Northwest European Bewick's Swans: a population in decline

Eileen C. Rees and Jan H. Beekman

Abstract Whereas most European swan and goose population trends are currently stable or increasing, the northwest European Bewick's Swan *Cygnus columbianus bewickii* population is of conservation concern because its numbers are in decline. Bewick's Swan numbers rose during the 1960s–1990s, but a co-ordinated international census in January 2005 recorded a total of c. 21,500 birds, a 27% decrease on the peak count of 29,277 in January 1995. National trends indicate that numbers have continued to decline since then. A Bewick's Swan action planning workshop in St Petersburg in September 2009 attempted to identify major threats to the birds and to develop the monitoring, research and conservation work required to halt and reverse the population decline. It was evident that no single issue could explain the decline in numbers since the mid 1990s, and that the combination of factors (including weather and habitat changes) affecting the swans' survival and productivity should be examined further. A Single Species Action Plan, which is now in draft, is due to be finalised and sent for government consultation by the end of 2010, in preparation for adoption at the African-Eurasian Waterbird Agreement (AEWA) Technical Committee in March 2011 and implementation thereafter.

Introduction

Of the three species of wild swan that occur in Britain, the Bewick's Swan *Cygnus columbianus bewickii* is perhaps the least familiar to many British birdwatchers. The Mute Swan *C. olor* is not only resident throughout the year but has a widespread distribution, frequenting a variety of wetland habitats ranging from slow-flowing rivers to lakes, ponds and estuaries, and is also found in urban areas (Rowell & Spray 2004). The migratory Whooper Swan *C. cygnus* occurs across much of Scotland and Ireland, where it can be found in small groups or large flocks in freshwater habitats and on agricultural land (Robinson *et al.* 2004; Worden *et al.* 2009). Bewick's Swans have a more localised distribution, being found mainly in southeast England (notably on the Ouse Washes and the Nene Washes), but also in southwest and northwest England, and feed mainly on arable crops and pasture (Worden *et al.* 2006). Numbers of all three species increased in Britain during the second half of the twentieth century, with the recovery of the Mute Swan population being attributed in part to a reduction in the incidence of lead poisoning following the ban on the sale of lead fishing weights in 1987, and also to increased survival and productivity of the species owing to mild winters in recent years (Kirby *et al.* 1994; Rowell & Spray 2004). Increasing

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population trends were also noted for many European goose species at this time and this, like the increasing numbers of Whooper and Bewick's Swans, has been attributed both to the birds' use of improved agricultural areas (notably arable crops and fertilised pastures; van Eerden *et al.* 1996, Madsen *et al.* 1999, Fox *et al.* 2005), and to reduced mortality rates due to bans on hunting throughout Europe (Ebbinge 1991). Additionally, a reduction in sewage spills and in the use of agricultural fertilisers has improved water quality, benefiting the growth of submerged aquatic vegetation in shallow lakes and bays. Swans in particular are strongly dependent on submerged vegetation for parts of the year (see Brouwer & Tinbergen 1939, Beekman *et al.* 1991).

However, while other goose and swan populations have either stabilised or continued to increase in recent years, the northwest European Bewick's Swan population is now in decline (see below), raising concern among conservationists and the wider public across the birds' migratory range. There is particular concern that, as a large Arctic breeding bird with a narrow time window for breeding and raising offspring, the Bewick's Swan may be an early indicator of how climate change influences population trends in other long-distance migrants, because the consequences of climate change (e.g. short-term weather variability) are predicted to be more pronounced and to occur more rapidly at high latitudes (Watson *et al.* 1998; Anisimov *et al.* 2007). The Dark-bellied Brent Goose *Branta b. bernicla*, also a high-Arctic breeder, has shown a similar recent decline in numbers. This paper reviews the Bewick's Swans' migration and ecology, provides an update of recent population trends and considers threats (known and potential) for the species. Plans being put in place to address the population decline are also described.

Species and populations

The Bewick's Swan and its conspecific, the Whistling Swan *C. c. columbianus* (which is native to North America), both breed at high latitudes and together have a pan-Arctic breeding distribution. Bewick's Swans nest on Russian tundras from Cheshskaya Bay, Arkhangelsk, to Chaun Bay, Chukotka, whereas the Whistling Swan breeds in Alaska and Arctic Canada, with small numbers also occurring in far eastern Siberia where it may interbreed with Bewick's (Evans & Sladen 1980; Syroechkovski 2002). The two subspecies of *Cygnus columbianus* are known collectively as Tundra Swan (as suggested by Palmer 1976) and this name has commonly been used for the Whistling Swan in North America since the 1980s. There have been increasing moves towards referring to Bewick's Swans as Tundra Swans in recent years (e.g. following the BOU recommendation that Bewick's and Whistling Swans be treated as a single species; Sangster *et al.* 2004), but this can cause confusion when referring to the swans' distribution in east Asia where both races occur.

Markus Varesvuo

352. A small group of Bewick's Swans *Cygnus columbianus bewickii* in Estonia, on their way north back to their breeding grounds, April 2004.

Three Bewick's Swan populations are recognised globally, and these follow very different migratory flyways (fig. 1). The northwest European population, estimated to number 21,500 birds in January 2005, breeds on the open maritime tundras of European Arctic Russia. This population migrates west along the Arctic coast of Russia, then southwest over Karelia and along the Baltic coast, to winter in western Europe. Staging areas in the Baltic countries are used for several weeks for refuelling in both autumn and spring; the White Sea is also an important site during spring migration, when most of the swans feed there prior to the breeding season (Beekman *et al.* 2002). The availability of high-quality food sources (particularly pondweeds *Potamogeton*) at the White Sea is considered crucial, not only for completing spring migration but also for laying down resources for egg production (Nolet & Drent 1998).

The majority (>90%) of Bewick's Swans in the northwest European population spend the winter in the Netherlands, Britain and Germany but several hundred birds winter in Denmark and Belgium, with smaller numbers in France and Ireland. Numbers wintering in Ireland have diminished substantially in recent years (see below), which may in part be attributed to the swans having a more easterly distribution in warmer winters.

Much less is known about the Caspian/west Siberian population, which numbers some 1,000 birds wintering on the Caspian Sea. The Caspian-wintering swans are thought to breed in the Arctic reaches of western Siberia, and may include birds nesting on the Yamal and the Gydan Peninsulas, though this is not known for certain. In particular, whether there is any overlap in breeding distribution with swans from the northwest European population (to the west) or the eastern population (to the east) is unclear. Information on the migration route is also patchy, but observations suggest that the swans follow the Ob River and the eastern slopes of the Ural Mountains to Kazakhstan before heading west to the Caspian wintering grounds (Syroechkovski 2002).

Resightings in China of swans fitted with neck-collars in the Lena Delta, in the far north of Siberia, indicate that Bewick's Swans breeding on and to the east of the Lena Delta are from the eastern population, which winters in China, Japan and Korea (Bird Ringing Centre of Russia pers. comm.). Information on population size and trends in

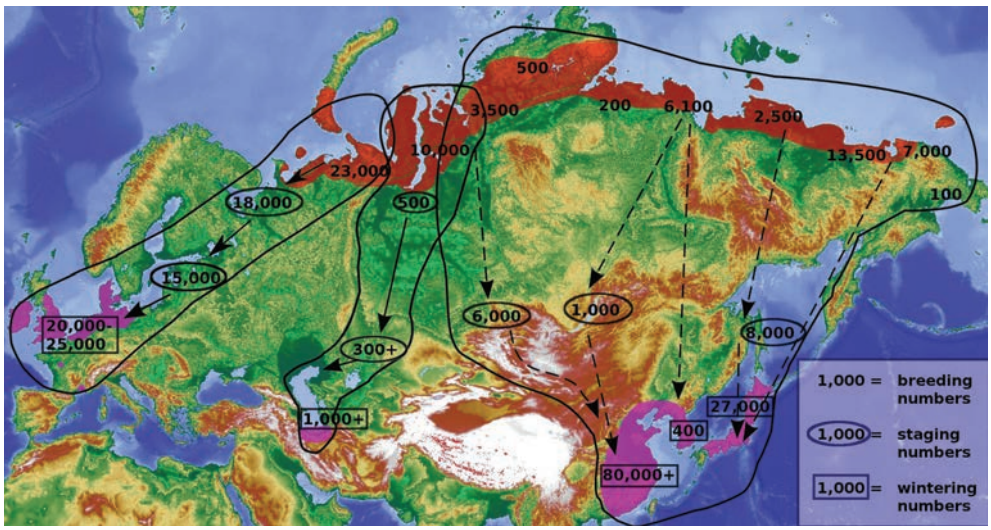

Fig. 1. Distribution of the three Bewick's Swan *Cygnus columbianus bewickii* populations (derived from Syroechkovski 2002 and Bowler 2005), described in the text as the northwest European, Caspian/west Siberian and eastern populations. Breeding areas are in red, wintering areas in purple, and migration routes indicated by arrows. Note that the boundaries of the three populations' breeding distributions are not known, and whether or not birds from different wintering sites coincide on the breeding grounds has yet to be determined.

Eileen Rees

353. Part of a flock of 15,000 Bewick's Swans *Cygnus columbianus bewickii* counted at Fengsha Lake, China, in February 2008, here seen roosting with Swan Geese *Anser cygnoides* and Ruddy Shelducks *Tadorna ferruginea* in the foreground (count data included in Cong *et al.* in prep.).

numbers for the eastern population was unclear during the twentieth century. Although midwinter counts showed that numbers in Japan increased from the 1980s onwards, there was very little information on the status of the species within China and relatively few (<100) birds now winter in the Republic of Korea (Moores 2005). The total population was estimated at 40,000 birds by the end of the 1990s (Miyabayashi & Mundkur 1999), of which nearly 30,000 were in Japan (Albertsen & Kanazawa 2002). More recently, however, counts of Bewick's Swans wintering in the Yangtze River floodplain in China during surveys co-ordinated by Mark Barter and Cao Lei in 2004 and 2005, as part of a WWF-China waterbird monitoring programme (Barter *et al.* 2004), has resulted in a substantial increase in population estimates for the eastern population. A total of 65,114 Bewick's Swans were counted in February 2005 (Barter *et al.* 2006), and the eastern population is now put at 92,000 birds (Wetlands International 2006). Although surveys within China have been less extensive since 2005, continued annual counts of lakes in the Yangtze River floodplain suggest that 65,000–123,000 Bewick's Swans winter in the region (Cong *et al.* in prep.; plate 353). Population estimates for the eastern population may therefore be revised upwards when next reviewed.

Bewick's Swan life-cycle: an overview

Bewick's Swan research undertaken by Wildfowl & Wetlands Trust (WWT) since the 1960s and by Dutch scientists since the 1980s has provided many insights into behaviour, ecology and migration strategies along the Northwest European flyway (full review in Rees 2006). The swans have high annual survival rates (initial analyses indicate >80% adult survival from one year to the next; Scott 1988) and are long-lived, with eight individuals known to have reached at least 25 years of age. It was found at an early stage that the swans are almost entirely monogamous; only three cases of 'divorce' have been recorded in >40 years of studying the species (Rees 2006). Whooper Swans and Mute Swans, in contrast, do occasionally switch mates. They may also pair for the first time at one year old, whereas Bewick's Swans do not pair until at least two years old (Evans 1979). These differences between the species have been ascribed to differing constraints on the swans' migratory and breeding cycles. British Mute Swans are largely sedentary and Whooper Swans have a much shorter (800-km) migration than Bewick's Swans to their breeding grounds in Iceland, where part of the population (up to 1,500 birds) overwinters (Worden *et al.* 2009). Bewick's Swans, on the other hand, are wholly migratory; the birds must breed, moult and embark on their 3,000–4,000-km migration to the wintering grounds in the four months that the tundra is habitable (late May to late September). Long-term pair bonds are therefore considered to be particularly advantageous for Bewick's Swans, since the swans have little time for courtship or pair formation on arrival on the breeding grounds. Pair formation occurs mainly in the non-breeding flocks during the summer months and has not been observed in the wintering range (Rees *et al.* 1996). Individual-based studies

have shown that the likelihood of a pair being observed with cygnets in the wintering range increases with the duration of the pair bond (Rees *et al.* 1996). Moreover, although the marked annual variation in the population's breeding success is associated with weather conditions in the Russian Arctic (Poorter 1991), pair duration remains an important determinant of an individual's breeding success (Rees *et al.* 1996).

Resightings of colour-ringed birds and (particularly) satellite-tracking individual birds on migration has shown that the northwest European Bewick's Swan population uses just two or three main staging areas for resting and refuelling during the journey between the breeding range and wintering grounds (Beekman *et al.* 2002). The maximum flight distance that Bewick's Swans can cover without refuelling has been estimated at 2,000 km, so the swans need at least one stopover site for putting on the fat (energy) required to complete each journey. Northern Germany and northern Denmark provide important departure and landfall sites within the wintering range; farther north, the two key staging areas are in the Baltic region (used in both spring and autumn) and in the White Sea (used only in spring), while a large pre-migratory gathering (5,000–15,000 birds) is found on the Pechora Delta in autumn (Rees *et al.* 1997; Beekman *et al.* 2002). The fact that the swans do not stop off at the White Sea staging area in autumn (individual birds have been recorded migrating from the Pechora Delta to Estonia in just 48 hours; Rees 2006) has the coincidental benefit of ensuring that aquatic macrophytes in the region (which constitute such important pre-breeding food for the swans) are not depleted just before the dormant winter period (Beekman *et al.* 2002).

Bewick's Swans traditionally fed on submerged vegetation in aquatic habitats in their European wintering range, but major landscape changes during the twentieth century precipitated a change in the swans' diet. In particular, drainage of wetlands and intensification of agriculture in the second half of the century, with farmers increasingly fertilising grasslands and planting arable crops, saw the swans move from feeding primarily on pondweeds (notably *Potamogeton pectinatus* and *P. perfoliatus*), stoneworts (*Chara* spp.) and eelgrass (*Zostera* spp.) to a greater use of improved pasture and, from the 1970s onwards, utilisation of harvest waste (stubbles, potatoes, sugar beet) and winter cereals. The loss of wetland sites and the deterioration of water quality through eutrophication led to a lack of traditional aquatic food sources for the birds. This negative development has been reversed in the Netherlands in recent years, and pondweed and stonewort vegetation has returned, but disturbance of swan flocks by (kite) surfers is now a major problem at these sites. Meanwhile, although the more numerous eastern Bewick's Swan population continues to feed mainly on submerged vegetation (particularly *Vallisneria* tubers) in its stronghold in the Yangtze River floodplain, here too there are concerns that changes in water quality and lake hydrology following the construction of the Three Gorges Dam may be affecting the swans' food supply and thus the future viability of this population (Cong *et al.* in prep.).

Nick Cottrell/WWT

354. Bewick's Swans *Cygnus columbianus bewickii* on their wintering grounds, in the Rushy Pen at WWT Slimbridge, Gloucestershire, December 2007.

National and international trends for the northwest European population

A key tool for assessing the conservation status of a population is the regular assessment of its numbers and distribution. Trends in the numbers of Bewick's Swans wintering in the UK are monitored annually as part of the Wetland Bird Survey (WeBS), with mid-monthly counts being made at key sites during October–March inclusive. Similar mid-monthly counts of key sites are conducted in other European countries, for example the Netherlands. The mid-January counts for the UK and for other countries across Europe are included in the International Waterbird Census (IWC), co-ordinated by Wetlands International, which determines trends for the population as a whole. Since the mid 1980s, the IWC has been augmented by co-ordinated International Swan Censuses (ISC), made at five-yearly intervals, which aim to achieve improved coverage and to count (nearly) all birds in the population, to determine the total population size and to verify the trend data (Beekman 1997).

Both international monitoring programmes have described substantial changes in the northwest European Bewick's Swan population over the years, and the patterns are similar irrespective of the methods used. Population size increased from an estimated 9,000–10,000 birds in the mid 1970s to around 16,000 birds in the mid 1980s (Beekman *et al.* 1985; Dirksen & Beekman 1991), 26,000 birds in January 1990, and a peak of 29,277 birds during the ISC counts in January 1995 (Beekman 1997). Numbers then declined, with 23,500 swans counted in the January 2000 ISC and 21,500 in January 2005 (fig. 2). This represented a decrease of 27% over the decade. Counts made in Britain & Ireland for the ISC in January 2005 found a c. 5% decrease in comparison with the January 2000 census, with the drop in numbers being most evident in Ireland and western parts of Britain (Worden *et al.* 2006). That the decline wasn't more marked in the UK can to some extent be attributed to numbers on the Ouse Washes holding up relatively well in the early twenty-first century, with a peak count of 7,491 recorded at the site in winter 2004/05. However, numbers there have also diminished annually during the period 2005/06–2007/08 inclusive (Holt *et al.* 2009). In the Netherlands, the decline was much more pronounced: in 2005 the numbers were less than half those counted in 1995 (SOVON data). Numbers wintering in Germany have increased in the past two decades, probably as a result of mild – and especially wet – winters, but the increase there falls way short of matching the decline in countries farther west, such as the Netherlands, Britain and Ireland.

Although counts during the most recent ISC (conducted in January 2010) are still being collated, national trends and IWC trends indicate that the population has continued to decline from 2005. Trends in WeBS data show a worrying 46% decrease in numbers wintering in the UK between 1996/97 and 2008/09 (Calbrade *et al.* 2010; fig. 3), which may be due both to a shift in winter distribution (with fewer swans reaching western sites in recent milder winters) and to a genuine reduction in population size. The

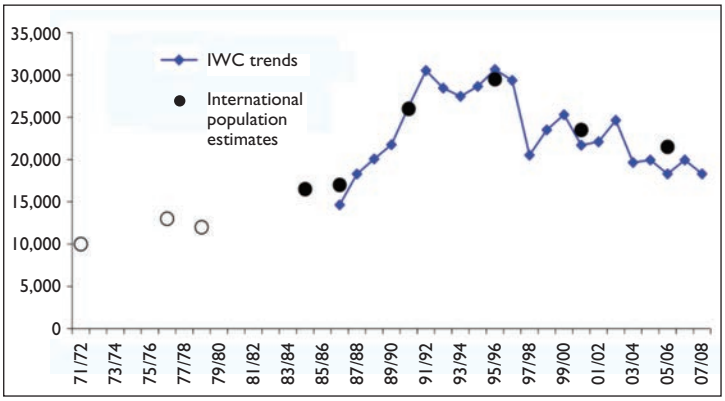

Fig. 2. Total population estimates for the northwest European Bewick's Swan *Cygnus columbianus bewickii* population since 1971/72 (open circles = Wetlands International estimates; filled circles = co-ordinated International Swan Censuses; Beekman 1997, Beekman *et al.* unpubl. data) and annual trends in numbers from 1986/87 to 2007/08 (IWC trends; Wetlands International unpubl. data).

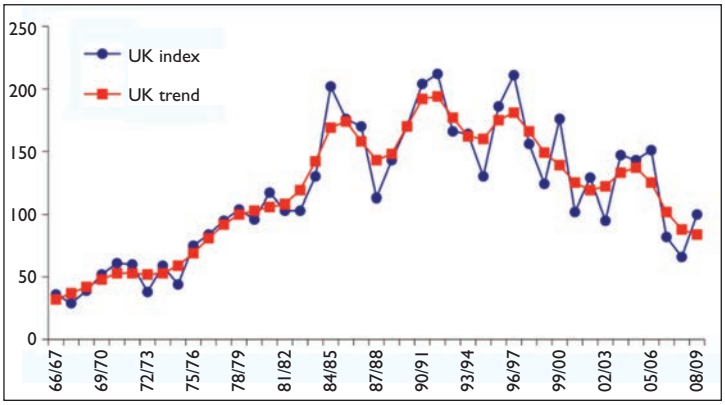

Fig. 3. Trends in the numbers of Bewick's Swans *Cygnus columbianus bewickii* wintering in the UK, 1966/67–2008/09 (WeBS data; Calbrade *et al.* 2010) (UK index = 100 in winter 2008/09, UK trend = 100 in winter 1978/79).

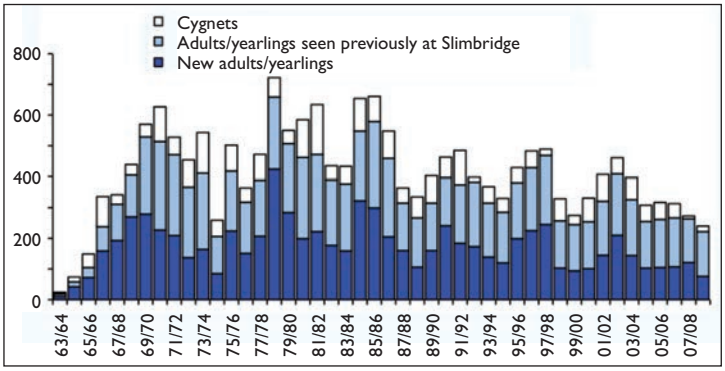

Fig. 4. Number of new/returning Bewick's Swans *Cygnus columbianus bewickii* (adults and yearlings) recorded in winter at WWT Slimbridge, Gloucestershire. The number of cygnets (all new to the site) is included to illustrate annual variation in breeding success.

former is evident in a drop in the proportion of new individuals reaching western sites such as WWT Slimbridge, Gloucestershire, in recent years. On average, 47–48% of birds identified each winter in the 1970s–1990s were new, compared with 42% in the 2000s (fig. 4), the latter after several exceptionally poor breeding seasons (<8% cygnets) from the mid 1990s onwards. The Irish Wetland Bird Survey (I-WeBS) and SOVON reports in the Netherlands also found a worrying post-2005 decline in Bewick's Swan numbers (Koffijberg *et al.* in press). Although the IWC data do not show a marked decline between January 2005 and January 2008 (fig. 3), there is no sign of a recovery in numbers across Europe, with indices for January 2008 being the lowest for 20 years. The ISC census conducted in January 2010 coincided with severe winter weather across Europe, which almost certainly caused the swans to move westward into their traditional winter haunts. This new population estimate will therefore have the advantage of not being influenced by uncertainties, such as an eastward shift in the swans' distribution into less well-covered regions.

Bewick's Swan action planning workshop

Given the increasing concern for the north-west European population, a Bewick's Swan action planning workshop was held on 25th–28th September 2009 to address the issue. The workshop drew together 30 experts on Bewick's Swans from throughout the birds' range to pool knowledge and data, to identify the key threats to the birds and to develop the monitoring, research and conservation work required to improve the conservation status of the species. The workshop was organised jointly by Wetlands International, the Wetlands International/IUCN-Species Survival Commission Swan Specialist Group and the WWT, and was hosted by Lenoble Priroda in St Petersburg.

During the course of the meeting it became evident that there was no single issue that could explain the decline in numbers since the mid 1990s, and that the combination of factors (including weather and habitat changes) affecting the swans' survival and productivity (i.e. the demographic variables underlying trends in numbers) should be examined in more detail. It was shown, for example, that overall breeding success, recorded throughout the wintering range in

late autumn, reached an average of just 8% cygnets over the past two decades, which is clearly insufficient to make up for annual adult mortality rates estimated at 10–15% (Beekman unpubl. data). While individual swans do occasionally switch migratory flyways (e.g. three Bewick's Swans ringed in Britain have been recovered along the Caspian flyway; Rees 2006), it was considered unlikely to have occurred at a sufficiently large scale to account for the diminishing numbers because Bewick's Swans (particularly adult birds) generally show a high level of site fidelity in the wintering range (Rees 1987).

A review of the sites of international importance for the species, undertaken by national delegates at the workshop, found that most of the main wintering sites in western Europe and staging areas in the Baltic countries are legally protected under the EU Birds Directive (as Special Protection Areas). Many are also classed as Ramsar Sites. However, management plans for these Natura 2000 areas are only just being developed and it is unclear whether or not the plans include specific measures aimed at improving water management, increasing aquatic food stocks and carrying capacity, and halting human disturbance, especially at crucial stopover sites during the Bewick's Swans' migration. Sites within Russia are also protected as federal or regional reserves under Russian legislation, but it was noted that the swans are particularly vulnerable to changes at the key spring staging site on the White Sea. It was agreed that the conservation of the species depends on the management of all sites used by the birds throughout their migratory range, including about a dozen key staging sites that require improvement in their management programmes and to have their protection status maintained.

Threats: known and potential

Although the combination of factors causing the northwest European Bewick's Swan population decline has yet to be confirmed, several threats to the swans' survival and breeding success have been identified. For instance, the breeding success for the population is strongly influenced by weather conditions in the breeding range (Poorter 1991), with initial analyses suggesting that the combination of a warm spring followed by a return to freezing conditions during the incubation period is associated with breeding failure (Syroechkovsky *et al.* 2002). Annual variation in the onset of freezing conditions in autumn and early winter is also likely to affect cygnet survival but this has not been studied in detail. Similarly, little is known regarding the effects of predator abundance in the breeding range on Bewick's Swan breeding success. Predator–prey cycles are closely linked with goose and wader breeding success in the Russian Arctic, with these birds reproducing particularly well in peak lemming *Lemmus* years, when the lemmings provide a good food source for Arctic Foxes *Vulpes lagopus* (Summers *et al.* 1998).

Several known causes of Bewick's Swan mortality, such as illegal hunting, lead poisoning and collisions with power lines, are still extant but their influence is thought to be either stable or declining. Collectively, these do not seem to be the only reason for the population decline over the past 15 years.

David Tipling

355. Bewick's Swans *Cygnus columbianus bewickii*, WWT Slimbridge, Gloucestershire, March 2010.

David Tipling

356. Bewick's Swans *Cygnus columbianus bewickii*, WWT Slimbridge, Gloucestershire, February 2009.

Illegal hunting is still very high for a species protected throughout its migratory range, but the 22.7% of birds with pellets in their body tissues (determined by X-raying swans caught at Slimbridge) in the 2000s is lower than the 34.1% recorded in the 1970s and 38.8% in the 1980s (Newth *et al.* in prep.). Construction of wind turbines along the migration route is a relatively recent phenomenon, and although windfarms may be problematic if sited inappropriately, there is little evidence to date for Bewick's Swans colliding with turbines.

Since the relatively large Whooper Swans dominate the smaller and lighter Bewick's Swans at sites where both species occur (Black & Rees 1984), Whoopers may displace Bewick's from feeding areas in winter and from nest-sites in summer, particularly if a longer breeding season enables Whooper Swans to breed successfully at high latitudes. So far there is no conclusive evidence for competition between the two species having a significant effect on Bewick's Swans: an assessment of the swans' wintering distribution in the UK in the mid 1990s found that the two species co-existed happily enough, with numbers increasing at some sites simultaneously (Rees *et al.* 1997; Rees & Bowler 1996); while, although the density of territorial Whooper Swan pairs in the Pechora Delta increased between 1980 and 2000 (Shchadilov *et al.* 2002), there is no evidence so far for them colonising Bewick's Swan territories c. 50 km to the north. Nevertheless, given that the increasing numbers of geese and Whooper Swans in Europe will be utilising the same or similar food resources as the Bewick's Swans, the issue of whether competition with other species is now contributing to the Bewick's Swans' population decline, or whether northward range shifts by Whooper Swans may affect the Bewick's Swans in the future, should perhaps be considered more rigorously.

Oil spills and other catastrophic events remain a threat for a species that congregates in large numbers at relatively few sites. In particular, oil exploration continues in the Russian Arctic, and an oil spill at the important breeding and moulting grounds in the Nenetskiy State Nature Reserve, or in the White Sea staging area, would have a devastating effect on the population. Disease outbreaks such as highly pathogenic avian influenza H5N1 are also a risk. Both Whooper and Mute Swans died during the main H5N1 outbreak in Europe in 2005, but fortunately there were no cases of mass mortality recorded for Bewick's Swans at that time.

Future plans for species conservation

Following the workshop, Wetlands International is now developing a Flyway Action Plan for the conservation of the northwest European Bewick's Swan population. The main goal of the plan is to halt the ongoing decline, promote population recovery and maintain the population at or above its 2005 level (S. Nagy pers. comm.). The Action Plan, to be submitted to the Technical Committee of the African-Eurasian Waterbird Agreement (AEWA) for approval in March 2011, will provide a framework for taking forward co-ordinated actions recommended within

the plan. Specific actions, some of which are already underway, will include continued monitoring of population trends, research into the causes of the population decline, and habitat management (including further site protection, improved water management directed to aquatic food stocks and banning disturbance by (e.g.) hunters, boats and surfers) for improving the swans' survival and productivity. In particular, the question of whether there has been an increase in mortality rates in recent years (and, if there has, the reason for this to be identified) must be addressed urgently. Implementation of the plan is to be led by the WI-IUCN SSC Swan Specialist Group in collaboration with the relevant governmental organisations, research institutes and non-governmental conservation organisations. This conservation effort will take place over the next ten years, after which the status of the population will be reviewed and the need for any further action will be considered.

Acknowledgments

We are grateful to all contributors to Bewick's Swan studies over the years and to participants in the Bewick's Swan Action Planning workshop in September 2009. Andy Musgrove kindly provided the data for UK Bewick's Swan trends, which had been gathered and reported by counters as part of the UK's Wetland Bird Survey scheme. Similarly, Szabolcs Nagy and Simon Delany made the International Waterbird Census data available for illustrating trends in Bewick's Swan numbers for the population as a whole. Baz Hughes, Julia Newth and anonymous reviewers made helpful comments on an earlier draft of the text. We are grateful to Robin Jones for preparing fig. 1.

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