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Brief report

Moult migration of Latvian Whooper Swans *Cygnus cygnus*

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This study is the first to demonstrate moult migration in the Whooper Swan *Cygnus cygnus*. Of cygnets hatched in Latvia and known to be alive about 99% left the country to moult somewhere else in their 2nd–6th calendar year. One-sixth of these were re-sighted in Finland during moult migration; these were solely from western Latvia. Moulting sites were recorded for nine individuals, of which seven had been marked with neck collars and two had satellite transmitters. Five of these nine swans moulted in Latvia, one in Estonia and three in the Arkhangelsk Region of Russia. Distances between sites of ringing and moulting varied between 0 and 1,455 km. All individuals were recorded moulting as two- or three-year old birds. Those moulting in Russia left Latvia/Estonia before 20 June and returned after mid September.

1. Introduction

Most birds replace their primary and secondary wing feathers one or two at a time so that their power of flight is not drastically impaired. Waterfowl, however, lose their wing feathers all at once and consequently lose the power of flight for a period. The Whooper Swan *Cygnus cygnus* moults its wing feathers from June to late August and is flightless for about 5–6 weeks (Dement'ev 1935). Breeding birds usually moult their wing feathers on their breeding territories and non-breeders in summer congregations. The Whooper Swan matures slowly and first breeding is usually at the age of 4–6 years (Einarsson 1996). A high proportion of the population therefore consists of non-breeding birds. About two thirds of the population does not attempt to breed in each year (Garðarsson & Skarphéðinsson 1984, Haapanen 1991, Rees *et al*. 1991, Einarsson 1996, Schadilov *et al*. 2002).

Non-breeders of most swan species gather in flocks and undergo wing moult near the breeding grounds (Brazil 2003). Of the swan species, moult migration has been described only for the Mute Swan (Salomonsen 1968). Whooper Swans in the Baltic region do not fit this general pattern, however. Mass-moulting sites have not been located in Fennoscandia, and only small groups of local birds numbering up to 18 individuals in large mire complexes are known (Haapanen 1991, Leif Nilsson *in litt*.). These groups cannot account for all non-breeding birds (especially 2–3 year old birds), as the total number of breeding pairs in Sweden and Finland numbers more than 10,400 (Väisänen *et al*. 2011, Ottosson *et al*. 2012). It is surmised that the Fennoscandian birds moult in highly produc-

Table 1. Known moulting sites of Whooper Swan cygnets marked with neck collars in Latvia during summers 2004–2008. Identification code, year of birth, age at moult (in calender years), moulting site, coordinates of the moulting site and distance between ringing and moulting sites are given for each individual.

Code	Year hatched	Age at moult	Moulting site	Coordinates	Distance (km)
2C38	2005	2nd cy	Skrunda fish ponds	56°42'N,21°59'E	15
2C38	2005	3rd cy	Skrunda fish ponds	56°42'N,21°59'E	15
3C20	2006	2nd cy	Skrunda fish ponds	56°42'N,21°59'E	4
3C41	2006	3rd cy	Skrunda fish ponds	56°42'N,21°59'E	0
4C39	2006	3rd cy	Matsalu Bay	58°47'N,23°41'E	215
4C48	2007	2nd cy	Satini fish ponds	56°38'N,22°21'E	37
4C70	2007	3rd cy	Nagli fish ponds	56°41'N,26°59'E	0
4C89	2007	2nd cy	Koida, Arkhangelsk	66°22'N,42°32'E	1,283
PTT1	2007	2nd cy	Mayda, Arkhangelsk	66°12'N,41°58'E	1,441
PTT2	2007	2nd cy	E Yazma, Arkhangelsk	67°04'N,45°19'E	1,455

tive wetlands in Russia (Beekman 1998) but, except for one Finnish bird found moulting on the Kanin Peninsula (Litvin & Gurtovaya 2003), concrete evidence is lacking. In the Baltic States there are three known moulting sites in each country, but a total of only 68–144 moulting Whooper Swans were counted in these nine sites each year in summers 2005–2009 (Boiko 2008, unpubl., Morkūnas *et al*. 2010, Trinus Haitjema *in litt*.)

Whooper Swans first bred in Latvia in 1973 (Baumanis 1975). Numbers of breeding pairs have increased substantially since then, reaching c. 150 pairs in 2004 and ca. 260 in 2009 (Boiko & Kampe-Persson 2010). There has been a similar increase in the number of non-breeding Whooper Swans in Latvia, from c. 600 individuals at the beginning of the breeding season in 2004 to ca. 1,050 in 2009. As the total number of Whooper Swans recorded moulting across Latvian moulting sites has not exceeded 95 birds (Boiko 2008, unpubl.), these sites account for only a fraction of all non-breeding birds occurring in the country. To date, nothing is known about where the other non-breeders spend the summer. This study is the first attempt to ascertain where Whooper Swans, that bred in Latvia, go to moult their wing feathers in subsequent years.

2. Material and methods

A total of 396 Whooper Swan cygnets caught in Latvia were fitted with neck collars during 2004–2008. Each collar had a four-digit alphanumerical code, readable at a distance of 50–300 m with a 20–60x telescope under normal field conditions. 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). Ten cygnets were fitted with satellite transmitters in 2007 but only two of them (PTT1 and PTT2) were transmitting location data in summer 2008.

All main areas for Whooper Swans in Latvia were visited at least once a week from May–October since 2004, to look for and identify any individuals with neck collars. Additional re-sightings were reported from Estonia, of which 98 were made in Matsalu Bay and two at neighbouring islands. Swans staging at Matsalu Bay were checked for collars almost daily (Trinus Haitjema *in litt*.). One individual re-sighted at Matsalu Bay in June was found moulting in Latvia the same year. With a flight speed of 60 km/h (Alerstam 1982) Matsalu Bay can be reached in 3.5 h from the main Latvian breeding grounds and in 7 h from the most distant breeding site in Latvia. Re-sightings made in Estonia therefore were grouped with the Latvian re-sightings in the analyses. The swans were not systematically checked for neck collars in other countries. Re-sightings made during the years 2005–2009 were used for this report.

Individuals re-sighted during the period 29 June–14 September were considered to have moulted at the observation site. This period was determined from the dates on which moulting Whooper Swans were first and last caught in Latvia. The pre-moult period was defined as 1 May–

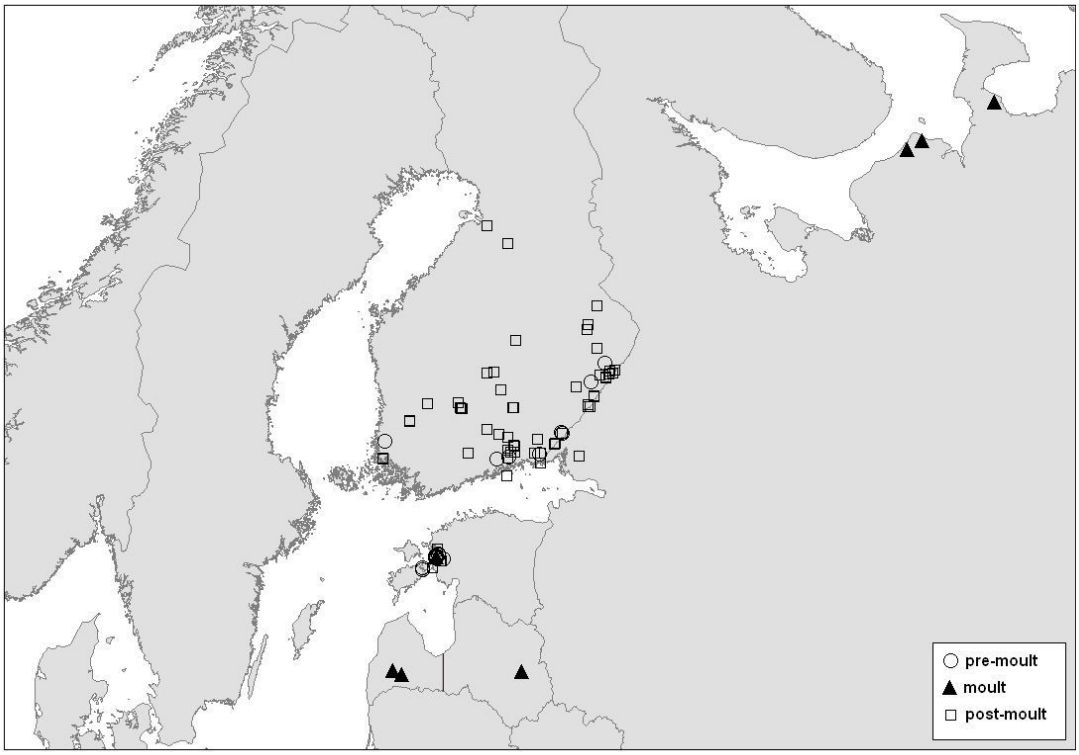

Fig. 1. Re-sightings outside Latvia during the pre-moult, moult and post-moult periods, respectively, and in Latvia during the moult period, for Whooper Swan cygnets marked with neck collars in Latvia in summers 2004–2008. Symbols were used irrespective of the number of individuals re-sighted at a site. Latvia was divided into two parts, western and eastern, by a line due south from the southern shore of Riga Bay.

28 June and the post-moult period as 15 September–31 October. The beginning of the pre-moult period overlapped with the end of the spring migration (Luigujõe *et al*. 2002), while the end of the post-moult period overlapped with the start of the autumn migration (Boiko 2008).

The number of marked individuals known to be alive at the beginning of the moulting season in the 2nd–6th calendar year was 310, 179, 87, 44 and 15, respectively.

A "last-sighting" was defined as the last re-sighting of an individual during the pre-moult period. Similarly, a "first-sighting" was defined as the first re-sighting of an individual during the post-moult period. Median dates were used to describe differences between sets of last- or first-sightings. Several studies have demonstrated that first- and last-sightings are good representatives of the true arrival and departure dates, respectively (e.g., Persson 1993, Andersson *et al*. 2001).

The probability of an individual being re-sighted varied among sites, countries, seasons, years and age groups. Chi-square statistics were therefore carried out only in a few cases.

3. Results

Of Whooper Swan cygnets marked with neck collars in Latvia and known to be alive at the beginning of their 2nd calendar year moulting season, 45% (N = 310) were re-sighted at least once during the pre-moult, moult and/or post-moult periods. Moulting sites were found for seven of the 396 cygnets marked with neck collars and two of the ten cygnets fitted with satellite transmitters (Table 1). The moulting sites fell into two distinct areas: Latvia/Estonia and the Arkhangelsk Region of Russia (Fig. 1). Among marked individuals known to be alive at the beginning of the moulting season, the bird moulted in Latvia/Estonia in 1.1% of the cases (N = 637). In all other cases, the bird

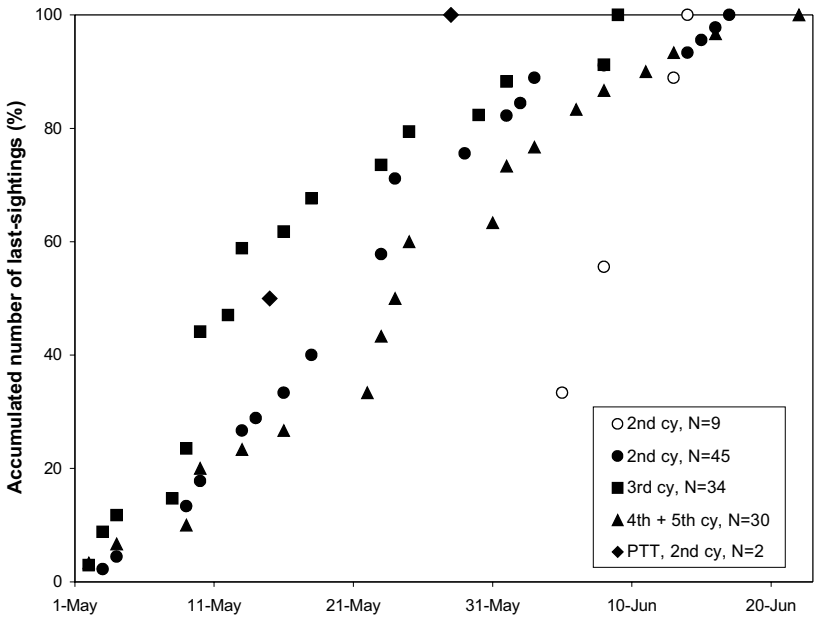

Fig. 2. Pre-moult departure from Latvia/Estonia described by accumulated last-sightings from the period 1 May–28 June in 2005–2009 of Whooper Swan cygnets marked with neck collars in Latvia in summers 2004–2008. Last-sightings after severe winters (open symbols) and very mild/average winters (filled symbols) in the main wintering area for Latvian Whooper Swans (Boiko & Kampe-Persson 2011) are shown separately.

apparently left Latvia/Estonia to moult somewhere else.

The pre-moult migration by Whooper Swans born in Latvia was expressed by last-sightings (Fig. 2). The birds started to leave Latvia/Estonia in the beginning of May, and the last individual usually left before 20 June. A few birds born in the western part of Latvia were re-sighted in south-easternmost Finland during their pre-moult migration (Fig. 1). Departure pattern did not differ between 2nd calendar year birds and 4th+5th calendar year birds, respectively, but 3rd calendar year birds left on average 11 days ahead of both younger and older birds (Fig. 2). After the only severe winter during the study period, the swans left later than during less severe winters. However, the sample size was small.

During the post-moult period, swans arrived earlier in Finland than in Latvia/Estonia; median dates were 4 October and 14 October, respectively (Fig. 3). Among individuals re-sighted in both Finland and Latvia/Estonia the same post-moult period, 8 October was the earliest re-sighting date in Latvia/Estonia. The proportion of re-sighted 3rd calendar year birds was the same in Finland and Latvia/Estonia, while the proportion of 2nd calendar year birds was slightly higher and the proportion of 4th+5th calendar year birds was slightly lower in Finland than in Latvia/Estonia, but there were no significant differences between Finland and Latvia/Estonia for these three age groups ($\chi^2 = 4.44$, ns). More individuals were re-sighted in Finland during the post-moult period than during the pre-moult period, and they were also found in a larger part of the country in autumn than in May/June (Fig. 1). All birds re-sighted in Finland originated from western Latvia. Overall, 52 birds of 344 marked in the western part compared to none of 52 marked in the eastern part were re-sighted in Finland, the difference being highly significant ($\chi^2 = 9.05$, $p < 0.005$). Of birds marked in western Latvia and known to be alive at the beginning of the moulting season in their 2nd calendar year, 19.3% ($N = 270$) were re-sighted in Finland. Median dates of the last and first sightings showed that, on average, the birds left Latvia/Estonia for almost five months during the summer to moult (Fig. 2–3).

4. Discussion

This study is the first to demonstrate moult migration in the Whooper Swan. About 99% of the swans born in Latvia left the country to moult somewhere else in their 2nd–6th calendar year. One-fifth of those born in western Latvia were re-sighted in Finland during the time matching moult

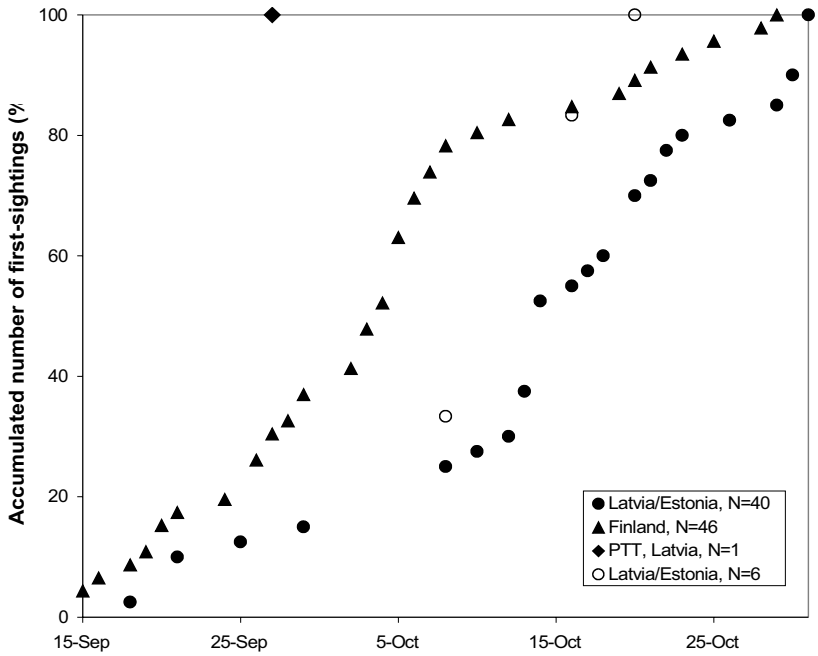

Fig. 3. Post-moult arrival in Latvia/Estonia and Finland, respectively, described by accumulated first-sightings from the period 15 September–31 October in 2005–2009 of Whooper Swan cygnets marked with neck collars in Latvia in summers 2004–2008. Arrival in Latvia/Estonia of individuals that had been re-sighted in Finland during the same autumn, is denoted by open symbols.

migration. As the swans were not systematically checked for neck collars in Finland, the true number staging in Finland might have been higher than that. Pre-moult re-sightings in Finland were concentrated to the south-easternmost part of the country, suggesting that the birds used the shortest route between Latvia/Estonia and the moulting grounds, a view supported by data from the two individuals fitted with satellite transmitters (Dmitrijs Boiko, unpubl. data). These two were both recorded moulting in the Arkhangelsk Region of Russia. The distribution of re-sightings in Finland during the post-moult period suggests that the Whooper Swans migrated on a much broader front after the moult than beforehand. However, only Whooper Swans born in western Latvia were recorded in Finland, indicating a low mixing of birds from different parts of Latvia. The earlier post-moult return in Finland compared to in Latvia/Estonia is probably attributable to Finland being situated closer to the Russian moulting grounds.

There was a close match of departure patterns in Latvia/Estonia (this study) and arrival patterns at the west coast of the Kanin Peninsula (Litvin & Gurtovaya 2003). Departure data from the Kanin Peninsula (Tolvanen 2009) indicated that there was ample time for stop-over during the post-moult migration from arctic Russia. An autumnal staging area for large numbers of post-moulting non-breeding Whooper Swans is situated in the southern Kola Peninsula (Bianki 1990), an area already being used by Whooper Swans in the 1950s (Bianki 1981).

The Whooper Swan is well studied in the Baltic States, which makes it unlikely that any significant numbers of moulting non-breeders were overlooked in these countries. There are no known moulting sites for Whooper Swans neither in the Regions of Pskov, Novgorod and Leningrad nor in the Republic of Karelia (Hoklova & Artemjev 2002, Tatiana Hoklova *in litt*.). It remains possible, however, that moulting sites of minor importance exist in this part of Russia. The only concentration of moulting Whooper Swans found during aerial surveys of the Murmansk Region in 1975–1986 was of 58 birds (Bianki 1981, 1990, Filchagov & Tserenkov 1984, Bianki & Shutova 1987). Whether the species has started to moult in important numbers in this region since then is currently not known. The lack of known moulting sites in the afore-mentioned republic and regions suggest that the moulting grounds situated closest to Latvia are to be found in the Arkhangelsk Region. The main moulting grounds for Whooper Swans in this region are situated west of Mezenskaya Bay and River Mezen, east of River Mezen,

around Cheshskaya Bay and in the Kanin Peninsula south of Kanin Kanem (Bianki & Shutova 1987, Litvin & Gurtovaya 2003). The species is also moulting further east in the Nenets Autonomous Area but little is known about the numbers involved (Mineev 1986, Bianki & Zhutova 1987, Mineev 2005). In 2010, the number of moulting non-breeding Whooper Swans in the Kanin Peninsula was estimated at 5,000–15,000 birds (Alexander Kondratyev & Konstantin Litvin, pers. comm.).

Most of the non-breeding Whooper Swans born in Latvia probably undergo a migration of more than 1,200 km to reach their moulting grounds. This likely applies to most Whooper Swans in the Baltic region, although birds from more northerly breeding grounds will have a shorter distance to cover. The known moulting grounds in the Arkhangelsk Region are thinly populated and in most cases inaccessible for humans. So, to improve knowledge of where the large numbers of Whooper Swans from the Baltic region undergo wing moult, methods other than marking individuals with neck collars should be used. Satellite telemetry has become a valuable tool for mapping migration routes as well as for determining sites used for stop-over, wintering and moulting. However, as the method is costly and only a small number of birds are marked with transmitters, it could be combined with aerial surveys to confirm the number of swans present at moult sites used by the satellite-tracked birds. Aerial surveys have been shown to be highly efficient for determining Whooper Swan numbers and distribution (Haapanen & Nilsson 1979). Thus, it is perhaps time to repeat the aerial counts made in the Arkhangelsk Region in the 1970s and 1980s (Bianki & Shutova 1987).

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Ruggningsflyttning hos sångsvanar i Lettland

Till skillnad mot det normala hos fåglar ruggar svanar, gäss och änder samtliga vingpennor på en gång, vilket gör att de för en tid förlorar flygförmågan. Sångsvanens ruggning infaller från slutet av juni till mitten av september och arten är flygoförmögen under 5–6 veckor. Hos svanar och gäss ruggar de häckande paren under häckningen, medan ickehäckarna samlas och ruggar i flockar. Hos svanar ruggar ickehäckarna vanligtvis i närheten av sina häckningsområden, men detta gäller inte de sångsvanar som häckar i Östersjöområdet. Eftersom sångsvanen inte börjar häcka förrän vid 4–6 års ålder, är den ickehäckande delen av populationen stor inom denna art; ungefär två tredjedelar av sommarpopulationen.

Trots att antalet häckande par i Sverige och Finland uppgår till minst 10 400 har inga ruggningskoncentrationer lokaliserats och allmänt antas att ickehäckarna ruggar någonstans i Ryssland. I Baltikum har sångsvanen konstaterats rugga på nio lokaler, tre i varje land, men tillsammans hyste dessa lokaler under åren 2005–2009 endast 68–144 ruggande ickehäckare. Studien syftade till att ge de första uppgifterna om var ickehäckande sångsvanar födda i Lettland ruggar sina vingpennor. Eftersom antalet ruggande ickehäckande sångsvanar i Lettland aldrig varit högre än 95, måste majoriteten av de lettiska ickehäckarna ha ruggat någon annanstans, ty antalet ickehäckare ökade under åren 2004–2009 från ca. 600 till ca. 1050 individer.

Detta är den första studien som påvisat ruggningsflyttning hos sångsvan. Bland 2K–6K fåglar födda i Lettland lämnade 99 % Lettland/Estland

före den 20 juni för att efter ruggning återkomma från mitten av september. En sjättedel av dessa sågs i Finland under flyttning till/från sina ruggningslokaler. Uppgift om ruggningslokal erhölls för sju halsringmärkta fåglar och två försedda med satellitsändare. Fem av dessa ruggade i Lettland, en i Estland och tre i den ryska regionen Arkhangelsk. I diskussionsavsnittet ställs dessa fynd i relation till såväl publicerade som opublicerade uppgifter från såväl Arkhangelsk som andra områden där ickehäckande sångsvanar kan ha ruggat. Slutsatsen är att majoriteten av de ickehäckande sångsvanarna från såväl Lettland som andra delar av Östersjöområdet med största sannolikhet ruggar i Arkhangelsk.

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