Winter distribution of Whooper Swans *Cygnus cygnus* cygnets bred in Latvia, 2004–2008

DMITRIJS BOIKO[1]* & HAKON KAMPE-PERSSON[2]

[1]Natural History Museum of Latvia, Kr. Barona 4, Rīga LV-1050, Latvia.
[2]Pulmaņi, Glūdas pagasts, Jelgavas novads, LV-3040, Latvia.
*Correspondence author. E-mail: dmitrijs.boiko@gmail.com

Abstract

Of 396 Whooper Swan *Cygnus cygnus* cygnets marked with neck collars in Latvia during the 2004–2008 breeding seasons, 70% were re-sighted at least once in winters 2004/05–2009/10. Overall, 91% of the 2,985 winter re-sightings were of swans seen in Germany, 5% were in Poland and the remaining 4% were distributed across Latvia, Lithuania, The Netherlands, Sweden, Denmark, France, Switzerland and Austria. The main wintering areas, situated 760–840 km from the ringing sites, were along the Rivers Elbe and Oder in inland northeast Germany and in neighbouring parts of Poland. The annual proportion of swans marked in Latvia which were re-sighted wintering in this region ranged from 41–80%. The maximum distance between the ringing and wintering sites recorded for each bird averaged 836 km (s.d. ± 169 km, range = 407–1,518 km). The average distance between the ringing and wintering sites correlated with winter severity, particularly amongst swans in their second winter or older.

Key words: cygnets, migration, neck collar, Whooper Swan, winter distribution.

Two breeding populations of Whooper Swan *Cygnus cygnus* have been described in the Western Palearctic: the Icelandic population which winters mainly in Britain and Ireland and the Fennoscandian/ Northwest Russian population which winters in continental Europe (Rees *et al.* 1997a). The latter population has undergone a spectacular increase in both range and population size since the 1950s (Laubek *et al.* 1999). In addition to a southwards expansion of its breeding distribution in Norway, Sweden, Finland and Russia, the species now breeds in the Baltic States, Poland, Germany, Denmark, the Netherlands, Hungary, Belarus and Ukraine (Rees *et al.* 1997a; Axbrink 1999; Hoklova & Artemyev 2002; Abramchuk *et al.* 2003; Vintchevski & Yasevitch 2003; Gaschak 2005; Kurlavičius 2006; Lehtiniemi 2006; Degen & Heinicke 2007; Sikora *et al.* 2007; Csörgö *et al.* 2009; Boele 2010; Boiko & Kampe-Persson 2010; Laubek 2011). Despite this increase in breeding range and numbers, the winter distribution seems to be largely unchanged (Rees *et al.* 1997a; Wahl & Degen 2009). The rate of increase in numbers has varied across the wintering range, however, supposedly reflecting the breeding origins of swans which show contrasting patterns in reproductive output (Wahl & Degen 2009).

Traditionally, Whooper Swans used shallow water habitats for both feeding and resting, but from the early 1970s onwards swans wintering in continental Europe have shown a gradual shift from aquatic to terrestrial feeding (Nilsson 1979, 1997; Nilsson & Persson 1988; Laubek 1995; Degen *et al.* 1996). Nowadays the swans exploit a variety of agricultural crops, ranging from autumn-sown cereals, oilseed rape and root crops left after the harvest to maize stubble and grasslands (Nilsson 2002; Wahl & Degen 2009; Hakon Kampe-Persson, unpubl. data). There are marked regional differences in the proportion of swans feeding on land in winter, however (Laubek *et al.* 1999), to the extent that the International Waterfowl Counts (IWCs, coordinated by Wetlands International) could no longer be used to provide an accurate estimate of population size (Nilsson 2002). Co-ordinated pan-European censuses of Whooper Swans in mid-winter therefore were initiated in the mid 1990s to confirm trends and total numbers for the species (Laubek *et al.* 1999; Wahl & Degen 2009).

Marking birds with individually-coded neck collars is an established method for mapping migration routes and determining links between breeding and wintering sites for swans and larger goose species (Garðarsson 1991; Laubek *et al.* 1998; Andersson *et al.* 2001). This method has been less successful for the Whooper Swans wintering in continental Europe. Few Swedish-breeding Whooper Swans have been ringed (Fransson & Pettersson 2001), but it is generally assumed that the birds breeding in north Sweden migrate westwards to winter along the Norwegian coast, while birds breeding in mid and south Sweden winter from south Sweden and Denmark to The Netherlands (Mathiasson 1991). Finnish birds migrate west of the Baltic Sea to winter in southern Norway, south Sweden, Denmark, western Germany, the Netherlands and Belgium, with a few in northeast Germany and northwest Poland (Laubek *et al.* 1998; Valkama *et al.* 2011). Whooper Swans ringed in northern Finland spend their winter in more northern areas than those ringed in southern Finland. Russian Whooper Swans winter in south Sweden and in northeast Germany (Fransson & Pettersson 2001; Degen & Heinicke 2007). The main wintering area for swans from east Germany seems to be Lake Constance at the borders between Germany, Switzerland and Austria (Degen & Heinicke 2007). Although Whooper Swans from the Icelandic population winter mainly in Britain, Ireland and Iceland (Newth *et al.* 2007), individuals from this population also occur in Norway, Denmark, Germany, the Netherlands, France and Spain (Rees *et al.* 2002). The extent of overlap between the continental European and the Icelandic populations is still unknown but estimates are of at least 200 Finnish birds reaching Britain (Laubek *et al.* 1998) and of up to 600 Icelandic birds wintering in continental

Europe (Garðarsson 1991; Cranswick *et al.* 1997).

Currently little is known about the migration routes and winter quarters for Whooper Swans from countries where the birds have started breeding only recently. Knowledge about staging and wintering areas is essential for the designation and management of Special Protection Areas (SPAs) and Ramsar sites. After Whooper Swans first bred in Latvia in 1973 (Baumanis 1975), numbers of breeding birds remained at 20–30 pairs until the early 1990s (Strazds *et al.* 1994). More recently numbers have increased, reaching *c.* 260 pairs by 2009 (Boiko & Kampe-Persson 2010), and Latvia now holds the most breeding pairs in continental Europe after Norway, Sweden, Finland and Russia.

This study aims to fulfil the recommendation of the Latvian Red Data Book (Andrušaitis 2000), by mapping the winter distribution of Latvian Whooper Swans and to establish the degree to which the choice of winter quarters is affected by winter severity. The focus is on Whooper Swans hatched in Latvia (*i.e.* excluding birds first marked as adults), as we cannot rule out the possibility that marked adults were recruits or moult migrants from other parts of Europe.

Materials and methods

A total of 396 Whooper Swan cygnets caught in Latvia were fitted with neck collars during 2004–2008. The collars were made of 3 mm thick plastic, were 83 mm high, with an inner diameter of 57 mm and weighed 71 g. Each blue collar had a 4-digit white alphanumerical code, readable at a distance of 50–300 m with a 20–60× telescope under normal field conditions. Cygnets were caught for ringing during mid July to early August at the age of 8–11 weeks, when they remain flightless but are large enough to retain a neck collar. The three main ringing sites: Skrunda fishponds (56°42'N, 21°59'E), Renda fishponds (57°04'N, 22°17'E) and Rimzāti fishponds (56°58'N, 22°10'E) are all in the Kuldiga district in the western part of the country (Fig. 1). The range of sites where cygnets were caught and fitted with neck collars reflects the breeding distribution of the species across Latvia (Boiko & Kampe-Persson 2010).

Re-sightings of marked individuals were generated by appealing for information on the home page of the Latvian Ornithological Society (LOB) and on the "European colour-ring birding" website (www.cr-birding.be). Between November 2008 and March 2010 observers were asked to enter their re-sighting data via the colour ring reporting website www.cr-reading.nl, and from April 2010 onwards via www.geese.org. All re-sightings obtained up to November 2010 were used in the analyses. Ringing data and re-sightings were stored in a Microsoft Access database. ArcMap 9.1 was used to map all ringing and re-sighting locations. The distance between the ringing and re-sighting sites recorded for individual swans was calculated in GoogleEarth.

In continental Europe, wintering Whooper Swans sometimes feed within hundreds of metres of their night roost, often at a distance of a few kilometres, but rarely more than 5 km away (Ulbricht & Klauke 2008; Hakon Kampe-Persson unpubl. data; Klaus-Jürgen Donner &

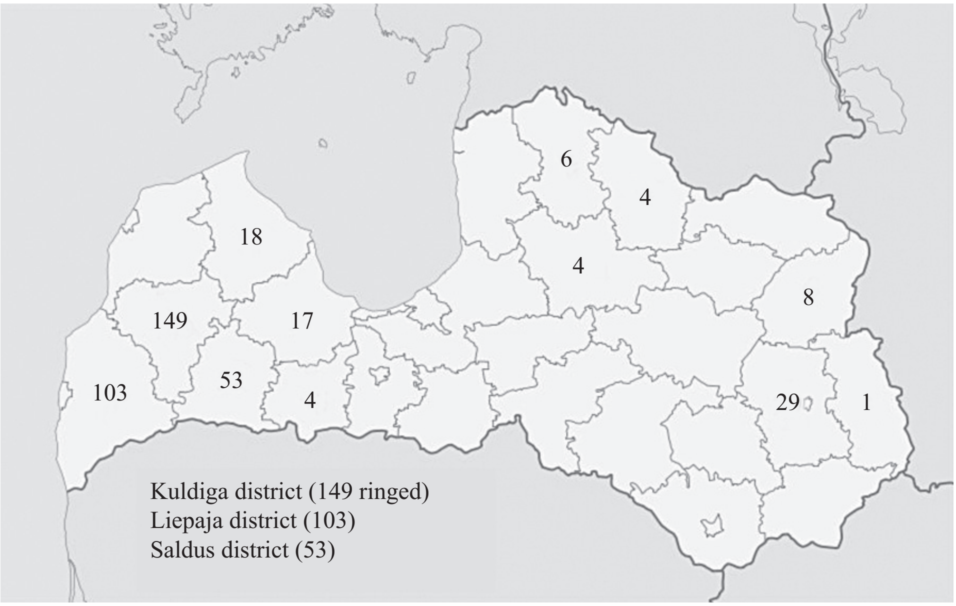

Figure 1. The number of Whooper Swan cygnets marked with neck collars in different Latvian districts in summers 2004–2008.

Norman Donner, *in litt.*; Joerg Lippert, *in litt.*; Nico Stenschke, *in litt.*; Thomas Tietz, *in litt.*). In this way, we established a hypothetical circular wintering area within 5 km of each roost site. This area becomes larger and non-circular if the swans use also a second roost situated < 10 km from the first one. The winter quarters of a Whooper Swan in a single winter consist of one or more wintering areas situated at varying distances from each other, more distant when cold weather movements occur (Mathiasson 1979; McElwaine *et al.* 1995; Rees *et al.* 1997b). Relying on volunteers makes it difficult to determine to what degree the re-sightings reflect the extent of an individuals' winter quarters, and it is not possible to compensate for this lack of data.

To overcome this problem, a number of specific definitions were used. For each individual and winter, "wintering site" was defined as the site where the bird was re-sighted farthest away from its ringing site during the months of December–February inclusive. The distance between the bird's ringing and wintering sites was defined as the "wintering distance" for each bird in each year. For each winter the "average wintering distance" was calculated for all birds and separately for first-winter birds and for birds re-sighted after their first winter. Because cygnets generally remain with their parents during their first winter, only one individual from each family was used when calculating the average wintering distance for first-winter birds.

The severity of each winter was expressed using the established German measurement Kaeltesumme ("sum of coldness"). The winter Kaeltesumme was calculated by summing all negative average daily temperature values during the period November–March, where the average daily temperature was the mean of hourly temperature readings (in °C) taken on the hour over a 24 h period. The Kaeltesumme for Berlin-Tempelhof was used in this study, because that meteorological station is situated in the middle of the main wintering area for Latvian Whooper Swans (Boiko 2008). Kaeltesumme can be used to categorise the severity of the winter; the higher the value the colder was the winter (Blüthgen & Weischet 1980).

Averages are given as mean ± standard deviation.

Results

Of the 396 Whooper Swan cygnets marked with neck collars in Latvia during the 2004–2008 breeding seasons, 56.8% were re-sighted in their first winter and 39.1% in the second winter. Overall, 69.9% were re-sighted at least once in the winters 2004/05–2009/10.

Most Latvian Whooper Swans leave their breeding grounds in September and October and arrive in the winter quarters in November and December (Boiko 2008) but some remain in Latvia into December. Thirteen collared birds (3.3% of the marked cygnets) were recorded in Latvia in December at least once (Fig. 2). Most of these were reported at winter quarters in Mecklenburg-Vorpommern, Sachsen-Anhalt or Niedersachsen within 1–3 weeks of the last re-sighting in Latvia, the others within 4–6 weeks. Spring migration generally starts in March but some individuals leave the wintering grounds in February. The earliest re-sighting date in Latvia of a Whooper Swan that had wintered in Germany (in Mecklenburg-Vorpommern) was 11 February. All re-sightings in Latvia, and Lithuania shown in Figure 2 were of birds on migration to/from their winter sites, and all individuals re-sighted in Sweden were on their way to unknown winter quarters. In Germany and Poland, the distribution of the re-sightings showed only small differences among the three winter months (Fig. 2). The main distributional difference was found furthest away from Latvia, as all but one of the re-sightings in the Netherlands and France were in January and February.

Of a total of 2,985 re-sightings in winter, 91% were in Germany, 5% in Poland and the remaining 4% were made across Latvia, Lithuania, the Netherlands, Sweden, Denmark, France, Switzerland and Austria (Table 1). Most swans re-sighted in Poland were recorded along the German border (43 birds; 84.3% of those recorded in Poland), and most re-sightings in Germany were in four regions in the northern part of the country (in Mecklenburg-Vorpommern, Brandenburg, Sachsen-Anhalt and Niedersachsen), along the Rivers Elbe and Oder (Table 2, Fig. 2).

The maximum distance between the ringing and wintering sites recorded for each bird averaged 836 ± 169 km (range = 407–1,518 km, n = 277). The distribution of wintering distances showed marked between-year differences (Fig. 3). Most birds were

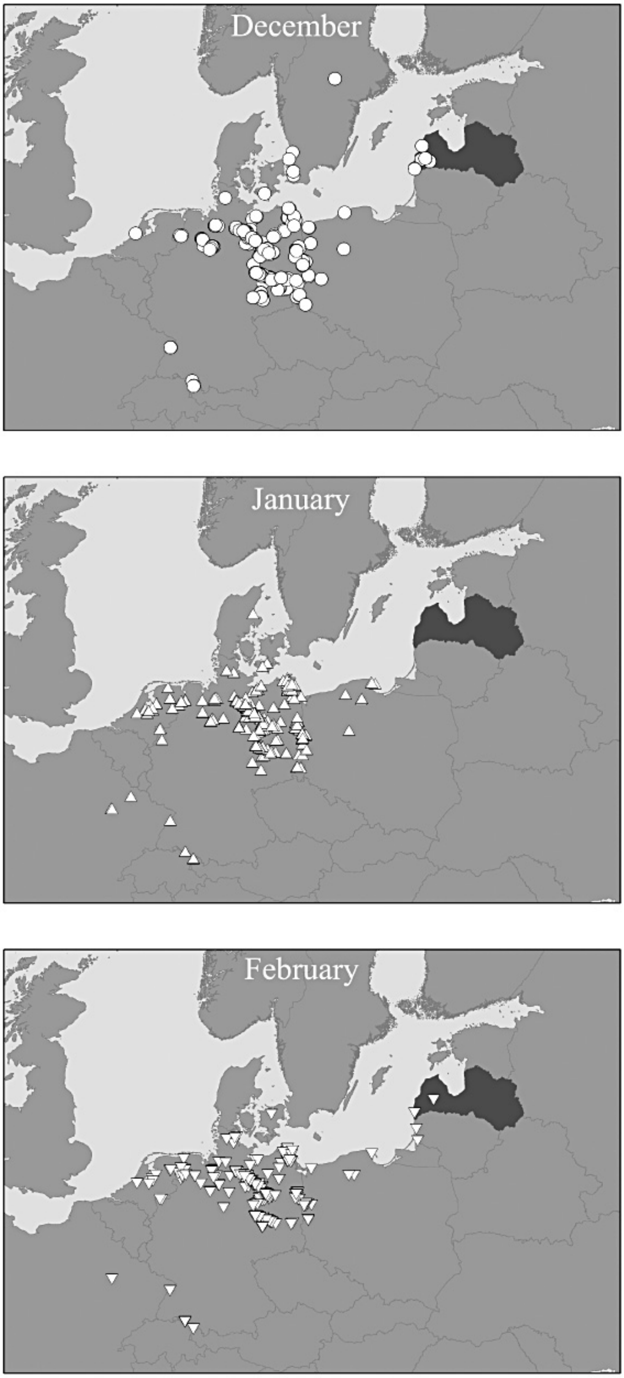

Figure 2. Sites where Whooper Swan cygnets marked with neck collars in Latvia in summers 2004–2008 were re-sighted during the winters 2004/05–2009/10. Data are given separately for December, January and February. The different symbols were used for a site independent of the number of re-sightings, or the number of re-sighted individuals.

Table 1. The number of re-sightings in different countries in winters 2004/05–2009/10 of Whooper Swans marked with neck collars as cygnets in Latvia in summers 2004–2008. The number of cygnets marked each year is shown in the top row.

	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	Total
No. marked	33	79	72	130	82		396
Latvia				5	2	10	17
Lithuania				2			2
Poland	17	1	26	35	73	12	164
Germany	170	521	356	643	625	394	2709
Netherlands		7	1	2	21	16	47
Sweden			1	4	1	2	8
Denmark		1		1	3	1	6
France					6		6
Switerzerland				4	12		16
Austria						10	10
Total	187	530	384	696	743	445	2985

re-sighted 760–840 km from the ringing site, but this proportion decreased from 76% and 80% of birds re-sighted during the first two winters of the study (2004/05 and 2005/06 respectively) to 41% and 46% during the last two winters (in 2008/09 and 2009/10). The proportion of swans found at ≤ 760 km varied between 12–38% without any obvious trend, while those observed > 840 km from the ringing site increased from 6% to 33% during the study period (Fig. 3). The average wintering distance differed significantly between years (one-way ANOVA: $F_{5,557}$ = 3.66, $P < 0.01$) and ranged from 766 ± 108 km (n = 74) in 2006/07 to 852 ± 190 km (n = 116) in 2009/10.

There was a significant correlation between the severity of the winter, expressed as Kaeltesumme, and the average wintering distance for swans in their second–sixth winter (Spearman's rank correlation: r_s = 0.95, d.f. = 3, $P < 0.02$; Fig. 4). A similar correlation, though non-significant, was found for birds in their first winter, or more precisely for pairs successfully bringing at least one collared young to their winter quarters (r_s = 0.37, d.f. = 3, n.s.; Fig. 4).

Table 2. The number of re-sightings in different regions of Germany in winters 2004/05–2009/10 of Whooper Swans marked with neck collars as cygnets in Latvia in summers 2004–2008.

	2004/05	**2005/06**	**2006/07**	**2007/08**	**2008/09**	**2009/10**	**Total**
Mecklenburg-Vorpommern	15	57	14	116	150	71	423
Brandenburg	44	69	99	198	173	57	640
Sachsen-Anhalt	43	213	85	158	200	140	839
Niedersachsen	68	168	138	154	82	79	689
Schleswig – Holstein			3		4	3	10
Sachsen		14	17	10	14	21	76
Thüringen				4		2	6
Nordrhein-Westfalen					2	11	13
Baden-Württemberg				3		10	13
Total	170	521	356	643	625	394	2709

There was variation between individual swans, and also between years, in the difference in the distance between the ringing and wintering sites (*i.e.* wintering distance) recorded in consecutive winters (Fig. 5). Wintering distances recorded in the swans' first and second winters differed by ≤ 10 km for 43.0% of birds, and by > 200 km for 4.7%. The average difference between these two winters was 65 ± 121 km (range = 0–808 km, n = 86). Differences between the second and third winters and between the third and fourth winters appeared greater than those between the two first winters, with annual variation in wintering distances of ≤ 10 km for 32.9% and 21.2% of birds, respectively, and the difference being > 200 km, for 10.1% and 12.1%. The average differences in wintering distances were also higher than between the first and second winters: 82 ± 61 km (range = 0–682 km, n = 79) on comparing years two and three, and 82 ± 109 km (range = 0–518 km, n = 33) on comparing years three and four. However, differences in wintering distances recorded between years two and three and between years three and four did not differ significantly from those recorded in the first two winters (t_s = 1.088, d.f. = 163, n.s. and t_s = 0.670, d.f. = 117, n.s., respectively).

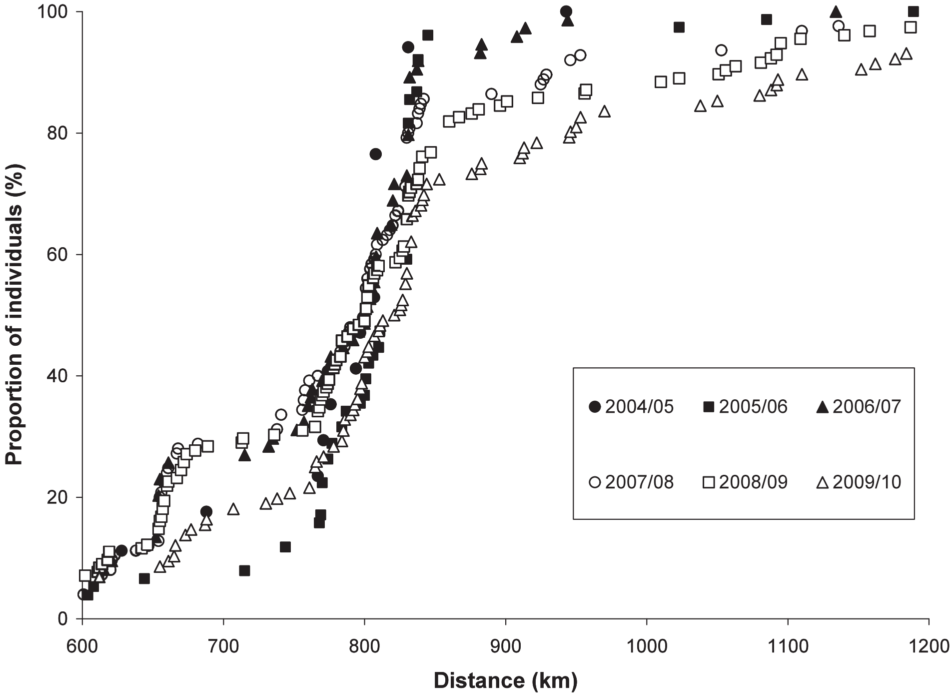

Figure 3. Distribution in each of the winters 2004/05–2009/10 of Whooper Swan cygnets marked with neck collars in Latvia in summers 2004–2008, expressed as percentages of wintering swans found within different distances from the ringing sites. Only distances in the range 600–1,200 km are shown. The number of re-sighted individuals in the winters 2004/05–2009/10 were 17, 76, 74, 125, 155 and 116 respectively.

Most swans migrated, at least up to their fourth winter, in the same direction as in the preceding winter. This was illustrated both by the proximity of the wintering sites used by individual swans in successive years, and by the difference between wintering sites being less than the difference in wintering distances in 73% of all cases (62 out of 86, 58 out of 79 and 24 out of 33; Fig. 5). Exceptions included two birds for which the distance between wintering sites was 270 and 637 km, while the difference in wintering distance was only 2 and 93 km respectively, because the birds migrated in different directions in the two years. In the second winter, 27.9% of birds were re-sighted ≤ 10 km of the site of the preceding winter, while 11.6% were found > 200 km away. The average distance between wintering sites in the first and second winters was 102 ± 149 km (range = 0–871 km, n = 86). The corresponding values were 17.7%, 19% and 119 ± 144 km (range = 1–698 km, n = 79) for the second and third winters, and 12.1%, 15.2% and 117 ± 130 km (range = 1–550 km, n = 33) for the third and fourth winters.

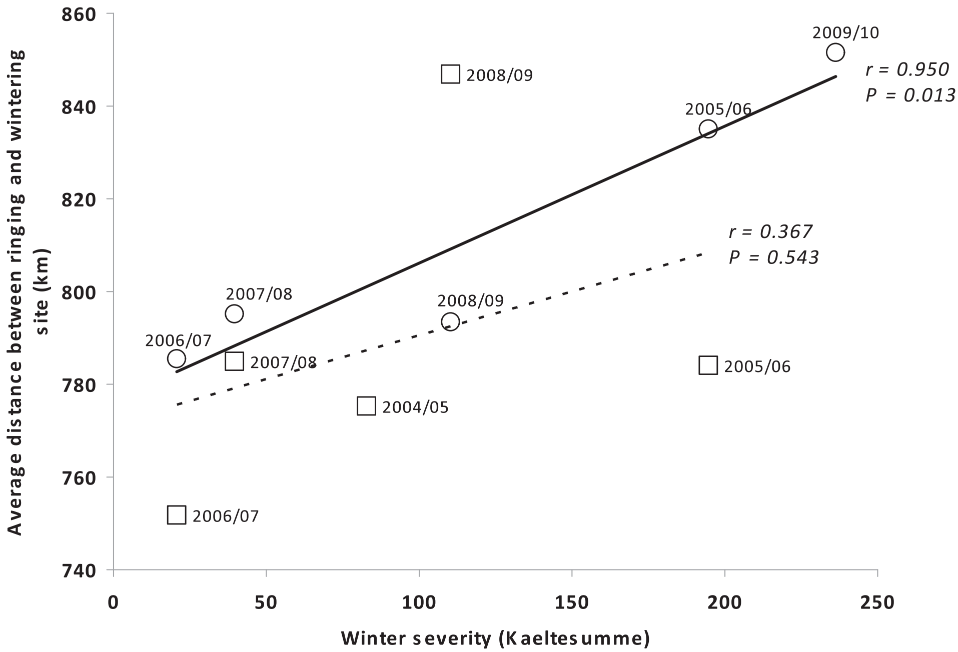

Figure 4. Relationship between winter severity, expressed as Kaeltesumme, and average distance between ringing and wintering site in each of the winters 2004/05–2009/10 for Whooper Swan cygnets marked with neck collars in Latvia in summers 2004–2008 and re-sighted in their first winter (squares, broken line) or in a later winter (circles, unbroken line). For first-winter birds, only one individual from each family was used when calculating the averages.

None of the two last-mentioned averages differed significantly from that of the first two winters (t_s = 0.734, d.f. = 163, n.s. and t_s = 0.496, d.f. = 117, n.s., respectively).

Discussion

Most Latvian Whooper Swans wintered in inland north-eastern Germany and neighbouring parts of Poland, mainly along the Rivers Elbe and Oder. This fits well into the overall picture of our understanding of where Whooper Swans from different parts of the breeding range spend their winter. Whooper Swans from Russia, Estonia and Poland also winter in north-eastern Germany (Degen & Heinicke 2007). As there are no reasons to assume the Latvian birds are less traditional than the Finnish birds in the choice of winter quarters (Laubek *et al.* 1998), the current winter distribution might reflect ancestral influence. If, as must have been the case, the growing Latvian breeding population (Boiko & Kampe-Persson 2010) recruited males from elsewhere (the male being the dispersing sex among swans and geese; Clarke *et al.* 1997), with the male in a pair also deciding where to winter (as

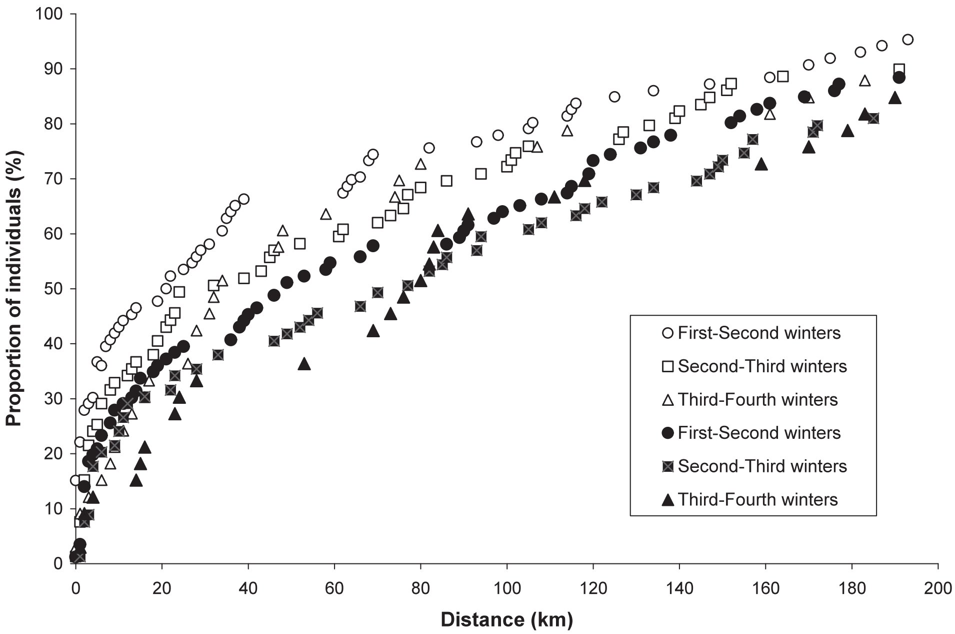

Figure 5. Difference between wintering distances (open symbols) and distance between wintering sites (filled symbols) given for Whooper Swan cygnets marked with neck collars in Latvia in summers 2004–2008 and re-sighted during two consecutive winters during the period 2004/05–2009/10, expressed as percentage of wintering swans found within different distances. Only distances in the range 0–200 km are shown, because few individuals had distances exceeding 200 km (for details, see the text). The number of re-sighted individuals in the first and second winters was 86, in the second and third winters 79 and in the third and fourth winters 33.

demonstrated for the Bewick's Swan *Cygnus columbianus bewickii*, Rees 1987, and the Greylag Goose *Anser anser*, Hakon Kampe-Persson, unpubl. data), it is not surprising that the winter distribution of Latvian Whooper Swans is similar to that of the rest of the Fennoscandian/Northwest Russian population, as depicted in this study.

To reach their wintering grounds the vast majority of the Latvian birds migrate southeast of the Baltic Sea (Boiko 2008). The others (in their second calendar year or older), after having undergone wing moult in northwest Russia and staged in Finland during the post-moult period (Dmitrijs Boiko & Hakon Kampe-Persson, unpubl. data), follow the same route as Finnish birds west of the Baltic Sea, some of them being re-sighted in Sweden in December (this study). Distances of 407–1,518 km between ringing and wintering sites recorded in this study are similar to the 700–2,100 km migration reported for Whooper Swans from Finland (Laubek *et al.* 1998) and the 800–1,200 km reported for Icelandic birds (Garðarsson 1991).

Cold winter movements, triggered by freezing of, or snow cover on, the feeding grounds, are common in the Whooper Swan, taking the birds southwards or westwards (Rees *et al.* 1997a; Koffijberg *et al.* 1997; Hornman *et al.* 2011). Latvian Whooper Swans re-sighted in the Netherlands and France probably reached these countries in under such circumstances. How far the birds migrate in winter depends on the severity of the winter. The reaction of the swans to between-year differences in winter severity varied greatly however. About one-third of the individuals changed their wintering distance from one winter to the next by ≤ 10 km, while about one-tenth of the birds changed by > 200 km. The distance between wintering sites was even larger than the difference in wintering distance, in some cases probably involving exploratory movements by young birds. About 20% of the birds were re-sighted ≤ 10 km of the site of the preceding winter, while about 15% were found > 200 km away. Birds in their third and fourth winters were less faithful and moved farther away from their wintering site in the preceding winter than swans in their second winter did. This contrasts with the established opinion that the Whooper Swan shows high site-fidelity to their winter quarters (Black & Rees 1984; Degen & Heinicke 2007). Further study, with the benefit of additional re-sightings data, may determine whether this reflects the tendency for some swans to use two or more wintering sites within a single winter (McElwaine *et al.* 1995). The readiness to change winter quarters might be related to sex, with females being more likely to change than males (Rees 1987), and to age, with older pairs being less disposed to change. Large differences in the proportion of first-winter birds in different parts of Germany in January 2005 were interpreted as an indication that families might have a different wintering strategy to non- and fail-breeders (Wahl & Degen 2009). However, a more likely explanation is that it just reflected differences in breeding output among birds originating from different parts of the breeding range. Breeding output has been shown to be related to both severity of the preceding winter on the wintering grounds and to weather conditions on the breeding grounds (Nilsson 1979). In Germany, the percentage of first-winter birds remained quite stable, even at sites where there were large changes in number of individuals counted during the winter (Wahl & Degen 2009). This does not lend any support for a higher site-faithfulness among successful pairs, rather the contrary. So, the degree of winter site fidelity is still an unsolved question for Whooper Swan in continental Europe.

The effect of winter severity on Whooper Swan distribution should be taken into account when designating protected areas. Wintering grounds should be large enough to safeguard the bird's requirements of food and safe roosting sites during winters of a wide range of severity. When feeding on winter cereals and oilseed rape, as most Whooper Swans do in Germany nowadays (Wahl & Degen 2009), the birds are less affected by low temperatures, and even after heavy snow fall, windblown fields continue to offer a rich food supply. In addition, these monocultures offer large amounts of food per hectare. Reliance on a few monocultures for feeding in winter makes the Whooper Swan susceptible to changes of varieties grown or farming technique however. Agricultural change can occur quickly and unexpectedly, sometimes rapidly, such as when a decision in Brussels resulted in the cessation of sugar beet production in Latvia (Piskunova & Alsiņa 2010). At the same time, climate change may create new feeding opportunities for wintering closer to the breeding grounds. In the middle of January 2005, there were 1,150 Whooper Swans wintering in Finland and the three Baltic States (Wahl & Degen 2009) compared to 607 birds ten years earlier (Laubek *et al.* 1999). Thus some countries may need to consider protecting additional sites and habitats for the species throughout the year, in winter as well as during the breeding season.

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Photograph: Whooper Swan nesting on a Latvian fishpond, by Dmitrijs Boiko.

