in Ireland took place in the winters between 1971 and 1974, and the results were published in *Ireland's Wetlands and their Birds* (Hutchinson 1979). Over a decade later, a follow-up survey, the Winter Wetlands Survey, was undertaken, covering the period 1984/85 to 1986/87. The results were published in *Ireland's Wetland Wealth* (Sheppard 1993). Given the requirement for more long-term monitoring, the winter of 1994/95 saw the first season of the Irish Wetland Bird Survey (I-WeBS). The methodology for this scheme is identical to that used in WeBS. Since the early 1990s, unco-ordinated count data on Bewick's Swans has routinely been collected by many key members of the Irish Whooper Swan Study Group (IWSSG), as both species utilize the same sites in Ireland.

#### *Roost counts*

At most sites, Bewick's Swans congregate at discrete, generally protected roosting areas during the night and disperse over a wide area to forage during the day. Temporal changes in feeding distribution occur through the winter as food supplies are utilised and new ones are exploited, often in relation to the extent of flooding at feeding sites, e.g. Bowler (1996). The birds therefore, are frequently counted at roost, at morning or in the evening, because roosting distribution is more predictable and the monitoring of local numbers more accurate (although some birds may return to roost sites after dark). This method also reduces significantly the amount of

effort required to find Bewick's Swan flocks during the day. Data collected during organised roost counts are now incorporated into the WeBS and I-WeBS data sets.

### **1.3.2 Productivity**

Productivity and brood size assessments are undertaken annually at various sites throughout Britain and Ireland, most intensively at the WWT centres at Slimbridge (Gloucestershire), Martin Mere (Lancashire), and Welney (Ouse Washes, Cambridgeshire), and also during the international censuses. Productivity is measured as the proportion of juvenile birds amongst the sample of birds aged and, if sample sizes are large, this figure may be indicative of productivity for the population.

### **1.3.3 Ringing**

Bewick's Swans have been ringed at WWT Slimbridge since 1961, colour-ringing starting in 1967 (Rees & Bowler 2002). Ringing began at Caerlaverock and Welney in 1980 and Martin Mere in 1990 with the erection of purpose-built swan pipes. Opportunistic catches elsewhere, e.g. Pensthorpe, Norfolk and Little Downham, Cambridgeshire, have added to the numbers of Bewick's Swans caught in the southeast of England. Just over 2,000 birds have been ringed in the UK (Rees & Bowler 2002).

Ringers in The Netherlands started a regular marking programme in 1985. Bewick's Swans have also been caught and marked at migratory sites in Germany, Denmark and Estonia and on the breeding grounds in Russia.

### **1.3.4 Population assessment**

#### **1.3.4.1 International**

The size of the Northwest European population at the beginning of the 20th century was thought to be between 5,000 and 10,000 individuals (Bauer & Glutz von Blotzheim 1968). Nisbet (1959) estimated that the population comprised 6,500-7,500 individuals in the mid 1950s, while Timmerman (1977) indicated that over 10,000 were recorded in The Netherlands alone in 1958. The lack of coordinated counting throughout the range, however, means that estimates calculated before 1970 may not have been accurate.

The results of the International Waterfowl Census, organised by the International Waterfowl Research Bureau (IWRB), which is based on counts at key sites for waterbirds during January, put the population at around 6,000-7,000 in the early 1970s (Atkinson-Willes 1975). The population was estimated at 9,000-10,000 in the mid 1970s (Atkinson-Willes 1981, Mullie & Poorter 1977) and at 12,000 in the late 1970s (Scott 1980a). The first co-ordinated international Bewick's Swan census was undertaken in January 1984. The results of this census put the population at 17,000 birds (Beekman *et al.* 1985, Monval & Pirot 1989). Numbers remained relatively stable through the late 1980s with a census total of 14,600-15,950 in January 1987 (Dirksen & Beekman 1991). The census in January 1990 put the population at around 26,000, and the January 1995 census recorded around 29,000 individuals (Beekman 1997), showing a substantial increase in numbers over the late 1980s. It has been suggested that this increase was probably the result of exceptionally high breeding success in the late 1980s (Beekman pers. comm. in Rees *et al.* 1997a). More recent trends will become apparent after analysis of the counts made during the January 2000 census.

#### 1.3.4.2 Britain and Ireland

##### *National censuses*

The status of the Bewick's Swan in Britain and Ireland between 1830 and 1950 is uncertain because, although the species was separated from the Whooper Swan *Cygnus cygnus* in 1830, many records still referred to mis-identified Whooper Swans (Ogilvie 1969). During the 19th century, large numbers of Bewick's Swans were thought to have wintered in Scotland and Ireland, whereas the species was much less frequently recorded in England and Wales (Merne 1977, Owen *et al.* 1986, Thom 1986). The first recorded increases in numbers in England and Wales were during the 1920s, with reports in *British Birds* of flocks in several counties. A further large influx of birds into England took place in the cold winter of 1938/39 (Witherby 1939) which subsequently led to the establishment of a regular wintering site in the fenlands of East Anglia (Nisbet 1959). Unfortunately, total numbers occurring in Britain and Ireland over this period are not known.

The first census of Bewick's Swans in Britain coincided with the cold weather influx in winter 1956/57 (Nisbet 1959). A peak count of around 1,600 birds was recorded during that winter with a further 2,700 recorded in Ireland (Merne 1977). Numbers remained relatively stable into the late 1960s; Ogilvie (1969) estimated around 1,400

Bewick's Swans in Britain and 1,000 in Ireland in 1968/69, although coverage was poor.

Through the 1970s, over 3,000 Bewick's Swans regularly wintered in Britain and 2,000 in Ireland (Merne 1977, Scott 1980a, Owen *et al.* 1986) rising to around 5,000, with a further 500-1,000 in Ireland, at the time of the first fully co-ordinated international census in January 1984 (Beekman *et al.* 1985). Over 8,000 and 1,100 Bewick's Swans, respectively, were recorded in Britain and Ireland during the 1987 international census, rising to around 8,800 and 2,000 in 1990 (Beekman 1997). The results of the January 1995 census indicated that there were around 7,000 Bewick's Swans in Britain and 600 in Ireland.

The most recent census, undertaken in January 2000, found 7,200 and 382 Bewick's Swans in Britain and Ireland, respectively, representing 25% and 1% of the Northwest European population (Colhoun *et al.* 2000). The results of the censuses indicate that following an increase in the numbers of Bewick's Swans visiting Britain through the late 1970s and 1980s, numbers have remained relatively stable. In contrast, the number of birds recorded in Ireland has declined radically since the early 1990s.

##### *WeBS indices*

Because WeBS sites are not necessarily all covered each year, population trends cannot be determined simply by comparing the total number of birds counted in each year. Consequently, indexing techniques have been developed which allow between-year comparisons of numbers, even if the true population size is unknown (see Pollitt *et al.* 2003 for further details). WeBS indices for the Bewick's Swan in Britain and Northern Ireland are presented in Fig. 2 and show similar long-term trends to those derived from the results of the national censuses.

As mentioned above, influxes of Bewick's Swans into Britain and Ireland occur during periods of cold weather on the continent. WeBS indices indicate the influxes related to low temperatures recorded in the winters of 1984/85, 1985/86, 1986/87, 1991/92 and 1995/96. The influx recorded in 1990/91 was thought to be related to a shortage of *Potamogeton* and drought conditions in the Lauwersmeer area of The Netherlands (Rees *et al.* 1991a). High numbers of birds were also recorded in the mild winters of 1989/90, 1998/99 and 1999/2000. It seems that relatively high productivity during these years may have influenced the large numbers of birds recorded.

### Productivity

Productivity varies markedly between years and between sites, from around 5% to 25% (Fig. 3). Among WWT centres, a higher proportion of young is generally present in the flocks wintering at Slimbridge. However, it has been shown previously that smaller flocks, such as those recorded at Slimbridge, comprise higher proportions of juveniles than do large flocks, which may help to explain this pattern (Rees *et al.* 1997b). Nevertheless, despite the variation between sites, this variation is generally consistent and there are good relationships between the annual productivity estimates measured at each of the centres. Fig. 3 shows the years of high productivity in the late 1980s and early 1990s, which are thought to have been responsible for the concurrent increases in population size at that time.

## 1.4 Annual cycle

### 1.4.1 Breeding season

Bewick's Swans favour nest-sites in open maritime tundra on the north Russian coast, using moss-lichen, moss-sedge and sedge tundras, and low-lying marshes with numerous pools and lakes and intersected by river channels (Rees *et al.* 1997a). The diet consists of shoots of *Carex aquatalis*, *C. lachenalii*, *Dupontia fisherii*, *Arctophila fulva*, *Calamagrostis neglecta*, and *Stellaria humifusum* (Ubels *et al.* 2000). Cygnets also consume adult and immature mosquitoes from tundra pools around the nest site.

Non-breeders move to shallow bays and coastal regions to moult. Large flocks of Bewick's Swans gather prior to the autumn migration, primarily on maritime sedge-grass water meadows, low-lying coastal marshes and shallow coasts of the Malozemelskaya and Bolshezemelskaya tundras, and at the mouth of the river Pechora (Mineyev 1991, Rees *et al.* 1997a), with numbers varying considerably from year to year at individual sites.

Breeding density tends to reflect tundra quality and the proportion of the population breeding each year. Breeding densities range from 1 pair/10 km<sup>2</sup> in the Yugor Peninsula (Mineyev 1991) and on Vaigach Island (Kalyakin 1987) to 40 pairs/10 km<sup>2</sup> in the Russkiy Zavorot (J. Bowler pers. obs.). It has been estimated that 54-62% of the adult population remain in non-breeding flocks through the summer, even in an area of high breeding density (Shchadilov *et al.* 2002), indicating that recruitment is based on the success of only 2,000-3,000 breeding pairs (Y.M. Shchadilov, Y.N. Mineyev, E.C. Rees & D.K. Scott pers. obs.).

Up to six eggs are laid in each clutch, depending on weather and food availability (Bowler in press). The clutch is laid in May-late June and the majority of eggs hatch before the end of June, incubation lasting 29-30 days (Rees *et al.* 1997a). Mean brood sizes of between three and four cygnets are recorded in most years (Rees *et al.* 1997a). Most cygnets fledge between 40-45 days after hatching.

The species is highly monogamous; amongst established pairs wintering at Slimbridge there has been no positive record of divorce for a pair known to have bred in 2,220 pair-years (Rees *et al.* 1996). One pair at Welney (Ouse Washes) separated after seven years of not rearing any young. Offspring stay with their parents through the winter but are not present with pairs on arrival on the breeding grounds. Some offspring rejoin their parents and new offspring in subsequent winters at the wintering sites.

Adult survival is high. Analyses of data from Slimbridge birds indicate that the survival rate is approximately 87%, and may be higher (Evans 1979a, Scott 1988). The main causes of death for Bewick's Swans in the UK are flying accidents (e.g. collisions with overhead power-lines), with shooting, lead poisoning, disease, and predation also contributing to winter mortality (Brown *et al.* 1992, Rees & Bowler 2002).

### 1.4.2 Autumn migration

Autumn migration is more rapid and direct than spring migration (Evans 1982). After leaving moulting grounds in the late summer, migrating birds initially stage on the large coastal lakes and estuaries of arctic Russia, especially on the Yugor peninsula (Mineyev 1991). Observations of marked birds, together with information gathered from satellite telemetry, have shown that from the White Sea, where few birds stage during the autumn (Nolet *et al.* 2001), Bewick's Swans head southwest across Karelia, via Lake Onega and Lake Ladoga, to the Gulf of Finland and the Baltic coast. The swans follow both the northern and southern shores of the Baltic, via Estonia, Gotland and southern Sweden, to wintering grounds in Denmark, northwest Germany, The Netherlands, Britain and Ireland, with smaller numbers occurring in Norway, Belgium and northern France (Rees 1991, Beekman *et al.* 1994, 1996, Luigujoe *et al.* 1996). A small wintering flock of around 100 birds has also become established in the Camargue, southern France, since the mid 1960s (Rees *et al.* 1997a).

### 1.4.3 Winter

#### *Range*

The winter distribution of the Bewick's Swan in Northwest Europe is highly concentrated (Beekman *et al.* 1994). In Britain, this species has had a southerly winter distribution since the middle of the 20th century with by far the largest flocks occurring in eastern England, especially the Nene and Ouse Washes (Rees *et al.* 1997b, Pollitt *et al.* 2003). Smaller flocks occur in western England with relatively small numbers in Wales. In Northern Ireland, the only flocks of note occur at Loughs Foyle, Neagh and Beg. In the Republic of Ireland, large flocks occur at sites in the southeast at Tacumshin Lake, the Wexford Slobs and The Cull & Killag (Colhoun 2001).

Birds reach Germany and The Netherlands during October. Bewick's Swans also arrive in Britain and Ireland during mid to late October but do not occur in large numbers until November, building up through December and January. Influxes later in the winter are generally related to hard weather movements or depletion of food reserves on the continent.

The Bewick's Swan generally shows a high level of site fidelity in Britain and Ireland (Evans 1979a, Rees & Bowler 2002). Family groups appear to use fewer staging sites on migration than unpaired birds or those pairs without families (Rees & Bacon 1996). Furthermore, although 491 Bewick's Swans have been marked in The Netherlands since the mid 1980s, few have been recovered in Britain and Ireland (Rees & Bowler 2002).

#### *Habitat and feeding ecology*

Over the last 30 years, Bewick's Swans have increasingly taken to foraging on agricultural land (especially on waste root crops, grain stubbles and winter cereals) throughout the winter range in Northwest Europe (MacMillan 1969, Merne 1972, Owen & Cadbury 1975, Dirksen & Beekman 1991, Poorter 1991, Laubek 1995, Rees *et al.* 1997b). This switch in diet may be attributed to changes imposed by land drainage and land-claim and the depletion of submerged macrophytes which are the major food supply (Poorter 1991). However, it is likely that Bewick's Swans have also taken to feeding preferentially in agricultural areas since intensification has increased food availability in this habitat. Generally, Bewick's Swans in Britain and Ireland move from arable foods to natural grasses through the winter (Rees *et al.* 1997b). Supplemental food is provided at WWT centres, generally consisting of grain and waste potatoes.

In Britain and Ireland, Bewick's Swans winter on shallow freshwater lakes, marshes or slow-moving rivers, near or adjacent to extensive grasslands liable to flooding (Rees 1990, Rees *et al.* 1991b, 1997b). Analyses of faecal samples at Slimbridge have shown that Bewick's Swans feed almost entirely on grasses when on farmland in the vicinity, especially on *Lolium perenne* and *Alopecurus geniculatus* (Rees 1990). *Agrostis stolonifera*, *Poa pratense*, *P. trivialis* and *Phleum pratense* are also grazed (Rees 1990). Individuals have also been observed feeding on the mudflats of the Severn Estuary, presumably taking intertidal invertebrates, in spring (Bowler 1996).

At the Ouse Washes, Bewick's Swans traditionally took soft grasses such as *Glyceria fluitans*, *Agrostis stolonifera* and *Alopecurus geniculatus*, plus coarser *G. maxima* and, in late winter, the roots of *Rorippa palustre*. However, since the early 1970s, birds have taken to feeding on waste potatoes, sugar beet and cereals at this site (Owen & Cadbury 1975; see below).

In Northern Ireland, Bewick's Swans feed predominantly on permanent wet grassland and, in the past, brackish coastal lagoons (Kennedy *et al.* 1954).

In general, Bewick's Swans feed by day and roost overnight, often in flocks of several hundreds. However, birds will feed at night if there is adequate moonlight (Bowler 1996).

### 1.4.4 Spring migration

Migration to the breeding grounds begins in late February, with movements to staging sites in Germany in March, along the Baltic in April and northwards to breeding areas in May (Beekman *et al.* 1996, Rees & Bowler 2002). Birds from Slimbridge, and presumably elsewhere, prefer to leave when there are tail winds (Evans 1979b). Re-sightings, counts and recovery data indicate that the birds use a number of staging sites and satellite telemetry has confirmed that several important sites are used during the 3,000-3,500 km journey between the wintering and breeding grounds (Beekman *et al.* 1996), notably in Sweden, Estonia, the White Sea region and the Pechora Delta (Luigujoe *et al.* 1996, Rees *et al.* 1997a, Nolet *et al.* 2001). Spring migration can take several weeks as birds need to stage to replenish fuel reserves (Nolet *et al.* 2001) and wait for favourable weather conditions (Rees & Bowler 1991). A recent study suggests that early arrival on the staging sites in the White Sea is advantageous because re-fuelling rates decline as main food supplies are depleted (Nolet & Drent 1998).

## 1.5 Conservation and management

### 1.5.1 Legislation and other conservation measures

#### 1.5.1.1 International

##### *Conservation status*

In BirdLife International's Species of European Conservation Concern, the Bewick's Swan is classified as a SPEC 3 species which means that it has an unfavourable conservation status in Europe but it is not concentrated in Europe (Tucker & Heath 1994). It is also listed under Category B (1) of the Africa-Eurasian Waterbird Agreement, prepared under the Bonn Convention on Migratory Species, because it is a population numbering between 25,000 and 100,000 individuals.

##### *Habitat protection*

The EC Directive on the conservation of wild birds requires Member States to classify Special Protection Areas (SPAs). In the UK, the SPA suite comprises 15 sites where Bewick's Swan has been listed as a qualifying species, supporting on average 7,072 individuals and representing 99% of the British population and 5% of the all-Ireland population (Stroud *et al.* 2001). A number of SPAs have also been designated for Bewick's Swans in the Republic of Ireland (Colhoun 2001). Further international protection of important wetland habitats for Bewick's Swans is provided through the Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat and through the Bern Convention on the Conservation of Wildlife and Natural Habitats 1979.

*Species protection.* The species is listed in Annex 1, but not Annex II, of the EC Directive on the conservation of wild birds which offers it strict protection throughout Europe. The species is also listed in Appendix II of the Bern Convention which offers it protection.

#### 1.5.1.2 Britain and Ireland

##### *Conservation status*

The Bewick's Swan appears on the 'Amber' list of 'The Population Status of Birds in the UK' because 20% or more of the Northwest European population occurs in the UK during the non-breeding season, 50% or more of the UK non-breeding population can be found at ten or fewer sites and because it has an unfavourable

conservation status in Europe (Gregory *et al.* 2002). It also appears on the 'Amber' list of the 'Birds of Conservation Concern in Ireland' because more than 50% of the Irish non-breeding population can be found at ten or fewer sites and because it has an unfavourable conservation status in Europe (Newton *et al.* 1999).

##### *Habitat protection*

The key site designation in Britain is Site of Special Scientific Interest (SSSI) and Area of Special Scientific Interest (ASSI) in Northern Ireland. Guidelines for the selection of sites were formally published by the Nature Conservancy Council in 1989 under the title *Guidelines for the selection of biological SSSIs*. National Nature Reserves (NNR) are areas of national and sometimes international importance which are owned or leased by the appropriate statutory conservation body, or bodies leased by them, or are managed in accordance with Nature Reserve Agreements with landowners and occupiers. NNRs are also classified as SSSIs and attract similar protection. Legislative protection for these sites derives from the Wildlife & Countryside Act 1981 and the Nature Conservation and Amenity Lands (Northern Ireland) Order 1985. Under these provisions, operations likely to damage the nature conservation interest of SSSIs are subject to control.

In the Republic of Ireland, site protection is offered under the Wildlife Acts 1976 and 2000. Important sites are designated as Nature Reserves, Refuges for Fauna or Natural Heritage Areas.

##### *Species protection*

The hunting of Bewick's Swans is illegal at all times in Britain and Ireland. In Great Britain it is fully protected under Schedule 1 of the Wildlife & Countryside Act 1981 and in Northern Ireland under Schedule 1 of the Wildlife (Northern Ireland) Order 1985. In the Republic of Ireland, the species is fully protected under the Wildlife Acts 1976 and 2000.

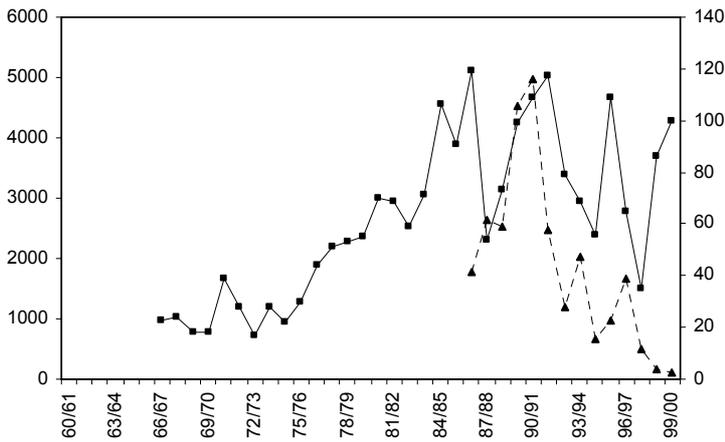
### 1.5.2 Hunting

Although this population is protected throughout its range, recent review of ringing recoveries has shown that over 7% had been illegally shot or deliberately taken by humans (Brown *et al.* 1992, Rees & Bowler 2002). Furthermore, X-ray analysis has shown that some 40% of birds caught have lead shot in their body tissues (Rees *et al.* 1997a). Both bodies of evidence serve to emphasize that illegal hunting occurs along the migratory route, and it is known to have occurred in the UK (Evans *et al.* 1983, WWT unpubl. data).

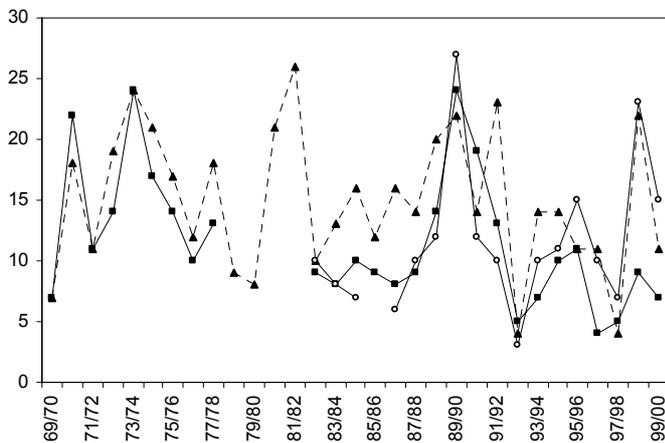
### 1.5.3 Agricultural conflict

The increased use of arable land by Bewick's Swans since the 1970s could potentially lead to some conflict with agricultural interests. Although Bewick's Swans do concentrate on arable fields (60% of Bewick's Swans recorded in winter 1990/91 were on root or cereal crops; Rees *et al.* 1997b), this occurs mainly in east central England, which holds up to

60% of the Bewick's Swans wintering in Britain and Northern Ireland. In contrast, flocks found on permanent inland waters (42%) are more numerous than those found on arable fields (23%), again indicating that use of agricultural land away from east and central England is low. However, it is clear that the potential conflicts between agriculture and feeding Bewick's Swans remains a priority for future monitoring and research, primarily to inform the development of future agri-environment schemes.



**Figure 2.** WeBS indices for Bewick's Swans in Britain (■) and Northern Ireland (▲)



**Figure 3.** Proportion of young in Bewick's Swan flocks (Slimbridge (▲), Ouse Washes (■) and Martin Mere (○)).

## 2 SURVEY OF WINTERING AREAS

The following accounts provide a detailed review of the abundance, distribution and phenology of Bewick's Swans wintering in Britain and Ireland, based on data collected through international and national monitoring schemes, and roost counts. Some counts were obtained from county bird reports or submitted by regional experts, e.g. members of the Irish Whooper Swan Study Group. Geographically discrete regions of importance for wintering Bewick's Swans are considered separately and each is split into four sections:

### *Background*

This section provides brief information on the distribution of Bewick's Swans in the region and the types of habitats that are used.

### *Historical status*

Based primarily on data collected since 1960/61, this section provides an overview of trends in numbers at a site-based and regional level. However, where data or published information are available, the status prior to 1960/61 is also reviewed. This section highlights those sites which were once important for Bewick's Swans but where numbers have fallen over the review period.

### *Internationally/nationally important sites*

Detailed accounts of internationally and nationally important sites are presented. Wetland sites are considered internationally important if they regularly support 1% of the individuals in the Northwest European population following the criteria agreed by the Contracting Parties to the Ramsar Convention on Wetlands of International Importance. A wetland in Britain is considered nationally important if it regularly holds 1% or more of the estimated British population and in the island of Ireland if it holds 1% or more of the estimated all-Ireland population. Provisional assessments of importance are made on the basis of a minimum of three years' data, following the Ramsar Convention.

The threshold for international importance during the five-year period used for site assessment in this review was 170 individuals (Rose & Scott 1997). However, international population estimates, and subsequent thresholds, are revised periodically and that for Bewick's Swan now stands at 290 (Wetlands International 2002). In line with accepted practice, we have not retrospectively applied this threshold and so some sites may be listed in this review as of international importance that in future assessments may not meet the revised international threshold.

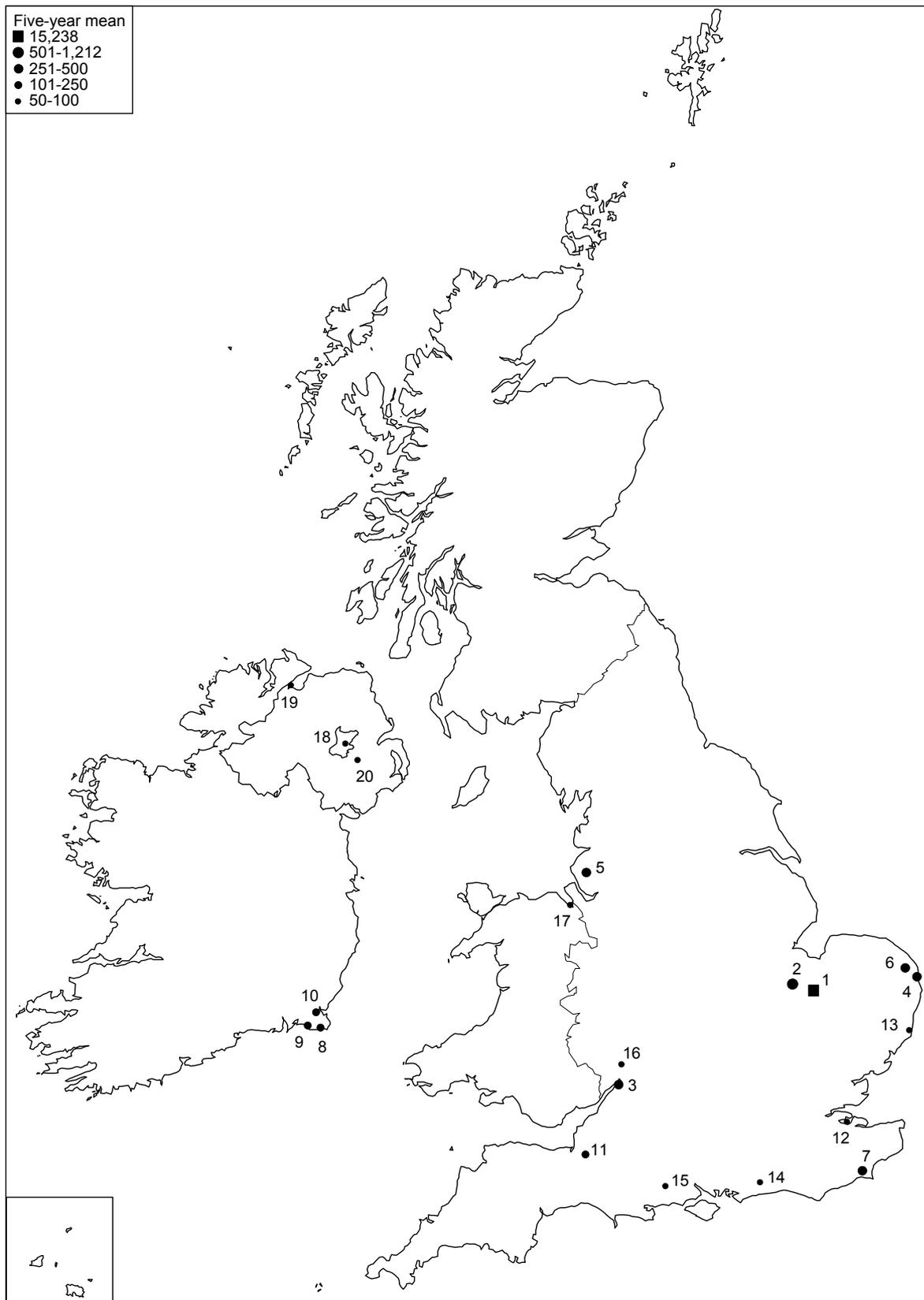
The threshold for national importance in Britain is 70 birds (Pollitt *et al.* 2003). Although the all-Ireland 1% threshold is 25, it has been a long-standing practice to require at least 50 birds to be regularly present on an Irish site before that site is considered nationally important (Colhoun 2001, Pollitt *et al.* 2003). Five-year mean maxima for each internationally and nationally important site in Britain and Ireland are shown in Table 1. The locations of each of these sites are illustrated in Fig. 4.

Site accounts contain detailed information on current status and trends, site protection measures, habitats present, and site use. For definitions of site safeguards and selection criteria/guidelines mentioned in the text, see [www.english-nature.org.uk](http://www.english-nature.org.uk) and [www.ehsni.gov.uk](http://www.ehsni.gov.uk) for Sites/Areas of Special Scientific Interest and National Nature Reserves in England and Northern Ireland, [www.heritageireland.ie](http://www.heritageireland.ie) for site protection measures in the Republic of Ireland, Stroud *et al.* (2001) and Dúchas (2002) for Special Protection Areas (SPAs) in Britain and Ireland, Ramsar (1999) for Ramsar sites, and Heath & Evans (2000) for Important Bird Areas (IBAs).

**Table 1.** Sites of international and national importance for Bewick's Swan in Britain and Ireland (arranged in descending order of importance)

Site name	5-year mean (1995/96-1999/2000)
1. Ouse Washes	4,988
2. Nene Washes	1,327
3. Severn Estuary	364
4. Breydon Water & Berney Marshes	360
5. Martin Mere & Ribble Estuary	346
6. St. Benet's Levels	303
7. Walland Marsh & Dungeness Gravel Pits	255
8. Tacumshin Lake	235
9. The Cull & Killag	195
10. Wexford Harbour & Slobs	191
11. Somerset Levels & Moors	187
12. Medway Estuary & Marshes	98
13. Alde-Ore Complex	90
14. Arun Valley	86
15. Avon Valley	85
16. Walmore Common	78
17. Dee Estuary (England/Wales)	72
18. Loughs Neagh & Beg	69
19. The Foyle/Swilly complex	57
20. River Lagan, Flatfield	53

**Figure 4.** Internationally and nationally important sites for Bewick's Swans in Britain and Ireland (see Table 1 for key to sites)



For each site, figures are presented showing the peak counts recorded in each season since winter 1960/61. Unless otherwise stated, years in which no counts were made at a site are highlighted by an asterisk. Figures illustrating the phenology of use are presented for sites with adequate data. Columns represent mean counts made in each month between 1995/96 and 1999/2000. Bars represent maximum and minimum counts over this period.

#### *Other site*

This section lists those sites which regularly support flocks of 20 or more Bewick's Swans during peak times in the winter and/or which have a long history of occupancy but which do not support nationally or internationally important numbers according to WeBS or I-WeBS data. For some sites, figures illustrating peak counts since winter 1960/61 are presented.

#### *Key references*

This section provides a comprehensive list of relevant literature and published monitoring data on Bewick's Swans in each region.

## 2.1 Britain

### 2.1.1 Scotland

#### 2.1.1.1 Background

The Solway Basin, lying partly in England and partly in Scotland, comprises great expanses of foreshore and saltmarsh ('merse'). The WWT reserve at Eastpark Farm, Caerlaverock (NY0565) currently supports a very small flock of Bewick's Swans, with fewer than 20 birds recorded in recent years. These birds feed on supplemental grain provided at the refuge and also roost there amongst a large herd of wintering Whooper and Mute Swans *Cygnus olor* (Black & Rees 1984). They also flight out of the refuge to feed on *Lolium* and *Pbleum* on old and re-seeded grasslands, merse grasses and riverine vegetation. The only other sites that hold significant numbers of Bewick's Swans in mainland Scotland are Loch Leven (NO1401) in Tayside and/or Ballo Reservoir (NO2205) in Fife. This site has supported a flock of up to 20 birds during peak periods mid winter. Flocks of around 20 birds are only recorded occasionally elsewhere in Scotland.

In recent decades, only small numbers of Bewick's Swans have occurred in the once important resorts on Orkney and Shetland, primarily during the period of autumn passage. Autumn arrival in Scotland is usually from mid October, but sometimes not until

November. In some years there are no reports before January.

#### 2.1.1.2 Historical status

In the 19th and early 20th centuries, large numbers of Bewick's Swan visited northwest Scotland, particularly the Outer Hebrides and on Tiree in the Inner Hebrides (Thom 1986). There were up to 200 birds on Tiree on a regular basis from at least 1892 to the mid 1940s, arriving in late October and staying for much of the winter (J. Bowler pers. comm.). The migration route passed over the Shetlands, through western Scotland and into Ireland (Baxter & Rintoul 1953). During the 1930s, the migration route shifted southwards (Owen *et al.* 1986) and the Whooper Swan replaced the Bewick's Swan as the most numerous of the two species in the Hebrides. The numbers wintering and staging in Scotland declined to almost nothing until a small flock began to use the Solway Firth, primarily at Caerlaverock, in the 1970s. However, this flock peaked in numbers during the winter of 1980/81 and has since declined markedly.

#### 2.1.1.3 Key references

Baxter & Rintoul (1953), Black & Rees (1984), Thom (1986)

### 2.1.2 Yorkshire

#### 2.1.2.1 Background

The only flock of Bewick's Swans occurring regularly in Yorkshire is at the Lower Derwent Valley (SE6938), a major floodplain system composed of a series of neutral alluvial flood meadows, fens, swamp valley mires, *Alnus* woodlands and other freshwater habitats lying adjacent to the River Derwent, Pocklington Canal and The Beck. The site is one of the largest and most important examples of traditionally managed species-rich alluvial flood meadow habitat remaining in Britain and currently supports a flock of around 10-70 Bewick's Swans (Fig. 5), peak numbers occurring during January and February. Bewick's Swans roost at North Duffield Carrs and Wheldrake Ings and feed on the floodplains during the early autumn, moving to sugar beet, oil seed rape and winter cereals later in the season. Although numbers have been low in recent years, the Bewick's Swan is a qualifying species for the Lower Derwent Valley SPA.

Elsewhere, small flocks, comprising fewer than 20 birds, are recorded regularly only at Fairburn Ings (SE4627) and the Humber Estuary (TA2020).

### 2.1.2.2 Historical status

It is likely that the Bewick's Swan was less numerous in Yorkshire during the 1800s and early 1900s, occurring there mainly when periods of severe weather on the continent forced birds across the North Sea (Nelson 1907). A single specimen was shot at the Lower Derwent Valley in March 1903 (C. Ralston pers. comm.). During the first half of the 20th century, numbers started to increase at the Lower Derwent Valley as a consequence of improved water level management and protection under National Nature Reserve designation.

Numbers of Bewick's Swans recorded in Yorkshire have fallen markedly since the mid 1980s primarily because of a fall in numbers at the key resort in the Lower Derwent Valley. This site used to support a flock of 100-300 birds up until the late 1980s, favouring Bubwith Ings, North Duffield Carrs and Aughton Ings. Around 10-20 birds now use the site regularly, numbers peaking in late February and early March. A flock of around 30 birds also occurred regularly at Hornsea Mere (TA1947) up until the late 1980s. The coincidental increase in the numbers of Bewick's Swans wintering in East Anglia shortly thereafter suggests that Bewick's Swans traditionally using sites in Yorkshire may have relocated to the Fens or to Martin Mere in Lancashire. Large numbers of Bewick's Swans used to feed on waste potatoes left on the banks of the River Derwent at Aughton Ings by duck hunters. This practice has now stopped which may, in part, have made this site less attractive to Bewick's Swans in recent years.

### 2.1.2.3 Key references

Nelson (1907)

## 2.1.3 Northwest England

### 2.1.3.1 Background

In northwest England, large flocks of Bewick's Swans generally occur in the agriculturally claimed fenland around the mouth of the Ribble, and at the Dee Estuary on the border between England and Wales.

### 2.1.3.2 Historical status

The Bewick's Swan has been a regular winter visitor to northwest England since the 1960s (Hedley Bell 1962). Although there was a rapid increase in the numbers of Bewick's Swans visiting the Ribble

Estuary, and particularly Martin Mere, between the late 1970s and the early 1990s, numbers have since declined markedly. In the winter of 1990/91, 1,046 Bewick's Swans were recorded at Martin Mere. Between 1995/96 and 1999/2000 the mean annual maxima recorded by WeBS was 346. However, in the most recent years of that five-year period, fewer than 200 birds have been recorded. Although numbers of Bewick's Swans visiting the Dee Estuary have increased since the Martin Mere flock has declined, it is clear that, overall, the numbers of birds visiting northwest England are currently declining.

### 2.1.3.3 Internationally important sites

#### i) Martin Mere & Ribble Estuary

Five-year mean 95/96-99/2000: 346

##### *Site conservation status*

SPA (Martin Mere: selection stage 1.1; Ribble and Alt Estuaries: selection stage 1.1)

Ramsar (Martin Mere: criterion 6; Ribble and Alt Estuaries: criterion 6)

NNR (Ribble Estuary)

SSSI (various)

IBA (Martin Mere and Ribble and Alt Estuaries: criteria A4i, B1i, B2, C2, C6)

##### *Site description and habitat*

Martin Mere (SD4105) occupies part of a former lake and mire that extended over some 1,300 ha of the Lancashire coastal plain during the 17th century. The land was purchased by WWT and development of the reserve began in 1972. The complex comprises open water, seasonally flooded marsh and damp, neutral hay meadows overlying deep peat. Large areas of agriculturally semi-improved damp grassland and rush pasture have been maintained and enhanced through appropriate grazing management.

##### *Numbers and trends*

Between the flooding of Martin Mere in 1972 and the early 1990s, there was a rapid increase in the numbers of Bewick's Swans spending the winter at Martin Mere (Fig. 6) and the Ribble Estuary (Fig. 7). The highest count recorded at Martin Mere was 1,046 in winter 1990/91 when large numbers of Bewick's Swans moved to Britain and Ireland from The Netherlands (Rees *et al.* 1991a). However, during the 1990s, numbers declined almost as rapidly as they had increased, resulting in a current flock size of fewer than 200 birds. The reasons for this decline are unknown but may be the result of mild winters, increased numbers remaining in the eastern part of the winter range (e.g. the East Anglian Fens and The Netherlands) and potential competition with Whooper Swans; the latter species has increased in

numbers as the Bewick's Swan flock has declined (Rees & Bowler 1997). The first Bewick's Swans arrive at Martin Mere in the late autumn and peak numbers generally occur during January (Fig. 8).

#### *Site use*

Bewick's Swans generally use Martin Mere for roosting and congregate in the evenings to take advantage of supplemental grain and potatoes supplied by WWT. Away from Martin Mere, Bewick's Swans roost on the Ribble Estuary and on the River Douglas. Sightings of ringed birds indicate that interchange between birds from Martin Mere and those recorded elsewhere on the south side of Ribble Estuary is high.

Although many Bewick's Swans feed in and around the WWT reserve at Martin Mere, flocks also feed on fields and marshes on the south side of the Ribble Estuary at Longton Marsh, Hutton Marsh, Hesketh Out Marsh, Banks Enclosed Marsh and Crossens Marsh (C. Liggett pers. comm.). In agricultural areas, Bewick's Swans generally forage on waste potatoes, split grain and sprouting shoots on barley stubbles, re-seeds and newly-sown winter wheat.

#### 2.1.3.4 Nationally important sites

##### i) Dee Estuary (England/Wales)

Five-year mean 95/96-99/2000: 72

#### *Site conservation status*

SPA (Dee Estuary: non-qualifying species)  
Ramsar (Dee Estuary: non-qualifying species)  
SSSI (Dee Estuary; Inner Marsh Farm)  
IBA (Dee Estuary: criterion C6)

#### *Site description and habitat*

The Dee Estuary (SJ2675) is a funnel-shaped estuarine system. Saltmarsh continues to expand, following large-scale historical land-claim in the early 1700s. Nevertheless, the estuary supports extensive areas of intertidal sand and mud as well as saltmarsh. Where agricultural land-claim has not occurred, the saltmarshes grade into transitional brackish and freshwater swamp vegetation.

#### *Numbers and trends*

Before the early 1990s, fewer than ten Bewick's Swans were recorded regularly during the winter (Fig. 9). The increase in numbers over the early 1990s coincided with the creation of lagoons at the RSPB reserve at Inner Marsh Farm, currently the main roost site, and increases in the size of the NW European population as a whole. A peak count of 107 birds was recorded in winter 1996/97 and a

flock of over 40 birds now uses the estuary regularly. Peak counts tend to occur during January or February (Fig. 10).

#### *Site use*

The Bewick's Swan flock roosts on artificially created lagoons at the RSPB reserve at Inner Marsh Farm (C. Wells pers. comm.). Birds fly out from this site to feed predominantly on saltmarsh grasses, e.g. *Puccinellia*, waste potatoes when available, and winter wheat. Some birds also feed on *Potamogeton* spp. in brackish pools in and around the RSPB reserve.

#### 2.1.3.5 Other sites

Away from Martin Mere, around 20-30 birds roost regularly at nearby Marton Mere (SD3435) and Foulridge Reservoir (SD8841). Peak counts of Bewick's Swans recorded at Morecambe Bay (SD4070) and the Mersey Estuary (SY4578) fluctuate markedly between years. Both sites support flocks of around 20 birds in most years; the former site has hosted up to 120 birds.

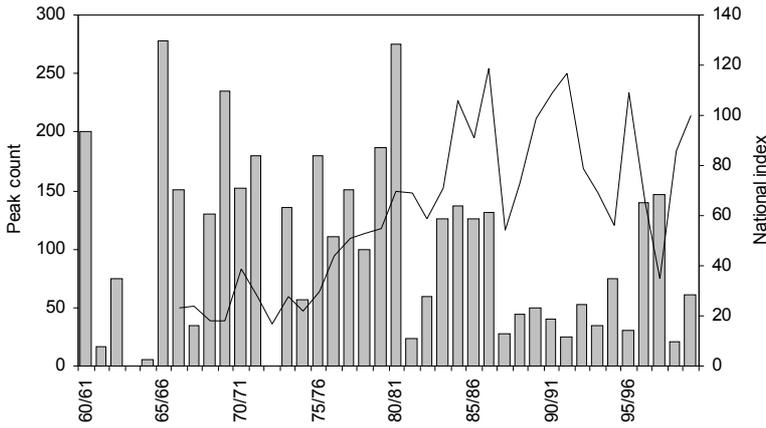
#### 2.1.3.6 Key references

Hedley Bell (1962), Rees & Bowler (1997)

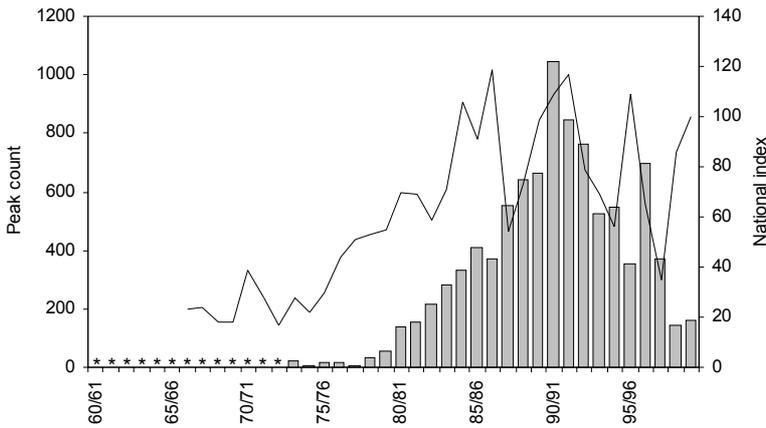
### 2.1.4 Wales

#### 2.1.4.1 Background

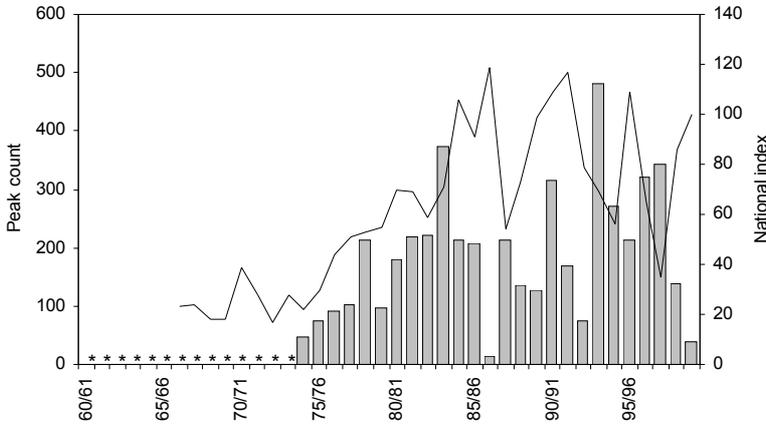
The most suitable habitat for Bewick's Swans in Wales is found on Anglesey. The key resort on the island is currently the Cefni Reservoir (SH4475), which supports around 20 birds at peak periods during the winter. Small flocks also occur in Dyfed, primarily in the vicinity of the river Tywi at Dryslwyn (SN5720), where 10-40 birds spend the winter. The other notable sites for Bewick's Swans in Wales are located in the southwest, in and around the Gwent Levels. Llandegfedd Reservoir (ST3298) supports a flock of 10-70 birds. A small flock of around 20 birds also occur along the River Wye at Glasbury (SO1739). Ring re-sightings from Glasbury support the idea that interchange between Bewick's Swans in the Gwent area and the Severn floodplain is frequent (Bowler *et al.* 1993).



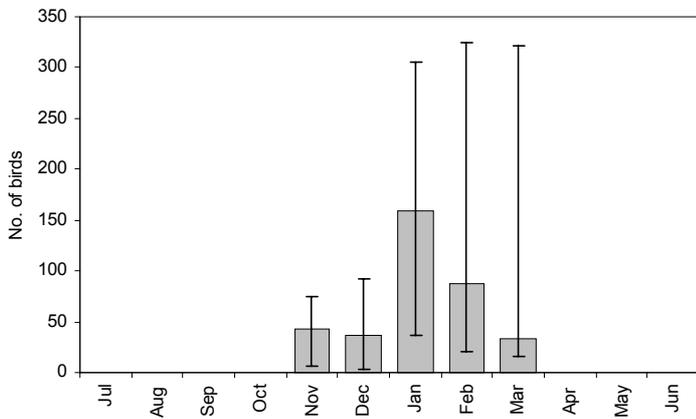
**Figure 5.** Bewick's Swans at the Lower Derwent Valley, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



**Figure 6.** Bewick's Swans at Martin Mere, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



**Figure 7.** Bewick's Swans at the Ribble Estuary, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



**Figure 8.** Bewick's Swans at Martin Mere, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)

### 2.1.4.2 Historical status

During the 19th century, Bewick's Swans were frequent visitors to many coastal areas of Wales, especially in Cardiganshire and Pembrokeshire, and particularly during severe weather (Lovegrove *et al.* 1994). Throughout the first half of the 20th century, Bewick's Swans were regular visitors in small numbers to a few estuaries, lowland bogs and shallow lakes. Anglesey was a stronghold for the species in Wales with flocks of 40 birds present at several sites during the first half of the 20th century. In recent years, fewer than 30 birds have remained on the island through the winter; large flocks (200-300) occur very rarely, and primarily during spring and autumn passage.

Further south, 40-50 birds used to occur regularly at Cors Caron (SN6863) and the Dyfi Estuary (SN6394). During the late 1990s, the Dyfi Estuary supported very few Bewick's Swans with large flocks, around 200, generally present only during spring passage. The flock at Cors Caron has dwindled to almost nothing since the early 1980s.

The flock of Bewick's Swans around the Gwent Levels and Llandegfedd Reservoir built up in numbers between the 1960s and 1990s. This increase from around 20 to 70 birds over a 30-year period is thought to have occurred as birds moved from the large flocks on the Severn. Drainage of sites in the Severn/Vrynwy confluence (SJ3215) and in Montgomeryshire meant that the small flocks that used to occur there have disappeared. A flock of around 30 Bewick's Swans that used to visit Kenfig NNR (SS7981) in the 1930s now comprises only a handful of birds annually.

Overall, the numbers of Bewick's Swans wintering in Wales have remained relatively stable since the beginning of the 20th century; declines in many areas are offset by increases in numbers at the Dee Estuary and sites in the southwest of the country.

### 2.1.4.3 Key references

Lovegrove *et al.* (1994)

## 2.1.5 The Midlands

### 2.1.5.1 Background

For the purposes of this report, the Midlands are defined as the counties of Nottinghamshire, Leicestershire, Staffordshire, and Derbyshire. Although there are currently no nationally or

internationally important sites for Bewick's Swans in this region, there are small flocks dispersed over a large area, predominantly in the vicinity of large reservoirs and river systems. Numbers peak between December and February.

In Staffordshire, flocks of 10-40 Bewick's Swans occur at Blithfield Reservoir (SK0524), Fisherwick & Elford Gravel Pits (SK1710), and Croxall Pits (SK1814). In Derbyshire, a small flock, consisting of 20-30 birds in most winters, occurs around the River Trent between Shardlow and Sawley (SK4530).

The largest flocks in the region occur in Nottinghamshire and Leicestershire. Between 10 and 60 birds have been recorded along the River Idle (SK7195), between Bawtry and Misterton and at Gringley Carr, in the 1990s (Fig. 11). Similarly sized flocks also occur at Besthorpe/Girton Gravel Pits (SK8165) and at the lagoons at Cottam Power Station (SK8279), near Newark. In Leicestershire, a flock of Bewick's Swans moves between the two large reservoirs of Rutland Water (SK9207) and nearby Eyebrook Reservoir (SP8595), often using flooded fields between Caldecott and Great Easton (Mitcham 1984). The former was first flooded in 1975, the latter in 1934. This flock comprises 20-80 birds between December and February, although flocks of 10-20 birds have been more regular during the late 1990s. Further south, Pitsford Reservoir (SP7669) in Northamptonshire currently supports a flock of fewer than 20 birds.

### 2.1.5.2 Historical status

The Bewick's Swan was an uncommon visitor to the Midlands prior to the 1950s (Harrison 1982). Numbers of Bewick's Swans at most sites in the region fluctuate markedly between years and therefore it is difficult to identify any trends in numbers over time.

A new flood prevention scheme at the River Idle may have been responsible for a decline in the Bewick's Swan flock at that site in the early 1970s. Fluctuating conditions at this site prior to this period meant that numbers of Bewick's Swans present were also unpredictable. However, peaks of 100-165 were recorded in the three winters of 1969/70-1971/72 (Fig. 11).

### 2.1.5.3 Key references

Harrison (1982), Mitcham (1984)

## 2.1.6 East Anglia

### 2.1.6.1 Background

The fenlands of East Anglia are by far the most important area for Bewick's Swans in Britain. The Fens consist of a network of canals and ditches covering some 3,400 sq km and are the drained part of the Wash basin. The courses of the main fenland rivers - the Great Ouse, Nene, Welland and Witham - have been so changed and supplemented by drainage operations that their original courses are obscure. Straight, embanked canals were cut through the marshes and water pumped into them from low-lying farmland alongside. To allow for seasonal floods, canals were cut parallel and the land between left as floodplains, into which sudden surpluses of water could be directed and later removed. Two areas which have undergone such management, the Ouse Washes and Nene Washes, are now internationally important sites for Bewick's Swans.

The Wash is a large estuarine expanse (23,700 ha) of sand/silt flats and 2,600 ha of saltmarsh, and supports small flocks of Bewick's Swans. It incorporates the estuaries of the East Anglian Ouse, the Nene and the Welland flowing in from southerly directions, and the Witham from the northwest. Further east along the north Norfolk coast, small numbers of Bewick's Swans are recorded moving west at various coastal sites between October and November. Around 10-20 birds are present at any one time along the coast at this time but very few birds stay to feed (J. Kemp pers. comm.).

Inland lie the Norfolk Broads. Many of the inland marshes and fens along the River Yare and around Breydon Water have now disappeared and the Broads remain threatened by human pressure and nutrient enrichment from surrounding agricultural land. However, large flocks of Bewick's Swans roost on several of the Broads and feed on natural foods and arable land during the day.

Several sites between the Alde-Ore and Thames Estuaries also support flocks of Bewick's Swans during the winter.

### 2.1.6.2 Historical status

Little is known about the Bewick's Swans in East Anglia before the beginning of the 19th century. There is an interesting record of 20 birds at the Nene Washes in March 1855, three of which were shot. It was described as a rare straggler to Cambridgeshire prior to the early 1930s (Bircham 1989) and Payn (1962) stated that it was recorded in Suffolk only

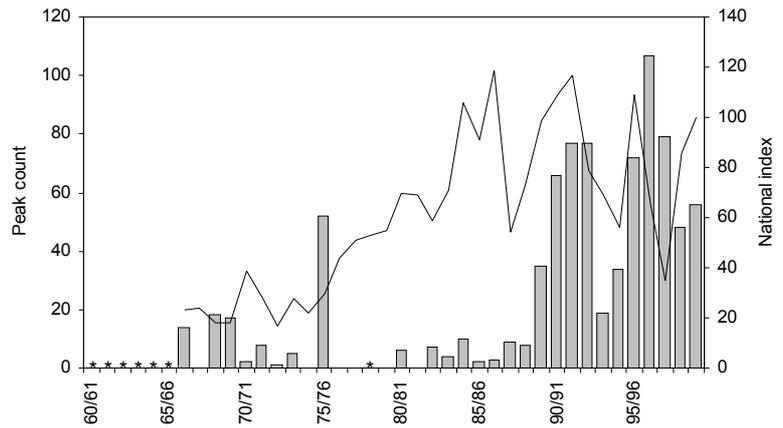
during hard weather. Witherby (1939) reported that the first influx into Britain occurred in winter 1938/39 when Bewick's Swans were driven from The Netherlands by extremely cold weather. In 1939, there were five records of up to 11 Bewick's Swans at the Ouse Washes (Bircham 1989). The site started to become more important for the species in the 1940s (Nisbet 1955, Ogilvie 1969).

There has been a steady increase in the numbers of Bewick's Swans visiting the fenland sites in Norfolk and Cambridgeshire, such that the East Anglian region has become considerably more important since the mid 1950s (Cadbury 1975). Three factors have been identified which may explain this large increase in numbers in the Washes in particular. The first was the cold winter of 1955-56, when 705 birds came to the Ouse Washes and started the tradition of wintering in the area (Nisbet 1959). The establishment of WWT and RSPB nature reserves has provided roosting areas free from disturbance and well managed flooding regimes since 1967. At this time the numbers of Bewick's Swans visiting the area became more predictable. The third reason was a change in feeding habits in the early 1970s. Prior to this period, Bewick's Swans fed almost exclusively on wet meadow grasses and aquatic vegetation. In 1970, when the Washes were both flooded and frozen, Bewick's Swans started to feed on agricultural crops on the fens (Cadbury 1975). By the mid 1970s, they had become dependent on feeding on arable land outside of the Washes, using reserves primarily to roost.

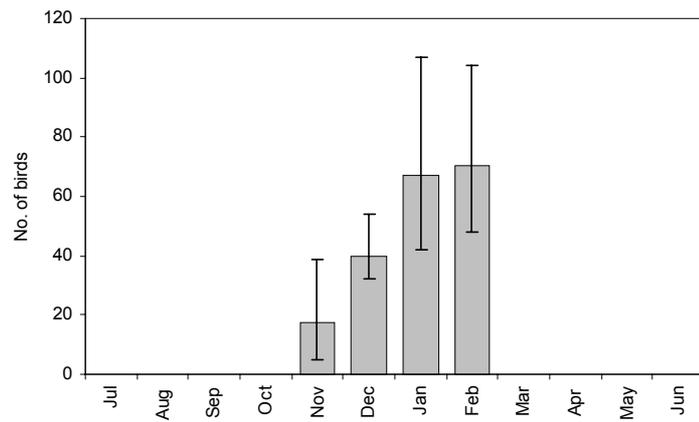
The Nene Washes, 18 km northeast of the Ouse Washes, were flooded fairly regularly in the winter months up until 1960-61. Between 1952 and 1958, Bewick's Swans occurred regularly at the site, but in flocks of fewer than 20 birds. Between 1958 and 1961, flock size increased to a maximum of 180 in 1961. Changes to water level management at the Nene Washes meant that ploughing of summer meadows could be undertaken to the detriment of the Bewick's Swans. This resulted in low numbers occurring at the site over much of the 1960s and 1970s. However, improved water level management by the RSPB in recent years has increased the attractiveness of the site to Bewick's Swans and increased its status to international importance.

Regular wintering of Bewick's Swans in the Broadlands commenced in the 1960s. However, numbers have declined over the period of increase on the fenland sites. Much larger flocks used to occur at Horsey Mere (TG4422) (Fig. 12) and Martham Broad (150-200 in mid 1980s) in particular.

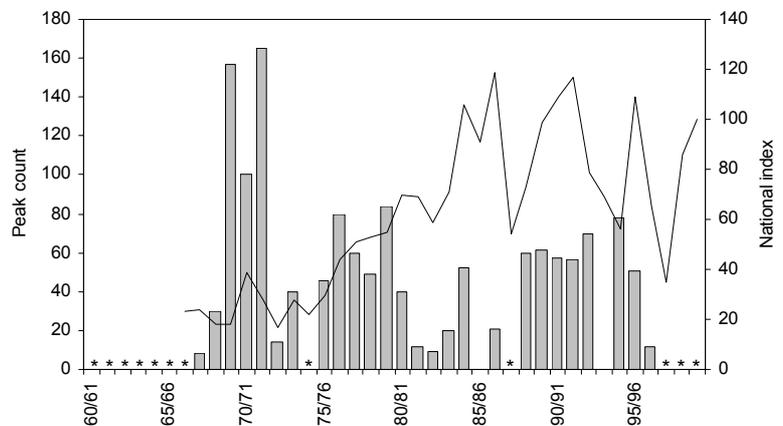
**Figure 9.** Bewick's Swans at the Dee Estuary, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



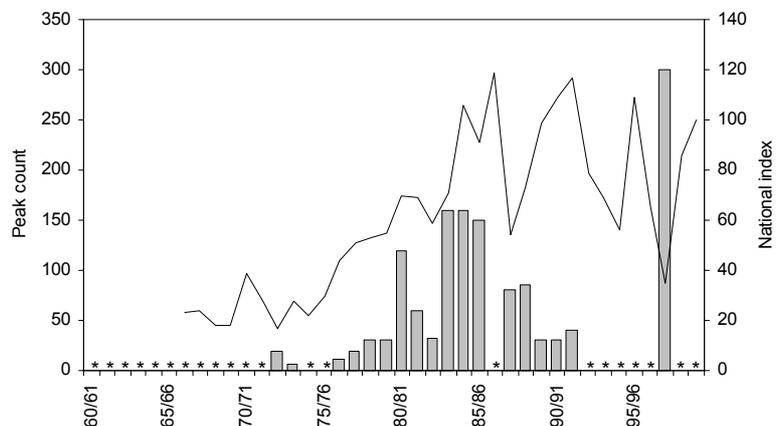
**Figure 10.** Bewick's Swans at the Dee Estuary, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



**Figure 11.** Bewick's Swans at the River Idle between Bawtry and Misterton, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



**Figure 12.** Bewick's Swans at Horsey Mere, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



### 2.1.6.3 Internationally important sites

#### i) Ouse Washes

Five-year mean 95/96-99/2000: 4,988

##### *Site conservation status*

SPA (Ouse Washes: selection stage 1.1)

Ramsar (Ouse Washes: qualifying criteria 6)

SSSI (Ouse Washes)

IBA (Ouse Washes: criteria A4i, B1i, B2, C2, C6)

##### *Site description and habitat*

The Ouse Washes (TL5394) are located in eastern England on one of the major tributary rivers of The Wash, the Great Ouse. It is an extensive area of seasonally flooding wet grassland lying between the Old and New Bedford Rivers, and acts as a floodwater storage system during the winter. The cycle of winter storage of floodwaters from the river, followed by summer grazing by cattle as well as hay production, has given rise to a mosaic of rough grassland and wet pasture.

##### *Numbers and trends*

The Ouse Washes and surrounding fens have been an important wintering area for Bewick's Swans since the 1940s (Nisbet 1955, Ogilvie 1969). There has been an increase in the numbers of Bewick's Swans visiting the Ouse Washes since the mid 1950s (Cadbury 1975; Fig. 13), coinciding with declining numbers at sites elsewhere in Britain and Ireland and mirroring trends in the NW European population as a whole. Peaks have tended to coincide with cold weather influxes from the continent. Some 5,000 Bewick's Swans now regularly spend the winter at the Ouse Washes, arriving in mid October, and with largest numbers recorded in mid winter (Fig. 14). The timing of arrival and the number of birds visiting the site is largely dependent on climatic conditions on the continent, especially at key resorts in The Netherlands. Sightings of colour-marked birds suggest that the site is also important as an autumn staging site for birds moving further west.

##### *Site use*

The WWT reserve located at Welney offers safe roosting during the night (C. Mitchell pers. comm.). However, when water levels are particularly high on the Ouse Washes, many birds move to roost at the Nene Washes and various other satellite sites.

Bewick's Swans generally feed in agricultural areas within 10 km of the Ouse Washes (J. Kemp pers. comm.). They feed on root crops, predominantly harvested potatoes and sugar beet, but will also take spilt grain on stubble fields, winter wheat and occasionally oil seed rape. Large flocks still forage on

vegetation on the Washes themselves, favouring *Glyceria maxima*, *Agrostis stolonifera* and especially *Rorippa palustre* when available.

#### ii) Nene Washes

Five-year mean 95/96-99/2000: 1,327

##### *Site conservation status*

SPA (Nene Washes: selection stage 1.1)

Ramsar (Nene Washes: criterion 6)

SSSI (Nene Washes)

IBA (Nene Washes: criteria A4i, B1i, B2, C2, C6)

##### *Site description and habitat*

The Nene Washes (TF3300) run from Peterborough to Guyhirn. A cycle of winter storage of flood-waters and traditional summer grazing and mowing at this site has given rise to a mosaic of rough grassland and wet pasture, with a diverse ditch flora. There are also two bunded arable farms on the Washes.

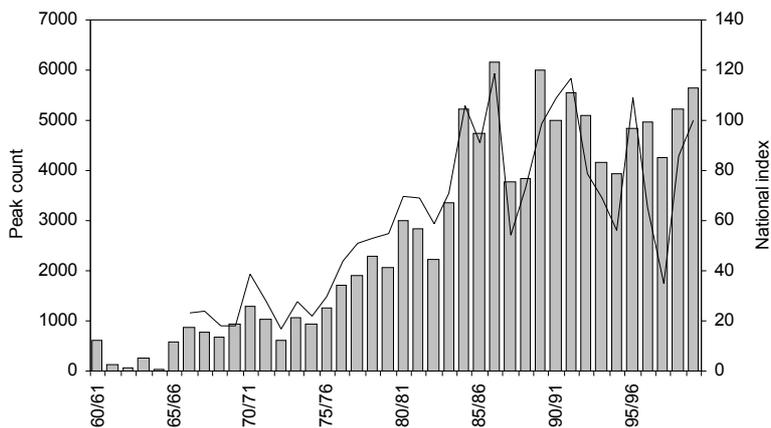
##### *Numbers and trends*

The Nene Washes were flooded fairly regularly in winters up to the 1960/61 season. Flocks of around 20 birds were recorded between 1952 and 1958, increasing to a maximum of 180 in 1961 (Cadbury 1975). Detrimental changes to water level management resulted in low numbers occurring at the site over much of the 1960s and 1970s (Fig. 15). However, improved water level management by the RSPB in recent years has increased the attractiveness of the site to Bewick's Swans, which is now of international importance for the species. The highest counts generally are a result of birds moving to the Nene from the nearby Ouse Washes when water levels there are particularly high. Peak counts are usually recorded during January and February (Fig. 16).

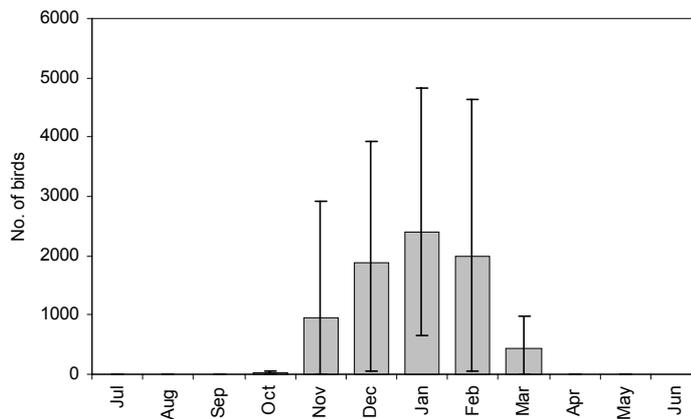
##### *Site use*

Bewick's Swans roost on the Nene Washes with highest numbers recorded when high levels of flooding make conditions unfavourable for roosting at the nearby Ouse Washes (C. Kitchin pers. comm.). Roost sites change within and between winters according to flood levels. The arable farms are the preferred roost sites when they are flooded. Flooded grassland at Eldernell, Ring's End and on the RSPB reserve are also used. In winters without natural flooding, the artificial floods on the RSPB Reserve are particularly important. Small numbers of birds also roost on gravel pits at Prior's Fen, generally when the Washes are frozen.

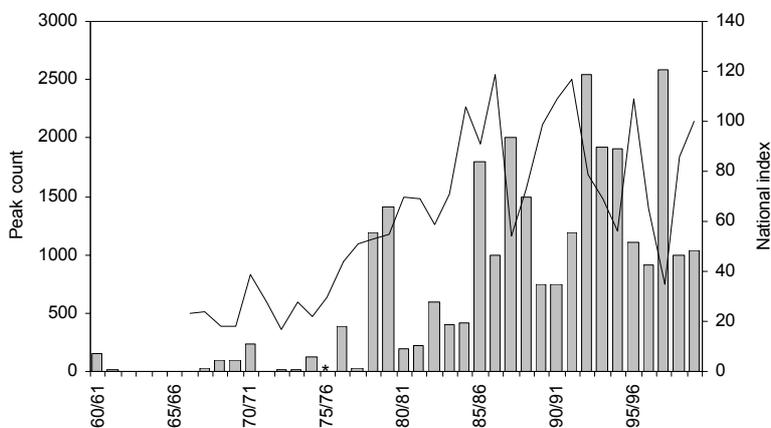
**Figure 13.** Bewick's Swans at the Ouse Washes, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



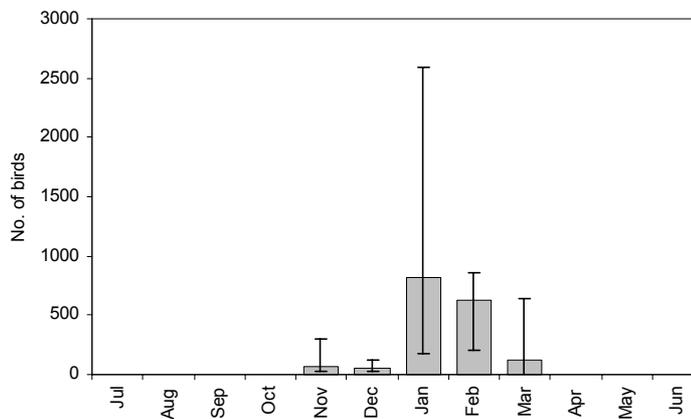
**Figure 14.** Bewick's Swans at the Ouse Washes, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



**Figure 15.** Bewick's Swans at the Nene Washes, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



**Figure 16.** Bewick's Swans at the Nene Washes, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



The Bewick's Swans that roost on the Nene Washes feed predominantly on arable land within 3 km of the site (C. Kitchin pers. comm.). Here they feed on root crops, mainly harvested potatoes and sugar beet, and also winter wheat and oil seed rape. They also feed within the Nene Washes, particularly on the flooded arable farms and less frequently on natural plants in the flooded grassland.

### iii) St. Benet's Levels

Five-year mean 95/96-99/2000: 303

#### *Site conservation status*

SPA (Broadland: selection stage 1.1)

Ramsar (Broadland: criterion 6)

NNR (Ant Broads & Marshes)

SSSI (various)

IBA (Broadland: criterion C6)

#### *Site description and habitat*

St. Benet's Levels (TG3815) is a 3 km length of traditional grazing marsh situated to the south of Ludham.

#### *Numbers and trends*

Bewick's Swans began to use sites in Broadland during the 1960s. Regular monitoring since the mid 1980s has shown that large numbers of Bewick's Swans regularly use St. Benet's Levels (Fig. 17). Over 500 birds have been recorded at the site, with peaks recorded around the cold winter of 1995/96.

However, a flock of 120-250 birds is more regularly recorded, peaking in number for one to three days annually (S. Linsell pers. comm.). Peak counts are generally recorded during January or February (Fig. 18).

#### *Site use*

The Bewick's Swans forage within the site and roost at Ranworth Broad to the south and in some years at Hickling and Barton Broads, and Reedham Water at How Hill (S. Linsell pers. comm.). Occasional southeasterly movements away from St. Benet's Levels, presumably to Breydon Water, have also been recorded.

Up until the mid 1980s, Bewick's Swans fed predominantly on the soft grasses on the grazing marsh at St. Benet's Levels (S. Linsell pers. comm.). However, in recent years the flock has also taken to feeding on waste potatoes (since December 1995), winter wheat and sugar beet on arable land around Hickling, Sutton, Catfield, Horning, Ludham and Potter Heigham. The flock is highly nomadic, moving between feeding areas in response to human disturbance (S. Linsell pers. comm.).

### iv) Breydon Water & Berney Marshes

Five-year mean 95/96-99/2000: 360

#### *Site conservation status*

SPA (Breydon Water: selection stage 1.1)

Ramsar (Breydon Water: criterion 6)

SSSI (Breydon Water; Halvergate Marshes)

IBA (Breydon Water: criteria A4i, B1i, B2, C2, C6)

#### *Site description and habitat*

Breydon Water (TG4907) is an estuary at the mouth of the River Yare and its confluence with the Rivers Bure and Waveney. It includes extensive areas of mudflats, which are the only tidal flats on the east coast of Norfolk.

#### *Numbers and trends*

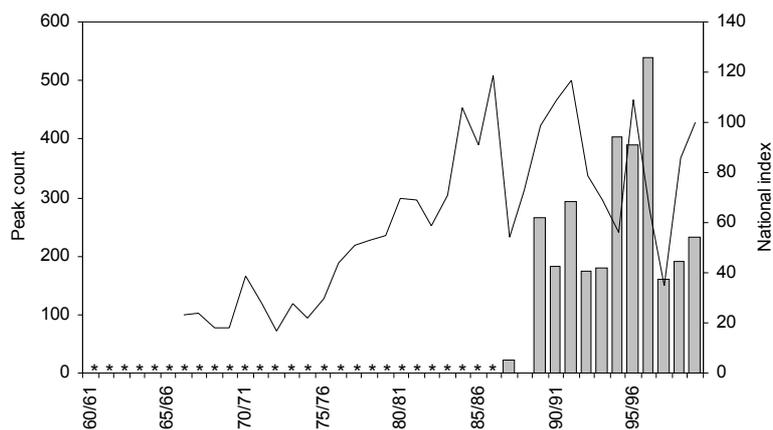
Numbers of Bewick's Swans at Breydon Water and Berney Marshes have increased since the early 1960s with particularly high peak counts recorded in the late 1980s and mid 1990s (Fig. 19). The highest count was recorded during 1995/96 when an influx of birds to Britain and Ireland from the continent was triggered by very cold weather. Numbers generally peak in February (Fig. 20).

#### *Site use*

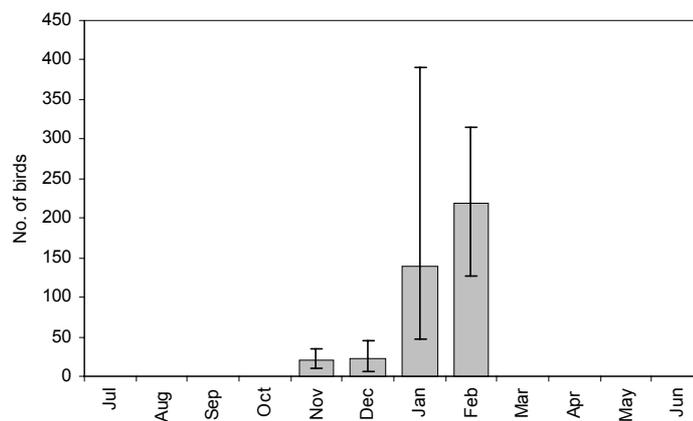
Bewick's Swans roost very rarely on Breydon Water itself but favour tidal lagoons on the estuary in hard weather. Otherwise they prefer to roost on pools and flooded grasslands at the RSPB nature reserve at Berney Marshes.

In the late 1980s, Bewick's Swans roosting at Berney Marshes fed on re-seeded grasslands surrounding the reserve and at Halvergate (J. Rowe pers. comm.). However, in more recent years, flocks have been recorded feeding on sugar beet. Birds also feed on traditionally managed grasslands at Halvergate. Interchange between birds from sites in Broadland and Breydon Water is thought to be high.

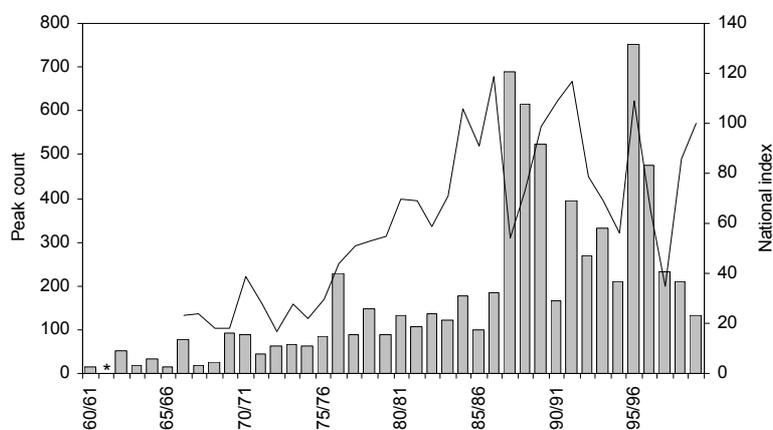
**Figure 17.** Bewick's Swans at St. Benet's Levels, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



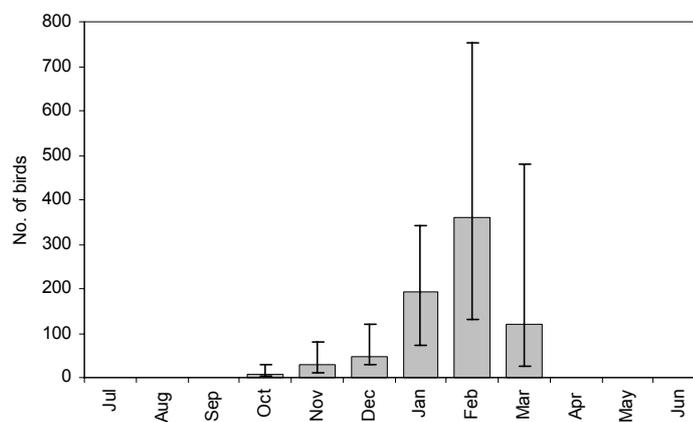
**Figure 18.** Bewick's Swans at St. Benet's Levels, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



**Figure 19.** Bewick's Swans at Breydon Water & Berney Marshes, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



**Figure 20.** Bewick's Swans at Breydon Water & Berney Marshes, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



#### 2.1.6.4 Nationally important sites

##### i) Alde-Ore Complex

Five-year mean 95/96-99/2000: 90

###### *Site conservation status*

SPA (Alde-Ore Estuary: non-qualifying species)  
Ramsar (Alde-Ore Estuary: non-qualifying species)  
SSSI (Alde-Ore Estuary)  
IBA (Alde-Ore Estuary: non-listed species)

###### *Site description and habitat*

The Alde-Ore Complex (TM4257) covers the estuaries of the Alde, Butley and Ore rivers. There are a variety of habitats present, including intertidal mudflats, saltmarsh, vegetated shingle, saline lagoons and agriculturally improved grazing marsh. This variety of habitats makes the complex particularly attractive to a large number of waterbirds, including a large flock of Bewick's Swans which traditionally uses Sudbourne Marshes.

###### *Numbers and trends*

The numbers of Bewick's Swans recorded at the Alde Complex have increased markedly since the early 1960s (Fig. 21). However, peak counts fluctuate markedly between years, often coinciding with cold weather influxes from the continent, and occur in mid to late winter (Fig. 22). Over 100 birds have also been recorded at the RSPB nature reserve at North Warren, just north of the Alde-Ore Complex as defined by WeBS.

###### *Site use*

The Bewick's Swans at this site feed at the northern end of the Sudbourne Marshes on sheep-grazed grasslands and also on root crops and sugar beet on arable land near Orford (R. West pers. comm.).

The RSPB's management of the marshes at North Warren, north of Aldeburgh, has attracted large numbers of Bewick's Swans and movements of birds between the favoured sites in the area is likely to be frequent (R. West pers. comm.). Some birds also feed at Aldeburgh Marshes.

#### 2.1.6.5 Other sites

The Bewick's Swan flock that occurs along the south and east shores of The Wash (TF5540) fluctuates in size between years (Fig. 23). Although peak numbers are recorded in mid winter, large transitory flocks also occur during autumn and spring passage periods. For this reason, the Bewick's Swan is listed as an important species within The Wash IBA. These birds feed on arable land and roost at the Snettisham

Pits (TF6335). A flock of around 20-30 birds also occurs at Nocton/Dunston Fens (TF1065) on the Lincolnshire side.

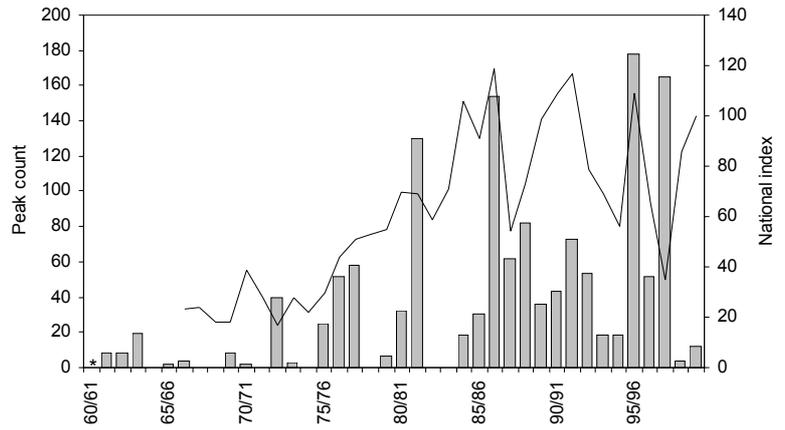
Movements of birds between the sites in Broadland probably occur on a regular basis. A flock of 10-70 Bewick's Swans regularly uses the Yare Marshes (TF3504), Hickling Broad (TG4121) supports up to around 200 birds, Mautby Marshes (TG4810) up to 40 birds and Martham Broad (TG4520) 10-40 birds. Large feeding flocks of 100-500 birds have been recorded at sites around Wood Street (TG3822) and Brumstead/East Ruston (TG3527) in recent winters and are probably linked to the St. Benet's Levels flock. Smaller flocks are often present along other Broads, at Minsmere (TM4666) (Fig. 24) and to the south around the Blyth Estuary (TM4675).

Further south along the coast, small flocks of Bewick's Swans are recorded at the Blackwater (TL9307) (10-20 birds) and Colne Estuaries (TM0614) (10-50) and at Hamford Water (TM2225) (up to 50). These flocks generally peak in number during the mid winter and may be associated with the large flock that occurs at the Alde-Ore Complex. Further inland, the flock of Bewick's Swans at Abberton Reservoir (TL9818) may number almost 100 birds at times (Fig. 25), although counts fluctuate markedly between years often coinciding with cold weather influxes from the continent. A flock that uses the Thames Estuary (TQ7880) during mid winter, also fluctuates in size between years (Fig. 26).

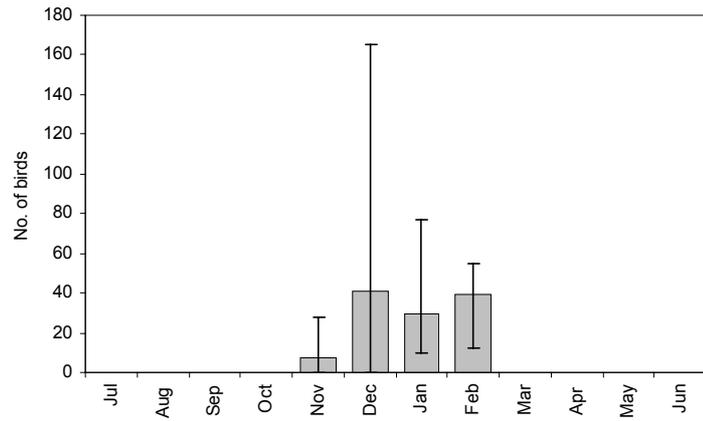
#### 2.1.6.6 Key references

Witherby (1939), Nisbet (1955, 1959), Payn (1962), Cadbury (1975), Owen & Cadbury (1975), Scott (1980b), Rees & Bowler (1997), Bircham (1989), Taylor *et al.* (2000)

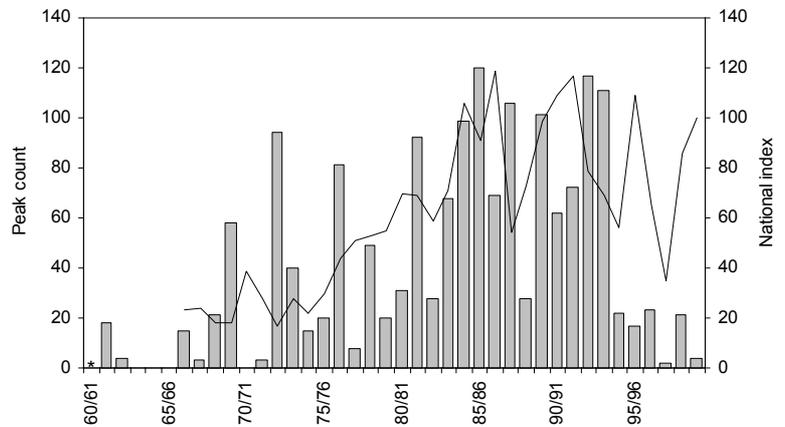
**Figure 21.** Bewick's Swans at the Alde-Ore Complex, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)

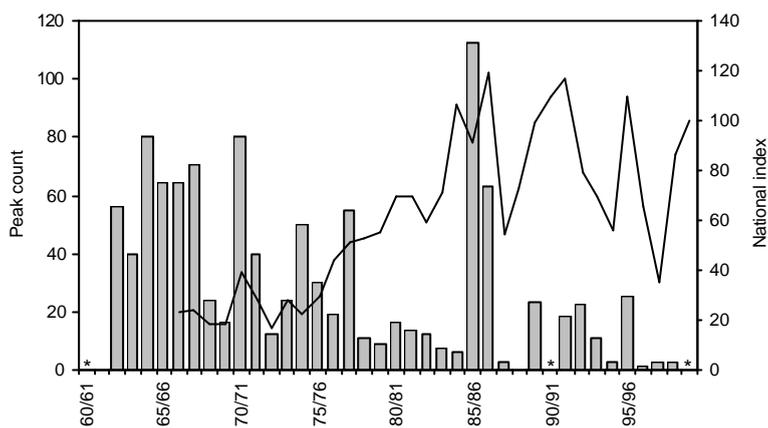


**Figure 22.** Bewick's Swans at the Alde-Ore Complex, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)

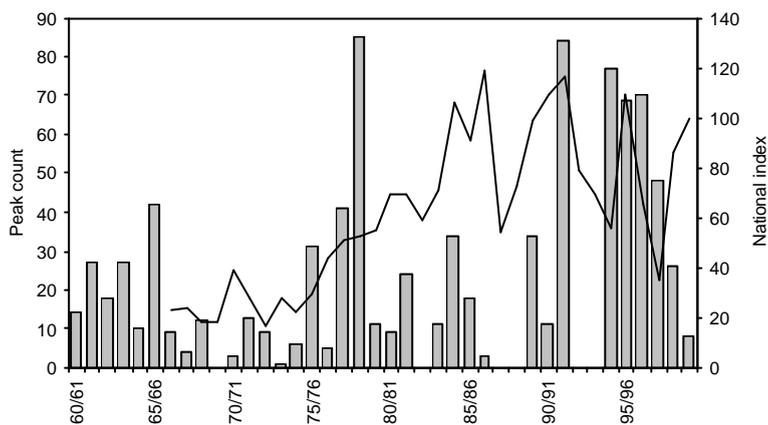


**Figure 23.** Bewick's Swans at The Wash, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)

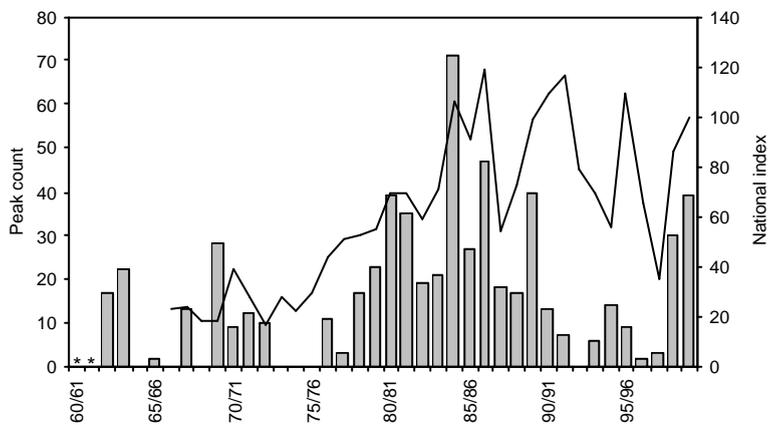




**Figure 24.** Bewick's Swans at the Minsmere Levels, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



**Figure 25.** Bewick's Swans at Abberton Reservoir, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



**Figure 26.** Bewick's Swans at the Thames Estuary, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)

## 2.1.7 The Severn

### 2.1.7.1 Background

The English part of the Severn Valley is predominantly agricultural and supports a large number of Bewick's Swans during mid winter.

### 2.1.7.2 Historical status

Bewick's Swans were uncommon winter visitors to the Severn until the mid 1950s (Swaine 1982). The first few Bewick's Swans frequented the saltmarshes at WWT's reserve at the New Grounds Slimbridge, and other sites along the Severn, during the 1950s, but numbers did not exceed 30 birds on a single day (Ogilvie 1969, Rees & Bowler 1997). Many more birds came in the cold winters of 1961/62 and 1962/63 and in 1964 the provision of supplemental grain at an artificial pool at WWT Slimbridge was introduced (Scott 1966). The tradition of using Slimbridge gradually increased through the 1970s and 1980s. The site provides a protected roost site, pasture for feeding on the reserve and supplemental food is still provided. Numbers also increased at other sites in the vicinity at Walmore Common, Coombe Hill Canal, Ashleworth Ham and surrounding agricultural land. Rodley Common (SO7412) has also supported small flocks of Bewick's Swans in the past. Total numbers of Bewick's Swans visiting the Severn Valley have declined slightly since the 1980s, probably as a result of mild weather conditions and favourable feeding conditions on the continent, and a reluctance of Bewick's Swans to move from the East Anglian strongholds except for those individuals that traditionally winter at Slimbridge or during severe weather.

### 2.1.7.3 Internationally important sites

#### i) Severn Estuary

Five-year mean 95/96-99/2000: 364

##### *Site conservation status*

SPA (Severn Estuary: selection stage 1.1)

Ramsar (Severn Estuary: criterion 6)

SSSI (various)

IBA (Severn Estuary: criteria A4i, B1i, B2, C2, C6)

##### *Site description and habitat*

The Severn Estuary (SO7105) is fed by five major rivers: the Severn, Wye, Usk, Parrett and Avon. Classically funnel-shaped, the estuary has the second widest tidal range in the world. There are extensive

intertidal areas comprising mudflats, sand banks, shingle and rocky platforms. *Salicornia* and *Suaeda maritima* colonise the open mud, with beds of all three species of *Zostera* occurring in more sheltered mud and sand banks. Large areas of *Spartina* occur on the outer marshes. Heavily grazed saltmarshes fringe the estuary. The middle sward is dominated by *Puccinella maritima* and the upper marsh is dominated by *Festuca rubra* and *Juncus*.

##### *Numbers and trends*

The first few Bewick's Swans were recorded at the New Grounds at Slimbridge in the 1950s. Many more birds arrived during the cold winters of 1961/62 and 1962/63 and the tradition of using Slimbridge gradually increased through the 1970s and 1980s (Fig. 27). Around 360 birds currently winter in and around the WWT reserve at Slimbridge. The site provides a protected roost site, low-lying and often partially flooded pasture for feeding and supplemental food is provided. Peak counts are generally recorded in January (Fig. 28).

##### *Site use*

In the 1960s and early 1970s, Bewick's Swans used to roost on the River Severn (Evans 1978). Today, freshwater pools at WWT Slimbridge provide key roosting areas for the large Bewick's Swan flock that feed in and around the reserve (S. Carman pers. comm.). Bewick's Swans graze in the managed grasslands and saltmarshes of WWT Slimbridge, primarily on The Dumbles, New Piece and Tack Piece (J. Earle pers. comm.). Additional fields are used between the reserve and the Gloucester-Sharpness Canal, and the swans also feed on flooded pasture 1.5 km further south at The Moors.

In natural habitats, Bewick's Swans feed almost entirely on grasses, especially *Lolium perenne* and *Alopecurus geniculatus* (Rees 1990). *A. stolonifera*, *Poa pratense*, *P. trivialis* and *Phleum pratense* are also grazed (Rees 1990). In agricultural areas, the birds feed on re-seeds and waste sugar beet. Supplemental grain, and in some years waste potatoes, is provided at WWT Slimbridge. Bewick's Swans have also been recorded feeding on macro-invertebrates on the intertidal areas of the Severn, presumably taking *Corophium* and/or *Nereis* (Bowler 1996).

#### 2.1.7.4 Nationally important sites

##### i) Walmore Common

Five-year mean 95/96-99/2000: 78

##### *Site conservation status*

SPA (Walmore Common: selection stage 1.1)

Ramsar (Walmore Common: criterion 6)

SSSI (Walmore Common)

IBA (Walmore Common: criteria B2, C6)

##### *Site description and habitat*

Walmore Common (SO7425) lies in the Severn Vale, about 10 km north of Gloucester, and is an area subject to winter flooding. The site comprises a network of ditches supporting a rich vegetation community and separate grass fields where Bewick's Swans feed and sometimes roost when flood levels are suitably high. The site overlies peatland and provides both agriculturally intensified and un-intensified pasture. Part of the site is common land.

##### *Numbers and trends*

The number of Bewick's Swans visiting Walmore Common is highly dependent on the extent of flooding at the site and conditions at WWT Slimbridge. As mentioned above, peak counts at this site have increased as the Severn flock as a whole has grown and often coincide with cold weather influxes of birds from the continent (Fig. 29). Because flood levels change within and between years, the timing of peak counts is also highly variable, although they generally occur in the spring (Fig. 30). Given this pattern, the site may serve as an important pre-migratory site when flooded during spring.

##### *Site use*

Bewick's Swans roost on the flooded grasslands when water levels are favourable (S. Carman pers. comm.). The flock generally feeds on re-seeded grasses on intensified pastures within the Common. The site is vacated during dry periods, when the Bewick's Swan flock moves to WWT Slimbridge and to other sites along the Severn.

#### 2.1.7.5 Other sites

Away from the two key sites on the Severn, two other sites support large flocks, generally at times when the feeding opportunities are good. The low-lying sumps at Combe Hill Canal (SO8626; Fig. 31) and Ashleworth Ham (SO8326) generally host around 40 Bewick's Swans at peak periods but numbers can be much higher. The peak number of birds recorded at the former site was recorded in 1985/86 when large numbers of birds crossed the

North Sea from the continent during very cold weather. Birds formerly used flood meadows adjacent to the Avon at Tewkesbury, providing a link between those sites on the Severn and those on the Wye at Glasbury and Letton.

#### 2.1.7.6 Key references

Scott (1966), Evans (1978, 1979a, b, 1980), Swaine (1982), Rees (1988, 1990), Bowler (1996), Rees & Bowler (1997)

### 2.1.8 Somerset

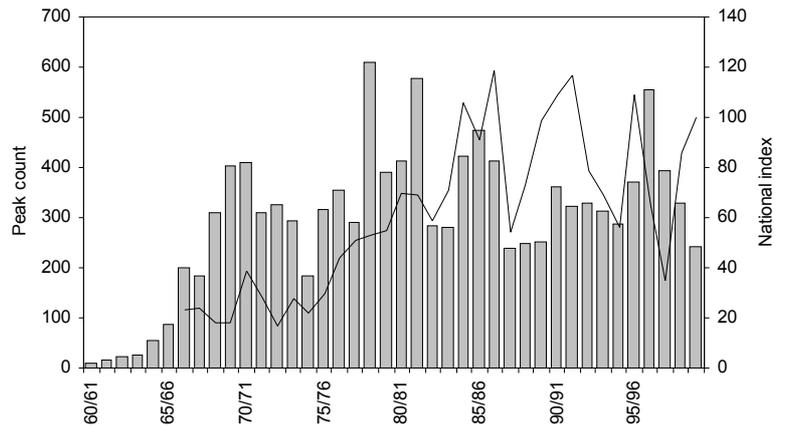
#### 2.1.8.1 Background

To the south and east of Bridgwater Bay, the floodplains of the Parrett, Cary, Brue and Exe rivers extend inland for up to 30 km. Low-lying areas, known as the 'Levels and Moors', are surrounded by higher ground and therefore flood regularly during the winter. It is this area that attracts the largest concentrations of Bewick's Swans in Somerset (see below). A number of reservoirs to the south of Bristol also attract small flocks of Bewick's Swans during mid winter.

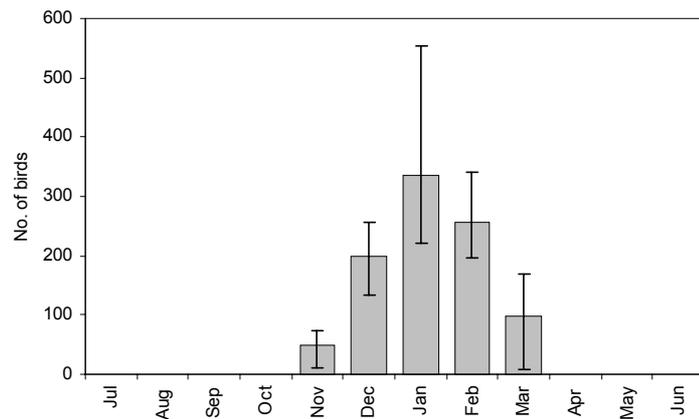
#### 2.1.8.2 Historical status

The Bewick's Swan was absent in Somerset between 1891 and 1937, and only rarely recorded at reservoirs and the Levels and Moors before 1950 (Somerset Ornithological Society 1988). Although a series of drainage projects were undertaken at the Levels and Moors, from the 1940s onwards, numbers of Bewick's Swans using the site started to increase. Only 20-30 birds were present in the early 1950s, climbing to 400 in the early 1980s. Numbers have since declined; fewer than 200 birds currently use the site. Numbers have also declined at the Chew Valley/Blagdon complex over the same period, where up to 90 birds were present during the mid 1980s. A combination of mild winters on the continent and highly favourable conditions at the East Anglian fenlands probably contributed to the reduction in numbers wintering in Somerset in the late 1980s and the 1990s.

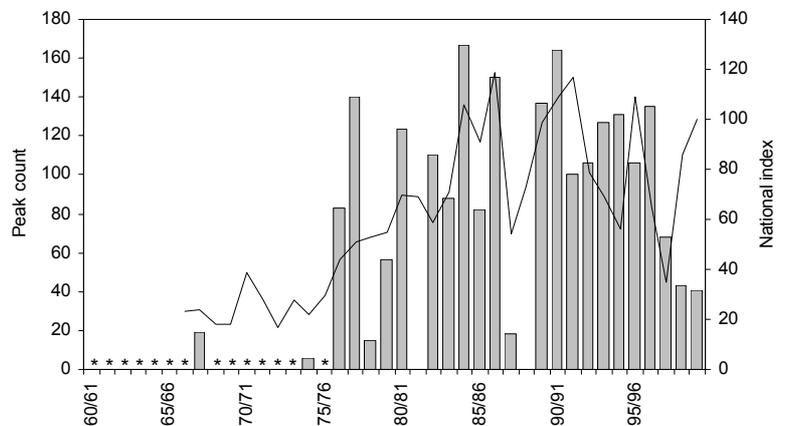
**Figure 27.** Bewick's Swans at Slimbridge, Severn Estuary, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



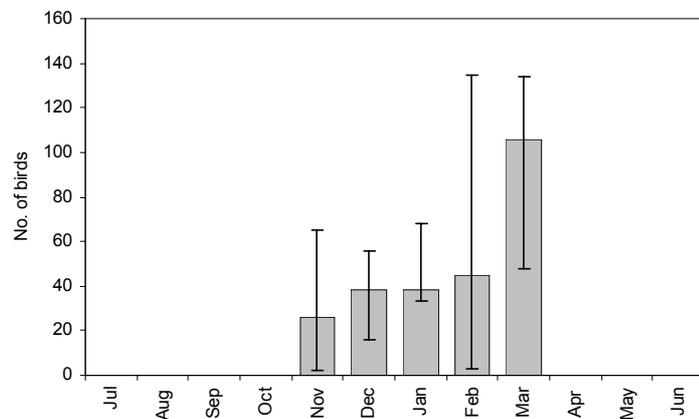
**Figure 28.** Bewick's Swans at Slimbridge, Severn Estuary, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



**Figure 29.** Bewick's Swans at Walmore Common, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



**Figure 30.** Bewick's Swans at Walmore Common, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



### 2.1.8.3 Internationally important sites

#### i) Somerset Levels & Moors

Five-year mean 95/96-99/2000: 187

##### *Site conservation status*

SPA (Somerset Levels and Moors: selection stage 1.1)

Ramsar (Somerset Levels and Moors: criterion 6)

NNR (Somerset Levels)

SSSI (Various)

IBA (Somerset Levels and Moors: criteria B2, C6)

##### *Site description and habitat*

The Somerset Levels and Moors (ST4040) comprise the largest area of lowland wet grassland and associated wetland habitat remaining in Britain. It covers around 35,000 ha in the floodplain of the rivers Axe, Brue, Parrett, Tone and their tributaries. Most of the site is only a few metres above sea-level and drains through an extensive network of ditches, rhynes, drains and rivers. Winter flood levels are dependent on rainfall.

##### *Numbers and trends*

As mentioned above, only 20-30 Bewick's Swans were present on the Somerset Levels and Moors in the early 1950s, increasing to over 400 in winter 1981/82 (Fig. 32). Since then, numbers have declined; fewer than 200 Bewick's Swans now use the site, with peak numbers occurring in mid winter (Fig. 33). Peak counts in the 1990s have tended to coincide with influxes of birds to Britain and Ireland from the continent during cold weather.

##### *Site use*

The use of roost sites by Bewick's Swans is dependent on the level of flooding over the Levels and Moors. In dry winters, flocks congregate at the RSPB reserve at West Sedgemoor (S. Meen pers. comm.). However, in wetter winters, flocks will roost at King's Sedgemoor, Moorlinch, Wet Moor and North Moor, depending on where the flood conditions are most favourable.

Bewick's Swans fly to agricultural land close to roost sites to feed during daylight hours (S. Meen pers. comm.). They generally favour agriculturally improved grasslands, especially re-seeded pasture.

### 2.1.8.4 Other sites

When flooding conditions are unfavourable at the Somerset Levels and Moors, Bewick's Swans will sometimes roost at Durleigh (ST2636) (Fig. 34) or

Sutton Bingham Reservoirs (ST5410). There is substantial annual variation in numbers at these sites.

Blagdon Reservoir (ST5150) and Chew Valley Lake (ST5659) currently support a flock of around 20 birds between them at peak periods.

### 2.1.8.5 Key references

Somerset Ornithological Society (1988)

## 2.1.9 Sussex

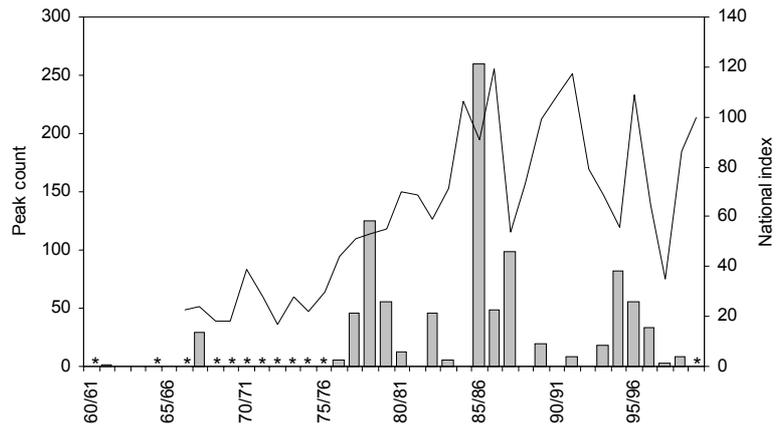
### 2.1.9.1 Background

Eastwards of Pagham Harbour, the chalk ridge of the South Downs gradually approaches the coast, reaching it 40 km to the east of Brighton. Between these areas lie two estuaries, the Arun and the Adur. The narrow outlets of these rivers make their lower reaches prone to winter flooding, attracting large numbers of wintering Bewick's Swans, peak numbers generally occurring in January. The main concentrations occur along the Arun Valley (see below), particularly between Pulborough and Amberley.

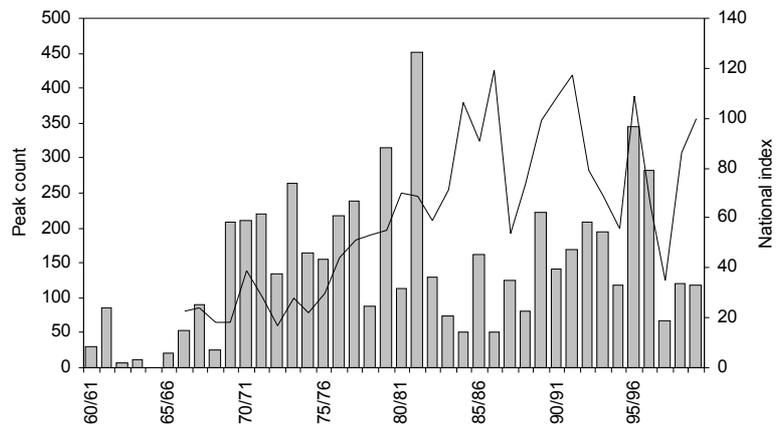
### 2.1.9.2 Historical status

Prior to 1940, the Bewick's Swan was recorded only rarely away from the coastal areas of Sussex (des Forges & Harber 1963), with numbers beginning to increase in the early 1960s (Shrubbs 1979). Fewer than 20 birds were recorded annually between 1952 and 1962, 70 between 1973 and 1972, and 100 between 1973 and 1976. The flock of Bewick's Swans that winter in the Arun floodplain increased rapidly through the late 1970s and early 1980s, from a flock of 20-40 birds to around 180 in winter 1985/86. Since then numbers have fallen and fewer than 100 birds have used this site during the late 1990s.

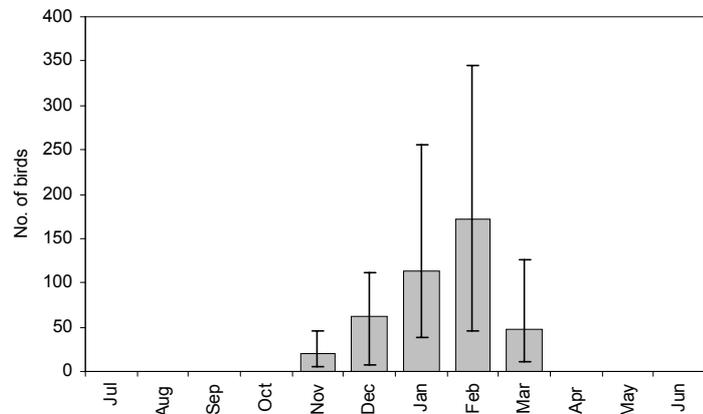
**Figure 31.** Bewick's Swans at Coombe Hill Canal, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



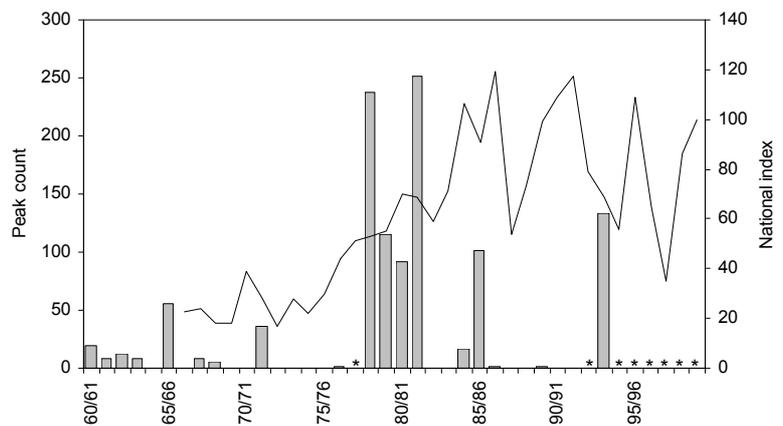
**Figure 32.** Bewick's Swans at the Somerset Levels & Moors, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



**Figure 33.** Bewick's Swans at the Somerset levels & Moors, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



**Figure 34.** Bewick's Swans at Durleigh Reservoir, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



### 2.1.9.3 Nationally important sites

#### i) Arun Valley

Five-year mean 95/96-99/2000: 86

##### *Site conservation status*

SPA (Arun Valley: selection stage 1.1)  
SSSI (Amberley Wild Brooks; Pulborough Brooks; Waltham Brooks)  
IBA (Arun Valley: criterion C6)

##### *Site description and habitat*

The Arun Valley (TQ0314) is characterised by alluvial grazing marsh, pasture and cultivated land, forming a mixed wet and dry field and ditch network that supports a rich floral community. Bewick's Swans frequent the levels between Pulborough and Amberley, occasionally using the valley to the south towards Lyminster and Ford or to the north near Strotham House and Pallingham.

##### *Numbers and trends*

The numbers of Bewick's Swans occurring in the Arun Valley increased markedly from around 40 birds in the early 1970s to almost 180 in winter 1985/86 (Fig. 35). Since then, numbers have fluctuated in response to flooding levels in the valley and influxes of birds into Britain and Ireland during cold weather on the continent, but have generally declined. Numbers generally peak in mid to late winter (Fig. 36).

##### *Site use*

Although the reserves at Waltham Brooks (Sussex Wildlife Trust) and Arundel (WWT) were favoured roost sites until the mid 1980s, most birds now roost at the RSPB reserve at Pulborough Brooks (Hughes 1992). The roost at WWT Arundel is generally used during cold weather. Given that recent winters have been comparatively mild, this may explain why this roost site has not been used regularly in recent years.

Most of the Bewick's Swans that winter in the Arun Valley feed on agriculturally improved pastures in seven discrete areas between Pulborough Brooks and North Stoke (Hughes 1992).

### 2.1.9.4 Other sites

The Adur Levels (TQ1912) supports a flock of around 20-100 Bewick's Swans. Only very small flocks of birds are recorded regularly elsewhere in the county (Hughes 1992). Movement of birds between the Arun and Adur is likely to be high.

### 2.1.9.5 Key references

des Forges & Harber (1963), Shrubbs (1979), Hughes (1992)

## 2.1.10 Kent

### 2.1.10.1 Background

Numerous estuaries and marshes along the Kent coastline play host to large flocks of Bewick's Swans during the winter, although numbers fluctuate markedly between years. The Medway Estuary qualifies as nationally important for this species according to WeBS data (see below), yet the size of the five-year mean is determined largely by a high count of 302 birds in 1998/99.

Further east, the floodplain of the Great Stour supports an irregular flock of Bewick's Swans.

The lower reaches of the River Rother flow through the western edge of the huge expanses of agriculturally claimed land comprising the Rother Levels, Shirley Moor and Romney Marsh in the south of the county. A large flock of Bewick's Swans has been recorded at these sites, most frequently at Walland Marsh and Dungeness Gravel Pits in recent winters.

### 2.1.10.2 Historical status

Before the early 1970s, the Bewick's Swan was an irregular visitor to the Kent marshes, occurring in high numbers only during hard weather (Gillham & Homes 1950).

### 2.1.10.3 Internationally important sites

#### i) Walland Marsh & Dungeness Gravel Pits

Five-year mean 95/96-99/2000: 255

##### *Site conservation status*

SPA (Dungeness to Pett Level: selection stage 1.1)  
Ramsar (Dungeness to Pett Level: criterion 6)  
NNR (Dungeness)  
SSSI (Dungeness; Pett Level)  
IBA (Dungeness to Pett Level: criteria A4i, B1i, B2, C2, C6)

##### *Site description and habitat*

Walland Marsh (TQ9824) was once an extensive area of grazed marsh which was close-cropped by sheep. Although much of the area has been largely

converted to arable land, some sheep grazing still remains and it is attractive to a large flock of Bewick's Swans during periods of flooding. The nearby Dungeness Gravel Pits (TR0619) are an important roosting site for the flock during the early winter.

#### *Numbers and trends*

The numbers of Bewick's Swans visiting Walland Marsh (Fig. 37) and Dungeness Gravel Pits (Fig. 38) during the winter increased markedly between the late 1960s and mid 1990s, from fewer than 20 in the early 1960s to 300-350 birds in the mid 1990s. It remains unclear whether low counts in the late 1990s are the result of real reduction in site usage by Bewick's Swans or redistribution in the area. Peak counts are generally recorded in late winter or early spring (Fig. 39).

#### *Site use*

Although many Bewick's Swans roost at the Dungeness Gravel Pits, regularly flooded land at a recently established private nature reserve at Cheyne Court on Walland Marsh provides an alternative safe roosting area (P. Akers pers. comm.). Other gravel pits in the area are also used for roosting at times.

Bewick's Swans feed almost exclusively on arable land between Walland Marsh and Dungeness Gravel Pits, favouring oil seed rape and winter wheat in recent winters (P. Akers pers. comm.).

### 2.1.10.4 Nationally important sites

#### **i) Medway Estuary & Marshes**

Five-year mean 95/96-99/2000: 98

#### *Site conservation status*

SPA (Medway Estuary and Marshes: non-qualifying species)

Ramsar (Medway Estuary and Marshes: non-qualifying species)

SSSI (Medway Estuary and Marshes)

IBA (Medway Estuary and Marshes: non-listed species)

#### *Site description and habitat*

The Medway Estuary (TQ8471) forms a single tidal system with the Swale and joins the Thames Estuary between the Isle of Grain and Sheerness. It has a complex arrangement of tidal channels, which drain around large islands of saltmarsh and grazing marsh where Bewick's Swans occasionally feed. The mudflats support extensive areas of algae and *Zostera*.

#### *Numbers and trends*

Apart from winter 1998/99, fewer than 50 Bewick's Swans have been recorded annually at the Medway Estuary since the early 1970s (Fig. 40). Clearly, the size of the exceptional count made in January 1999 is responsible for the high conservation status of this site (Fig. 41).

#### *Site use*

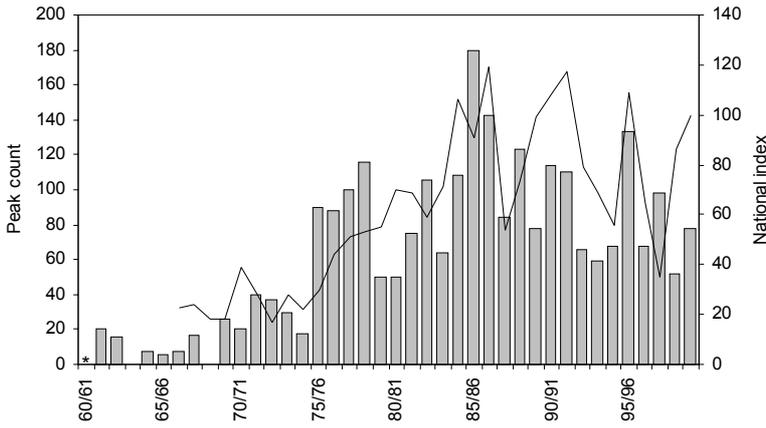
The usually small Bewick's Swan flock feeds on rough grazing marshes in the vicinity of the Chetney peninsula (A. Johnson pers. comm.).

### 2.1.10.5 Other sites

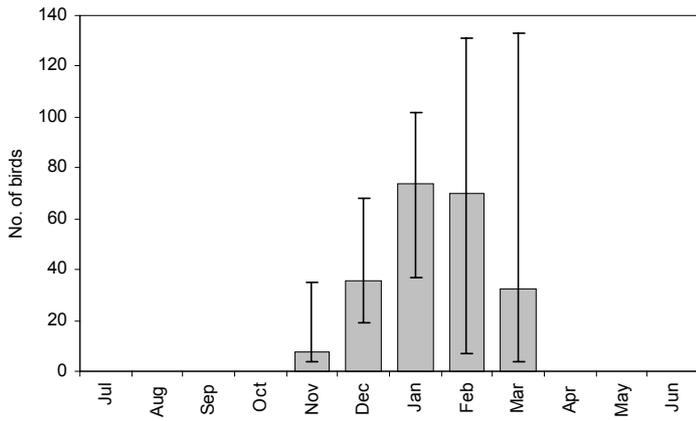
Up to 60 Bewick's Swans occur annually at the nearby Swale Estuary (TQ9765). The colliery subsidence of Stodmarsh NNR (TR2061) and adjoining marshes and lagoons towards Westbere support up to 35 Bewick's Swans. The Ash and Minster Levels (TR3162) and the Wantsum Marshes (TR2366) support a similar sized flock at times of severe weather on the continent when immigrants cross the North Sea.

### 2.1.10.6 Key references

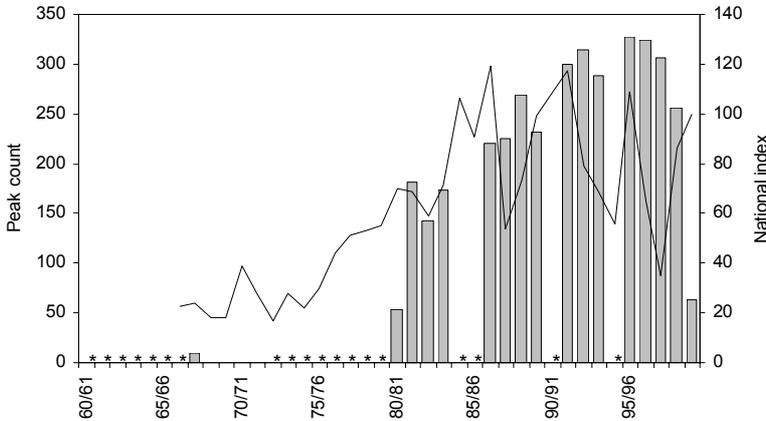
Gilham & Homes (1950)



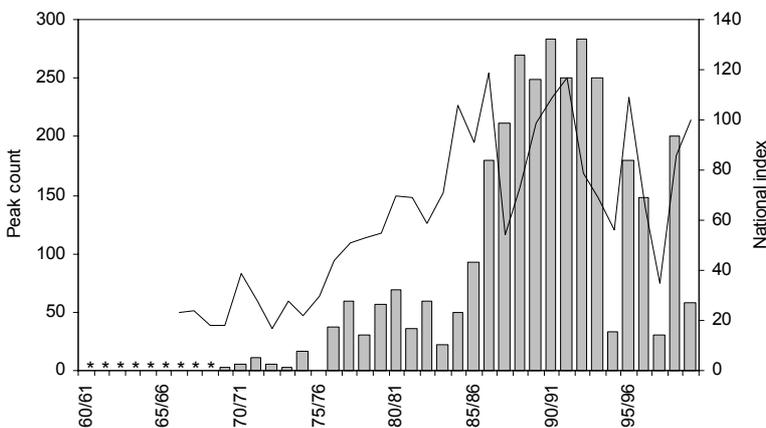
**Figure 35.** Bewick's Swans at the Arun Valley, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



**Figure 36.** Bewick's Swans at the Arun Valley, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)

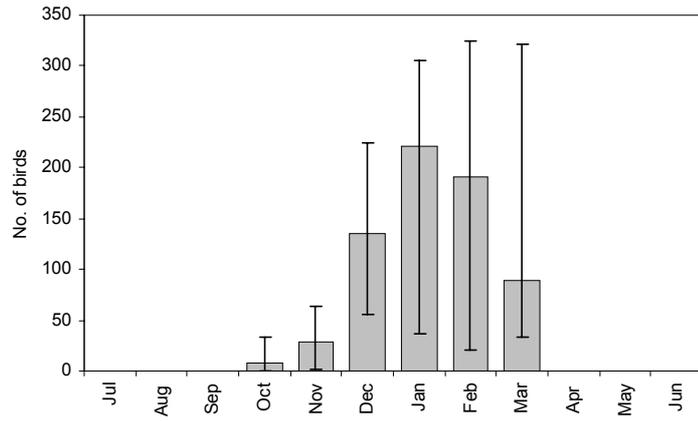


**Figure 37.** Bewick's Swans at Walland Marsh, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)

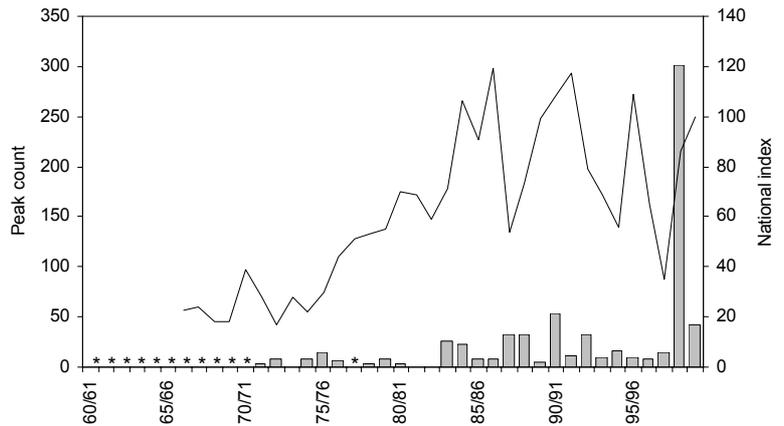


**Figure 38.** Bewick's Swans at the Dungeness Gravel Pits, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)

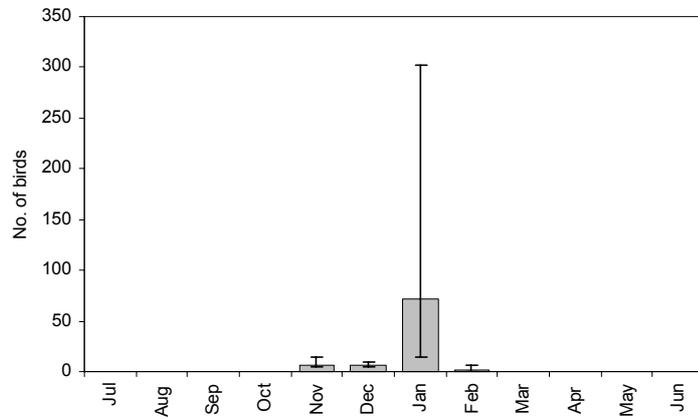
**Figure 39.** Bewick's Swans at Walland Marsh/Dungeness Gravel Pits, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



**Figure 40.** Bewick's Swans at the Medway Estuary & Marshes, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



**Figure 41.** Bewick's Swans at the Medway Estuary & Marshes, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



## 2.1.11 Dorset and Hampshire

### 2.1.11.1 Background

Most of the Bewick's Swans recorded in Dorset and Hampshire are thought to be linked to the main flock present on floodplains along the Avon Valley.

### 2.1.11.2 Historical status

There are few records of Bewick's Swans in Dorset prior to 1946 and none for 1947-55 (Predergast & Boys 1983). The species was also irregular in Hampshire before the cold winter of 1956, when there was a large influx of birds from the continent. Annual occurrence began in the late 1960s with the formation of the flock along the Avon Valley (Clark & Eyre 1993). This flock peaked in numbers during the mid 1980s during severe cold spells and has since declined markedly to an average of around 70 birds. A notable flock of 67 birds occurred at Abbotsbury during the prolonged cold weather of January-March 1963.

### 2.1.11.3 Nationally important sites

#### i) Avon Valley

Five-year mean 95/96-99/2000: 85

#### *Site conservation status*

SPA (Avon Valley: selection stage 1.1)

Ramsar (Avon Valley: criterion 6)

SSSI (Avon Valley: Bickton to Christchurch)

IBA (Avon Valley: criteria A4i, B1i, B2, C2, C6)

#### *Site description and habitat*

The lower reaches of the River Avon and its floodplain display wide fluctuations in water levels and parts of the valley are regularly flooded during the winter. The valley includes one of the largest expanses of semi-natural floodplain grassland in Britain. The Bewick's Swan flock currently uses the flooded areas between Fordingbridge and Ringwood (SU1510).

#### *Numbers and trends*

As mentioned above, Bewick's Swans began using the Avon Valley in the early 1960s. This group peaked at around 300 birds during the mid 1980s and has since declined to a five-year average of 85 birds. The flock that used to congregate on the floodplains between Christchurch and Ringwood (SZ1499), especially at Ogber and Avon Causeway, has declined to almost nothing in recent winters, mirroring the decline in the Avon flock as a whole

(Fig. 42). Around 50 birds are also regularly recorded in areas above Fordingbridge at Castle Hill (Fig. 43). Peak counts recorded in the Avon Valley increase during the course of the winter, often peaking in March (Fig. 44).

#### *Site use*

The current main feeding area is located between Ibsley and Bickton, and occasionally at Ellingham Meadows within the Somerley Estate (J. Clark pers. comm.). Birds have tended to roost at Blashford Lakes, although following heavy rain they may remain overnight on floodwater in the meadows.

Other sites have been used regularly in the past but, with the massive fall in numbers using the Avon Valley in recent winters, Ibsley is now the most frequently used site. The flock generally feeds on grass leys.

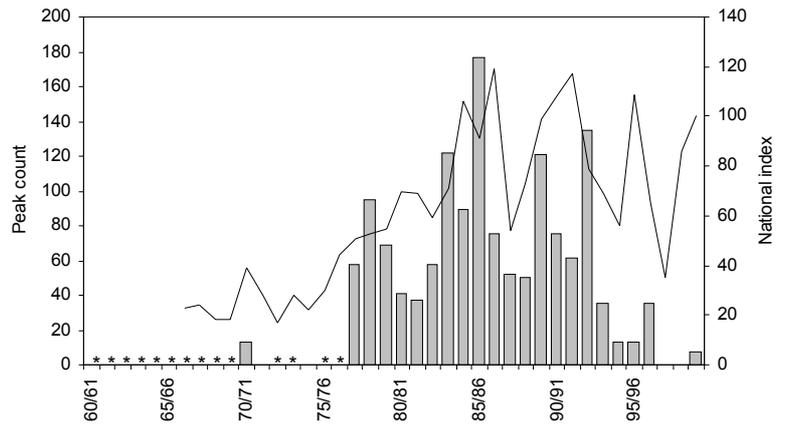
### 2.1.11.4 Other sites

The only flocks of note away from the Avon Valley occur occasionally at Poole Harbour (SY9988) and the wet grasslands on the Frome floodplain between Dorchester and Wareham (SY8786) and comprise 20-100 birds at peak times. For this reason, the Bewick's Swan is listed as an important species within the Frome floodplain IBA.

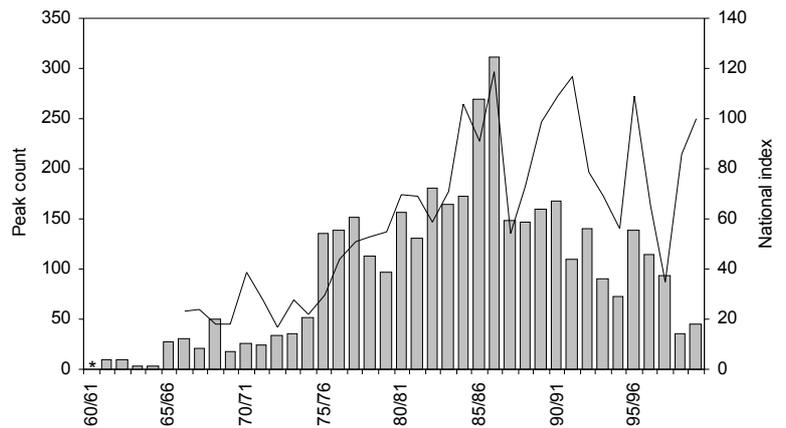
### 2.1.11.5 Key references

Cohen (1963), Predergast & Boys (1983), Clark & Eyre (1993)

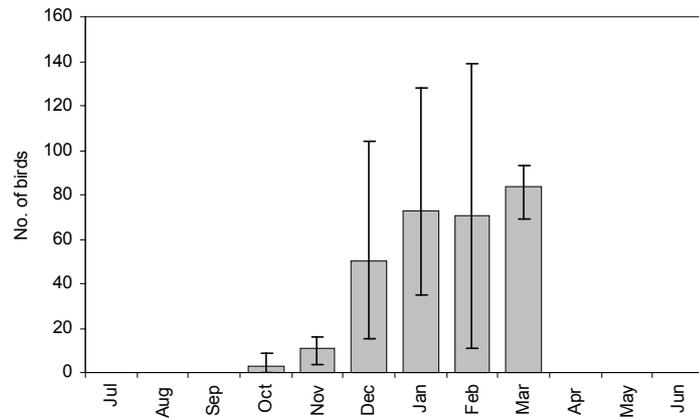
**Figure 42.** Bewick's Swans at the Avon Valley between Ringwood and Christchurch, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



**Figure 43.** Bewick's Swans at the Avon Valley between Fordingbridge and Ringwood, 1960/61-1999/2000: peak counts (bars) and British index (line) (asterisks denote years with no known data)



**Figure 44.** Bewick's Swans at the Avon Valley, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



## 2.2 Northern Ireland

### 2.2.1 Background

In Northern Ireland, the main concentration of Bewick's Swans occurs in and around the Loughs Neagh and Beg. Currently, the area supports around 100 birds at peak periods in late winter, with flocks comprising 20-70 birds recorded regularly around Lough Neagh and Lough Beg itself, and nearby sites at Derryscollop (H8755) and the River Lagan at Flatfield (J1961). Elsewhere in the province, numbers of Bewick's Swans are low. Bewick's Swans are regular at Lough Foyle (Fig. 45) but in recent years peak numbers have barely attained nationally important levels. The species also occurs in small numbers irregularly at Upper Lough Erne (H3231) and a variety of other sites.

### 2.2.2 Historical status

The first Bewick's Swans were recorded in Northern Ireland in 1829 and the species was thought more numerous than the Whooper Swan in Ireland during the 19th century (Thompson 1851). In 1900, the Bewick's Swan was still more numerous than the Whooper Swan in Ireland (Ussher & Warren 1900). However, through the early 1900s, the numbers of Bewick's Swans visiting Ireland declined (Kennedy *et al.* 1954). Marked influxes were recorded during the cold weather events in winters 1953/54 and 1961/62 and 1962/63, doubling the numbers present in Ireland (Merne 1977).

A census of Bewick's Swans in winter 1975/76 indicated that there were around 2,000 birds in Ireland, representing 27% of the Northwest European population at that time (Merne 1977). Since then, the numbers of Bewick's Swans wintering throughout the whole of Ireland have declined markedly; fewer than 500 birds are recorded annually with fewer than 200 in Northern Ireland (Colhoun 2001, Pollitt *et al.* 2003) and only 35 were recorded in the most recent international census in January 2000 (Colhoun *et al.* 2000). This decline is probably related to fewer birds moving west from the continent and the East Anglian fenlands in recent mild winters.

From the early 1990s, numbers have steadily dropped at Lough Foyle in the northwest of the province and resulted in the site dropping from internationally important status since 1994-95. Although large numbers have occurred at sites such as Strangford Lough (133 in 1993/94) and Bohill Fields (104 in 1991/92), the decline has been

accompanied by a contraction in range towards sites around Lough Neagh.

### 2.2.3 Nationally important sites

#### i) Loughs Neagh & Beg

Five-year mean 95/96-99/2000: 69

##### *Site conservation status*

SPA (Lough Neagh and Lough Beg: selection stage 1.1)

Ramsar (Lough Neagh and Lough Beg: criterion 6)

NNR (Lough Neagh-Oxford Island; Lough Beg)

ASSI (Lough Neagh; Lough Neagh-Oxford Island; Lough Beg; Portmore Lough)

IBA (Lough Neagh and Lough Beg: criteria A4i, B1i, B2, C2, C6)

##### *Site description and habitat*

Lough Neagh (JO575) is an extensive waterbody whose shores border five counties (Antrim, Down, Armagh, Tyrone and Londonderry). At 383 km<sup>2</sup>, it is the largest freshwater body in the UK. The majority of the shoreline is exposed and rocky, with less than 25% (29 km of the 125 km shoreline length) comprising sheltered sandy bays. The principal sites used by grazing Bewick's Swans are mostly in the predominantly grassland habitats concentrated along the south and east shores of the Lough. Three established sites are abandoned airfields: Toome (J9990), Kinrush (H9475) and Gartree (J0975).

Sites contributing to the overall Lough Neagh Bewick's Swan totals can be split into eight discrete areas (see below). These areas are primarily used by the more abundant Whooper Swan but are shared by Bewick's Swans, albeit in smaller numbers. A further six sub-sites frequently hold Whooper Swans but rarely hold Bewick's Swans; there have been no records of the latter species at these sites in the 1990s. These sites are described elsewhere yet it is possible that Bewick's Swans occasionally join Whooper Swan flocks in these areas.

Lough Beg is a shallow lake linked to Lough Neagh by a short length of the River Bann, which passes through the lake and exits at Newferry (J9897). The lake itself is surrounded by extensive marsh and surrounding farmland is dominated by grazing pasture.

*Numbers and trends*

Peak counts of Bewick's Swans at Loughs Neagh and Beg have fallen markedly since the early 1990s (Fig. 45) and it is unlikely that numbers will remain above all-Ireland thresholds for national importance in the next few years. As the numbers of individuals present appear to be related to weather conditions in continental Europe, it is likely that the downward trend will continue given that mild winters are becoming more frequent. Bewick's Swans begin to arrive at Loughs Neagh and Beg in the late autumn, with maximum numbers generally recorded in late winter or early spring (Fig. 46).

*Site use*

## 1. Lough Neagh:

*Carlane* (J0086): An area of low-lying grassland approximately 5 km from the nearest established site at Toome. Flocks utilise an area of 5 km<sup>2</sup> extending from Ballynamullan westward to Doss Tree. Birds occasionally use Brockish Bay (H9989) to the north, and adjacent grassland in that area. Small numbers occur here, with a peak count of nine birds in 1997/98.

*Gartree Point* (J0975): An abandoned airfield site on the eastern shore of Lough Neagh. The presence of arable habitats is attractive to swan flocks in the autumn and early winter period. Birds also use the Ardmore area to the north. Public access to the area is restricted. Bewick's Swan occurrences are infrequent, although up to around 40 birds have been recorded in recent years.

*Portmore Lough Complex* (J1169): A number of sites surrounding the key roost site at Portmore Lough RSPB reserve including established feeding areas at Deer Park/Derryola Bridge (J0968), Tunny Cut (J1069), Diamond Lane (J1066) and Ballymacilrany (J1166). The site comprises lowland wet grassland, used primarily by grazing Bewick's Swans in mid winter. This site is amongst the most regularly used around Lough Neagh with 30-40 birds recorded in recent winters.

*Cranagh/Annaghdroghal* (J0863): A wet grassland area centred on a disused canal with numerous drainage ditches. Bewick's Swans occur here irregularly and in small numbers.

*Closet Meadows/Derrymacash* (J0460): This area comprises a mix of arable and grassland habitats in a flat low-lying area surrounding the Closet River. This site is one of the few to hold small numbers in most years; up to 22 have been recorded since 1995/96.

*Bann Meadows/Muckery* (H9861): The Bann Meadows complex comprises an extensive area of wet grassland surrounding the lower reaches of the Upper River Bann. Sub-sites used on a regular basis are Motorway Fields (J0158), Ballynery Bridge (J0258), Bann Meadows (H9961), Muckery (H9861), Derryall Bridge/Greenisland (H9860) and Derrylard (H9662). Few Bewick's Swans have been recorded here in recent years although previous peaks of up to 47 (1993/94) have been recorded.

*Kinrush Airfield/Ardboe* (H9475): Kinrush is a disused airfield site on the western side of Lough Neagh. Flocks use the airfield itself and adjacent grassland sites at Ardboe and Kilmascally House. Bewick's Swans occur here infrequently and in small numbers, although a peak of 58 birds was recorded in 1992/93.

## 2. Lough Beg:

*Toome* (J9990): This area, to the west of Toomebridge, separates Loughs Neagh and Beg and forms one of the most extensive areas of flat low-lying grasslands in the entire Lough Neagh/Beg area. The areas to the north which bound the southern margin of Lough Beg (Creagh and Mullagh) are subject to periodic inundation depending on water levels. The fields to the north and south of the main road (A6) are agriculturally improved and a small area under cultivation sometimes providing stubble and potatoes for feeding Bewick's Swans. Recent intensification has increased the area of available re-seeded pasture for grazing Bewick's Swans. Small numbers of birds occur annually. In influx years, however, large numbers have been recorded, peaking at 90 birds in 1996/97.

## ii) The Foyle/Swilly complex (also Republic of Ireland)

Five-year mean 95/96-99/2000: Lough Foyle 57

*Site conservation status*

SPA (Lough Foyle: selection criteria 1.1; Lough Swilly; Inch Lough)

Ramsar (Lough Foyle: criterion 6)

NNR (Magilligan Point; Roe Estuary)

ASSI (Lough Foyle: Magilligan)

Wildfowl Sanctuary (Blanket Nook)

IBA (Lough Foyle and River Foyle: criteria B2, C6; Lough Swilly including Blanket Nook and Inch Lake: criteria B2)

*Site description and habitat*

Lough Foyle (C5025) is a large, shallow narrow-mouthed estuary on the northern Irish coast, which has shorelines bordering both the Republic of Ireland and Northern Ireland. The most extensive mud and sandflats occur on the southern margin and much of the waterbird interest on the site occurs here or in the adjacent polder areas. Similar to equivalent reclaimed areas bounding parts of Lough Swilly, much of the agricultural land is highly productive and dominated by cereal and potato growing. The entire southern margin of Lough Foyle between the mouths of the River Faughan (C4922) and River Roe (C6429), but especially those areas of reclaimed land, provides rich feeding habitat for grazing Whooper and Bewick's Swans. Lough Foyle provides ample roosting opportunities though preferred roost sites are associated with freshwater entrances of rivers and streams. Bewick's Swans are highly irregular on the western side of the Lough so this account refers exclusively to roosting and feeding areas within Derry.

Lough Swilly is a long, narrow estuarine inlet formed by glacial activity, which runs 50 km north to south and only 4 km wide at its maximum. A mix of estuarine and non-estuarine habitats is present, with the greatest extent of intertidal and shingle habitats in the upper parts of the estuary (around Big Isle C2314) and the Leannan Estuary (C2522). The brackish lakes of Blanket Nook (C3019) and Inch Lough (C3422) contribute to habitat diversity and the ornithological richness of the area. A highly productive mixed-farming landscape dominates the eastern fringe of the Swilly, extending inland to the low-lying 'valley' running south-east from Blanket Nook to the River Foyle at St. Johnstown (see Carrigans valley in River Foyle section). Habitat availability is further enhanced by the extensive areas of polder at Big Isle, Blanket Nook and Inch. These sites in particular provide rich, diverse feeding habitats in close proximity to suitable roosting sites and thus generally hold the bulk of grazing swans (both Whooper and Bewick's) in the Swilly area.

*Numbers and trends*

At Lough Foyle, annual peaks of Bewick's Swans vary widely between years but have shown a progressive decline since the early 1980s (Fig. 47). This decline was first evident in declining peaks recorded for the entire Foyle/Swilly area in and around 1980/81 (Sheppard 1981). A peak of around 470 birds was recorded in winter 1982/83 and has only been matched once in the period since (over 400 in 1989/90). Excluding these exceptional peaks, the long-term average is around 100 birds. This compares to averages for the periods 1974/75-1980/81 and 1981/82-1987/88 of 376

(Sheppard 1981) and 249 (Sheppard in Hutchinson 1989), respectively. Based on counts made since the early 1990s, it seems that numbers of Bewick's Swans will continue to decline at Lough Foyle. Numbers tend to peak during January or February (Fig. 48).

In the Lough Swilly area, around 130 birds were recorded annually during the period 1965/66 to 1980/81 (Sheppard 1981). In some years, over 400 birds were recorded. Although numbers fluctuated, no obvious trend was apparent until the early 1980s when numbers began to decline. In the period for which data are available between the early 1980s and mid 1990s, a peak count exceeding 100 birds was recorded only once. Since 1995/96, numbers of Bewick's Swans have fluctuated markedly at Lough Swilly. Peak counts of 48 birds in 1995/96 and 33 in 1996/97 were exceptional.

*Site use*

## 1. Lough Foyle:

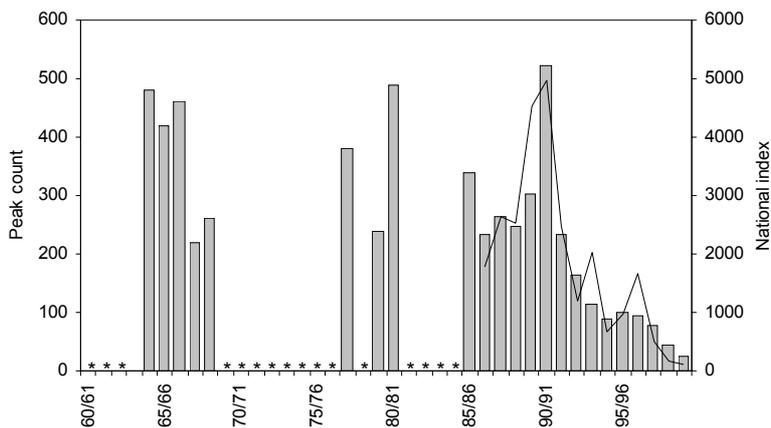
The areas used by grazing swans can be conveniently split into three major sections, defined by roosting and adjacent feeding areas and physical (landscape) features.

*Black Brae/Donnybrewer/Longfield* (C5123): These three polders form a continuous stretch from the western point of land claim on the lough (at the entrance of the River Faughan) to Longfield Bank to the east. Whilst the fields between the sea embankment and the railway line are typically the most frequently used by Bewick's Swans, areas south of the railway at Lower Campsey, Willsborough and Clanterkee are also used. Roost sites occur offshore, especially at Black Brae (C5024) and Longfield Bridge (C5422).

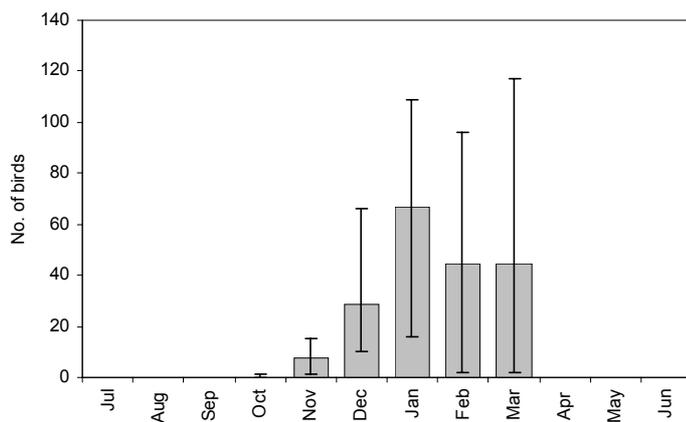
*Longfield Beg/Greysteel/Faughanvale* (C5721): This stretch largely comprises small fields with more grassland than at those areas west and east. Only small numbers of Bewick's Swans use this area. Longfield Beg and the Greysteel Bridge (C5621) areas are the most frequently used.

*Ballykelly/Myroe* (C6325): These two areas of polder, together with Black Brae, are the most intensively farmed on Lough Foyle. Of the two, Ballykelly is the less frequently used by Bewick's Swans. Early ploughing of stubbles at Walworth (C6122) and on the polder itself often reduces feeding opportunities in the autumn.

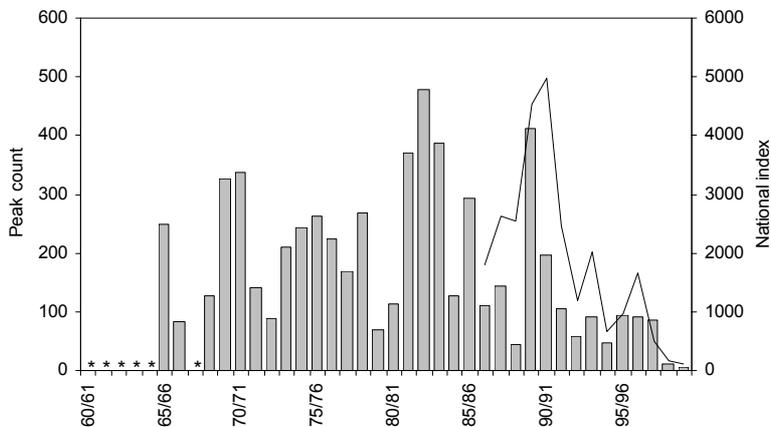
**Figure 45.** Bewick's Swans at Loughs Neagh and Beg, 1960/61-1999/2000: peak counts (bars) and Northern Ireland index (line) (asterisks denote years with no known data)



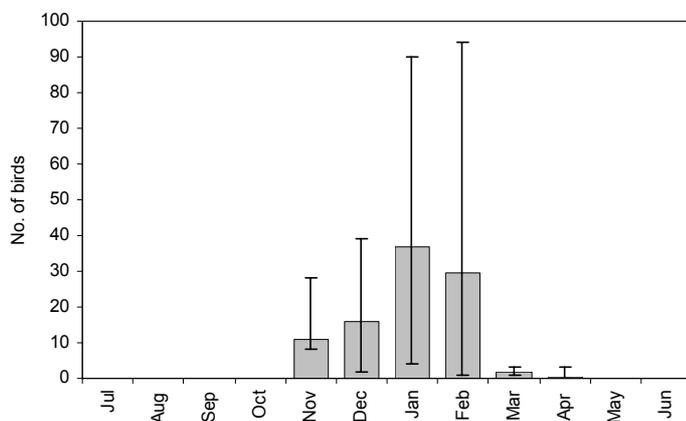
**Figure 46.** Bewick's Swans at Loughs Neagh and Beg, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



**Figure 47.** Bewick's Swans at Lough Foyle, 1960/61-1999/2000: peak counts (bars) and Northern Ireland index (line) (asterisks denote years with no known data)



**Figure 48.** Bewick's Swans at Lough Foyle, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



Myroe is probably the most consistently and intensively used site by Bewick's Swans on Lough Foyle. This arises primarily from the diversity and relative abundance of habitats present, the availability of stubbles and waste potatoes in autumn and mid winter and the fact that the nearby Roe Estuary provides the most suitable roost on Lough Foyle. Although the fields between the railway line and embankment are traditionally the most frequently used, an extensive area inland provides ample feeding opportunities, albeit further away from the major roost site.

*River Foyle* (C3513): The River Foyle forms at the confluence of three rivers at Lifford/Strabane and from there, northward, forms the boundary between Donegal to the west and counties Tyrone and Londonderry on the eastern portion. The land adjacent is predominantly agricultural with a mix of arable, wet meadow and improved grassland. Two contiguous river valleys (Carrigans area and Swilly Burn) adjoin the main river on the Donegal side. These comprise mixed and agriculturally semi-improved grasslands respectively, and are subject to periodic flooding. A flock of Bewick's Swans was recorded from both the Grange (Tyrone) and Carrigan's River (Donegal) sides of the river in January/February 1997.

## 2. Lough Swilly

The distribution of Bewick's Swans in the area is closely related to that of the Whooper Swan and the two species often occur in mixed flocks. The main feeding areas can be split into three discrete sites.

*Big Isle* (C2313): An area of approximately 150 ha polder adjacent to the largest intertidal area in the upper reaches of Lough Swilly. Although agricultural land use is varied, cereal stubbles and potatoes typically predominate and are the major attraction to large flocks. Although the main feeding areas are on the polder itself, birds opportunistically use feeding sites at nearby Plea Isle (C2312), Farsetmore/Trimragh (C2112) and Rossbracken (C2211). Birds roost on the adjacent estuary.

*Blanket Nook* (C3019): A small brackish lake (40 ha), separated from Lough Swilly by a disused railway embankment. An extensive area of 550 ha reclaimed land lies to the south and drains into Blanket Nook. The farmland area comprises a mix of pasture and arable habitats and is attractive to grazing swans. Both species use the lake primarily for roosting or refuge when disturbed and the adjoining farmland for feeding.

*Inch Lough & Levels* (C3422): Like Blanket Nook, a brackish lake created by impoundment with adjoining reclaimed farmland to the south and east, albeit on a much larger scale. Inch Lough (250 ha) is used for roosting with birds flying to the adjoining reclaimed land for feeding. The 'Levels' comprises some 800 ha of prime agricultural land, currently dominated by arable habitats but formerly more varied.

### iii) River Lagan, Flatfield

Five-year mean 95/96-99/2000: 53

#### *Site conservation status*

None

#### *Site description and habitat*

Flatfield (J1860) is a large area of flood meadow on the River Lagan, around 10 km east of the southeast corner of Lough Neagh, adjacent to the M1 motorway. Although geographically isolated from Lough Neagh, Flatfield is linked closely to southern sub-sites (see above, especially Portmore group, Closet Meadows and Bann Meadows) between which movements of Whooper Swans occur frequently. It is likely that Bewick's Swans also move between these areas. It is treated separately from Loughs Neagh & Beg due to the fact that it qualifies as nationally important in its own right, and is not included as part of Lough Neagh co-ordinated WeBS counts.

#### *Numbers and trends*

Around 30-40 Bewick's Swans are recorded in most years (Fig. 49). Peaks counts in excess of 70 birds were recorded in 1993/94 and 1995/96. However, none were recorded in 1998/99 or 1999/2000. Unfortunately, there are too few data to comment on the phenology of site use.

#### *Site use*

This site is generally only used during flood conditions when extensive areas of flooded grassland adjacent to the river forms suitable feeding habitat. Birds use flooded grassland at Flatfield (J1960) and less frequently Balloonigan (J1660). Other areas above the river floodplain are used on occasion.

## 2.2.4 Other sites

Elsewhere in Northern Ireland, the Bewick's Swan is rather uncommon. Fewer than 30 birds are recorded regularly at Upper Lough Erne (H3231). Derryscollop (H8755) comprises floodplain meadows along the River Blackwater (9 km from where it enters the southwest corner of Lough

Neagh) and is only used by Bewick's Swans when inundated. Derryscollop normally attracts large numbers of birds under these conditions, whilst Tullyroan is used irregularly. The recent five-year mean for this site is just 24 birds but higher numbers have occurred in 1992/93 (97 birds) and 1995/96 (43). This site is amongst the most regularly used by Bewick's Swans in Northern Ireland.

At Bothill on the outskirts of the town of Coleraine (Londonderry) (C8734) a maximum recent count of 40 was recorded in January 1997. Across the River Bann from that site, a single count of 33 swans on potatoes near the Bannmouth (C7835) in January 1999 was exceptional for the area.

### 2.2.5 Key references

Thompson (1851), Ussher & Warren (1900), Kennedy *et al.* (1954), Merne (1977), Winfield *et al.* (1989)

## 2.3 Republic of Ireland

### 2.3.1 Background

Bewick's Swans are currently scarce and localised in the Republic of Ireland. The mean of peaks for 1995/96-1999/2000 was just 586 birds and over 1,000 birds were only recorded in two of these years. Most birds (c. 70%) occur in the southeast of the country, in Wexford, and three sites support internationally important numbers. Elsewhere, numbers have declined markedly over recent decades with only four sites regularly holding flocks of around 20 birds. Numbers normally peak at all sites in January and February.

### 2.3.2 Historical status

The status of this species has changed considerably during the last century. In the 19th century, the Bewick's Swan was the most abundant of the two yellow-billed swans in Ireland, with records in Fermanagh, Dublin Bay, Coleraine, the River Shannon near Portnuma, Kilbarry Bog (Waterford), Clones, Wexford Harbour, and Roscommon (Thompson 1851). However, there was no estimation of numbers made at this time. Ussher & Warren (1900), writing 50 years later, indicated that the species was a regular visitor to Connaught and parts of Kerry. Keel Lake, the lakes of The Mullet (Mayo), Lough Conn and Cullin (Mayo), Killala Bay and sections of the Rivers Suck, Shannon and Moy

were all regular haunts during the late 20th century. Lough Gill in Kerry was particularly important at that time, with around 800 birds recorded there in January 1881.

During the early 20th century, Bewick's Swans abandoned many of their traditional areas (e.g. The Mullet), or at least decreased there (e.g. Lough Gill) (Kennedy *et al.* 1954). This downward trend was interrupted only by periodic cold-weather influxes in the 1950s (Merne 1977). By 1954, Whooper Swans outnumbered Bewick's Swans and there may have been an overall decrease in the numbers of the latter species in the Republic of Ireland. In the 1950s, Bewick's Swans were regularly recorded in southern Connaught (mainly counties Mayo, Roscommon, Galway and also Clare) and began to appear in Waterford and Wexford (Kennedy *et al.* 1954).

Influxes of Bewick's Swans in the successive winters of 1961/62 and 1962/63 were sustained at several of the most important sites and were followed by a more general increase from 1970/71. By then, Merne (1977) suggested that numbers may have been double what they were in 1956.

Between the 1970s and 1980s, although numbers remained relatively stable (around 2,300; Sheppard 1993), there was a shift in distribution. Birds moved away from the Connaught sites and were more regularly recorded at sites in the west and some new sites in the south (Cork/Waterford). In addition, sites in Kildare and northern Tipperary were occupied. Through the 1990s, declines have occurred at most of these sites and few regularly hold more than 20 birds annually. Declines have been particularly notable at Rahasane Turlough (Galway), River Suck Callows (Roscommon/Galway), Shannon Callows (Roscommon, Galway, Westmeath, Offaly and Tipperary), Ballingarry/Lismacrorry (North Tipperary), the River Barrow (Kildare), Castleplunket Turloughs (Roscommon), River Suir (Tipperary), Ballycotton (Cork), Corofin and Ballyallia Lakes (Clare) and Southern Roscommon Lakes.

In the southeast, numbers have increased since the early 1970s and the area is currently the most important, numerically, in the Republic of Ireland. Numbers at the principal site, Wexford Slobs, peaked at over 700 in 1975/76. Since then, birds have become more dispersed in the area, with flocks utilising other sites, notably the Cull & Killag, and numbers have declined. A similar decline has been recorded at sites in the northwest since the early 1980s (Sheppard 1981), mirroring the trends seen at the key sites in Northern Ireland.

### 2.3.3 Internationally important sites

#### i) Tacumshin Lake

Five-year mean 94/95-98/99: 235

##### *Site conservation status*

SPA (Tacumshin Lake)

Wildfowl Sanctuary (Tacumshin Lake)

IBA (Tacumshin Lake: criteria B2)

##### *Site description and habitat*

Tacumshin Lake (T0506) is a shallow coastal lagoon in County Wexford that has developed behind a sand bar. The area of the lagoon is 464 ha and was tidal until 1974 when the exit was blocked and a drainage pipe placed through the shingle bar. In the summer, the area of water is reduced to about 100 ha. Up to 1974, a narrow channel at the western end of the sand spit allowed the tide to flow in and out, but was periodically blocked by shifting sand.

##### *Numbers and trends*

This site is one of three internationally important sites in south Wexford, between which movements of birds occur within and between winters.

Historically, this site was used by smaller numbers than either of the other two; around 150-200 birds were regularly recorded between 1965/66 and 1980/81 (Fig. 50). Up to 470 birds were recorded in the mid 1980s and late 1990s and the most recent series of counts indicate that numbers are now higher than at the Wexford Slobbs and The Cull & Killag. There is little doubt, however, that the numbers at each of these sites are closely related.

##### *Site use*

Bewick's Swans feed in grasslands on the east side of the lake at Ballymurry (T0605) (A. Walsh pers. comm.).

#### ii) The Cull & Killag

Five-year mean 94/95-98/99: 195

##### *Site conservation status*

SPA (Ballyteigue Burrow)

IBA (The Cull/Killag: qualifying criteria A4i, B1i, B2, C2)

##### *Site description and habitat*

The Cull & Killag (S9307) is situated several kilometres west of Kilmore Quay on the south Wexford coast. This site comprises two main parts. The Cull (S9107) is a long narrow estuary and inlet, protected from the sea by a shingle spit and dunes. The eastern part (Killag; S9506) was reclaimed

during the last century and comprises intensively-managed agricultural land.

##### *Numbers and trends*

This site became important for Bewick's Swans when the Wexford Slobbs flock redistributed in the late 1970s. Prior to that, only small numbers were recorded (Fig. 51). Numbers increased in the winters of 1975/96 and 1976/77 when over 200 birds were recorded. Similar numbers were present at times throughout the 1980s and early 1990s, but numbers have been particularly low in the late 1990s. This decline appears to have occurred as numbers have increased at the Wexford Slobbs and declined in Wexford as a whole.

##### *Site use*

The birds feed primarily on the farmland at Killag/Newtown (S9507/S9506), using the Cull as a roost. Birds were recorded feeding on sugar beet tops in winter 1989/90 (J. Bowler pers. comm.).

#### iii) Wexford Harbour & Slobbs

Five-year mean 94/95-98/99: 191

##### *Site conservation status*

SPA (The Raven; Wexford Wildfowl Reserve; Wexford Harbour)

Ramsar (The Raven; Wexford Wildfowl Reserve)

Wildfowl Sanctuary (Rosslare Point)

IBA (Wexford Harbour and Slobbs: non-listed species)

##### *Site description and habitat*

Wexford Harbour and Slobbs (T0020) is located in a shallow estuary at the mouth of the Slaney River in County Wexford. The site includes extensive areas of intertidal mudflat and sandflats which are protected by Raven and Rosslare Points and behind which lie the north and south 'slobbs'. The slobbs are flat areas of predominantly arable and pasture farmland, empoldered by sea walls.

##### *Numbers and trends*

Although numbers are lower than the peaks of around 450-550 which occurred in the late 1970s, a flock of around 100-250 Bewick's Swans has been regularly recorded at Wexford Harbour & Slobbs during the late 1990s (Fig. 52).

##### *Site use*

Although both the North (T0924) and South Slobbs (T0717) are utilised, the vast proportion of feeding Bewick's Swans occur on the North Slob (A. Walsh pers. comm.). These birds roost on the enclosed tidal river, part of which lies within the Wildfowl Reserve, and sometimes in Wexford Harbour. Birds feed

primarily on sugar beet and grasslands, the latter being managed specifically for geese and swans since the mid 1980s.

### 2.3.4 Nationally important sites

#### i) The Foyle/Swilly Complex

(see Northern Ireland)

### 2.3.5 Other sites

The Lough Coy complex (M4907) comprises two areas northeast of Coole Lough in south Galway (M4204). The complex comprises a mix of turlough and dry grassland habitats, which provide variable roost and feeding resources depending primarily on water-table levels. The nearby Coole Lough-Newton Turlough area forms a continuation further south and the entire area is frequently used by grazing Whooper Swans and, on average, 40 Bewick's Swans. Around 50 birds have also been recorded at the nearby Castleboy Grassland (M5111).

The composite coastal system of Ballycotton, Ballynamona and Shanagarry (W9865), along the coast of eastern Cork, comprises a mix of brackish and freshwater lagoons, marsh, mudflats, sandflats, dunes and wet meadows. The main lagoon was formed following the build-up of shingle in the 1930s, which separated this former inlet from the sea. This was periodically breached until 1991 and has returned to its former state since then.

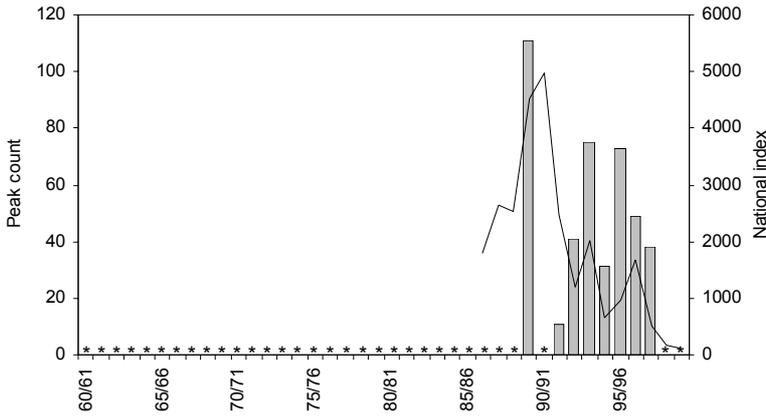
Numbers at this site peaked in the 1980s when, although annual peaks fluctuated widely, flocks in excess of 100 birds were recorded in several years. Prior to that, fewer than 20 birds were recorded regularly at the site and numbers have fallen to around 50 birds since the early 1990s. No birds have been recorded in three of the last six years despite intensive counting at this site. Cloyne (W9267) also supports up to around 50 birds at peak times.

The Curragh (S3678) lies on the floodplain of the Rivers Goul and Erkina west of Durrow (S4077) in county Laois. It is an area of marsh surrounded by agriculturally improved grassland in an area with little wetland habitat. Bewick's Swans graze the fields adjacent to the Erkina River 4-5 km west of Durrow at The Curragh (S3678). Given the small number of wetlands in the area, it appears likely that Grantstown Lake (S3380) and Ballycolla (S3881) are used for roosting as both are within a 3 km radius of the major feeding areas.

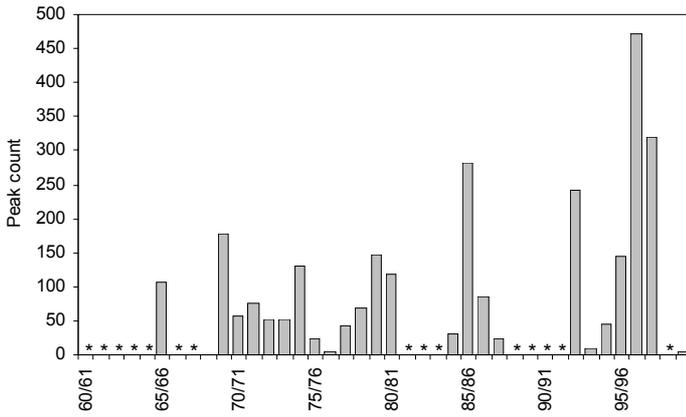
Although this area was counted during the 1980s and early 1990s, the first available count of Bewick's Swans refers to 42 birds in January 1996 (unidentified yellow-billed swans were recorded the previous year). This number has not since been matched yet Bewick's Swans have been recorded in all years since, albeit in smaller numbers.

### 2.3.6 Key references

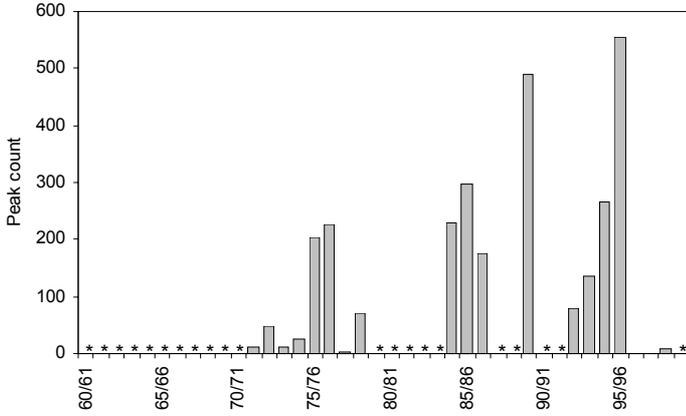
Thompson (1851), Ussher & Warren (1900), Kennedy *et al.* (1954), Merne (1977), Sheppard (1981, 1993), Hutchinson (1989), Colhoun (1998)



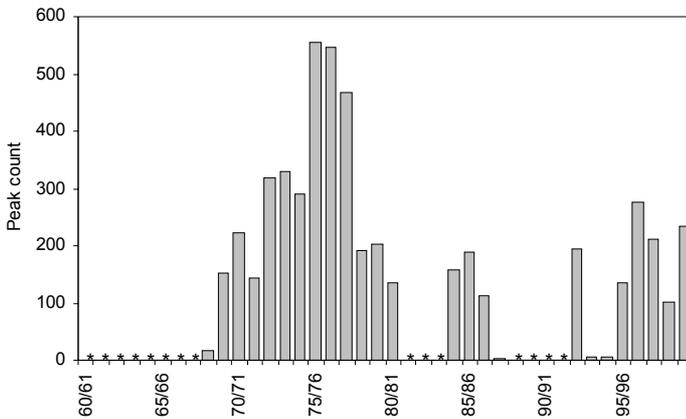
**Figure 49.** Bewick's Swans at the River Lagan, Flatfield, 1960/61-1999/2000: peak counts (bars) and Northern Ireland index (line) (asterisks denote years with no known data)



**Figure 50.** Bewick's Swans at Tacumshin Lake, 1960/61-1999/2000: peak counts (bars) (asterisks denote years with no known data)



**Figure 51.** Bewick's Swans at The Cull & Killag, 1960/61-1999/2000: peak counts (bars) (asterisks denote years with no known data)



**Figure 52.** Bewick's Swans at Wexford Harbour & Slobs, 1960/61-1999/2000: peak counts (bars) (asterisks denote years with no known data)

### 3 FUTURE RESEARCH NEEDS

Although much is known about the ecology and population dynamics of the Northwest European population of Bewick's Swans, it is clear that there are many questions that still need to be answered to ensure this population is sustainable. Future research should, in part, be aimed at underpinning a Flyway Management Plan for this population.

For example, although there are many demographic data available, we still do not have the ability to predict the effects of future conservation threats, such as climate change and habitat loss, on population trends and distribution. There is a need to develop population models, which can predict the impacts of novel circumstances. Studies of the effects of density-dependence, resource depletion dynamics and state-dependent behaviour will be required to develop these models. Given that the

numbers of Bewick's Swans have declined at some sites as numbers of Whooper Swans have increased, interspecific competition may be responsible for changes in distribution and requires further attention.

In light of continued changes to agricultural land use throughout Britain and Ireland, it is important to monitor variation in the distribution of feeding areas at key sites. In general, the agricultural feeding areas used by Bewick's Swans are not protected under any national legislation and therefore benefit only from wider countryside measures, e.g. stewardship schemes. Effective monitoring will be required to identify key feeding areas on agricultural land so that agri-environmental schemes can be designed to conserve Bewick's Swans in agricultural areas.

## 4 ACKNOWLEDGEMENTS

This review of monitoring information would not have been possible without the efforts of dedicated volunteer and professional ornithologists who monitor and research Bewick's Swans throughout their range. We are extremely grateful for their efforts and strongly encourage them to continue their valuable work into the future. We also wish to thank Helen Baker, David Stroud, Mark Pollitt, Colette Hall, Jenny Earle, Sue Carman, Paul Marshall, Stuart Pegler and Peter Cranswick for their

assistance during the production of this review and John Bowler who reviewed an earlier draft.

The authors have made every effort to include all known data in this review. Given, however, that a number of unpublished reports and databases may have been overlooked, we urge readers to submit new and additional data to the authors, especially where there are apparent gaps in our data-sets.

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