Bimodality of spring migration of the Whooper Swan *Cygnus cygnus* in Finland

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In the spring Whooper Swans migrate through Finland in two waves. The first wave moves about 350 km per day and the second seems to move slower, only 20-50 km per day. It is concluded that the first wave is formed by breeding birds and the second by non-breeders. The slower speed of the latter wave results in an arrival at the northern boreal region about one month later than the birds of the first wave.

The first Whooper Swans arrive at Kuusamo (66°N-66° 33'N) in northern Finland in early April, some even in late March. Their arrival takes place many weeks before the breeding season starts. Pairs defend their pre-breeding habitat, slow flowing shallow rivers. Most birds stay, however, in small flocks of 11-40 birds.

In Kuusamo the birds begin to visit breeding sites in late April. At that time the lakes and peatlands are fully covered by ice and the nest mounds are under the snow. As the swans can localize the nest mound in such conditions, they must remember the site exactly from the previous season. Habitat selection must therefore have taken place in one of the previous seasons when the site has shown its capacity as a breeding location.

Jahnukainen (1963) noticed two peaks in the spring migration of Whooper Swans *Cygnus cygnus* in the Helsinki region: one low peak in mid-April and another, much higher in late April and early May. He stated, however, that this may be due to pure chance. The aim of this study is to show that this bimodality is a normal phenomenom, which can be seen in data collected over a long time period as well as in data from various regions during one spring.

Materials and methods

For the years 1944-65, unpublished data collected by the secondary and high school Nature Club Mikro in Lappeenranta region, south east Finland were examined. Data for 1978-82 were obtained from the published journals of local ornithological clubs.

Jahnukainen (1963) has discussed to what extent this type of data can be biased e.g. the birds are observed only during weekends. In recent years bird watchers' activities have increased enormously, therefore the recent data are less biased than those used by Jahnukainen (1963), and no correction of the data has been used. The old data from Lappeenranta region have been used in such a way that no correction of the data is needed.

The field observations on the arrival of Whooper Swans at Kuusamo (66° N-66° 30'N) were made by the author Hannu Hautala between 1976-1980.

Results

The spring migration

The pattern of the spring migration in Lappeenranta region 1946-1965 shows the same bimodality as the data obtained by Jahnukainen (1963). The first low peak occurs in the middle of April and the second peak in late April and early May (Fig. 1). The bimodal pattern is especially clear in both the Lappeenranta and Helsinki data if the numbers of flocks are observed.

Most of the primary data (e.g. Heikkuri 1980, Miettinen *et al.* 1981, Reinikainen & Salonen 1981, Rauhala & Soppela 1981, Haapoja 1982) collected during a single year from different parts of the country, show the same bimodal pattern as well (see also Fig. 2).

When the migration pattern in Lappeenranta region over a long time period and those from

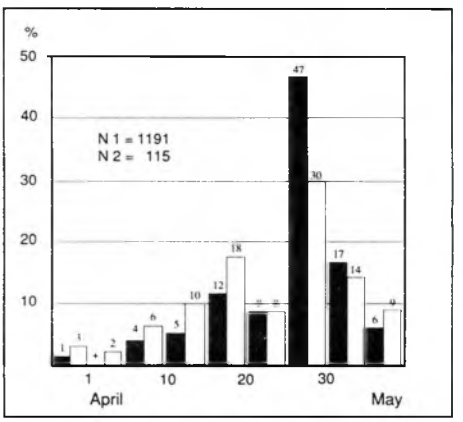

Figure 1. The spring migration pattern of the Whooper Swans in Lappeenranta region (61°N, 28°E) in south east Finland in 1946-1965. The dark bars show the distribution of numbers (N1=1191) and the light bars the flock number distribution (N2=115).

certain single springs were analyzed using semilogarithmic paper, it was apparent that the occurrence of each series of data form two different parabola. This suggests that there were two different cases both with normal distribution.

Analysis of data from different parts of Fin-

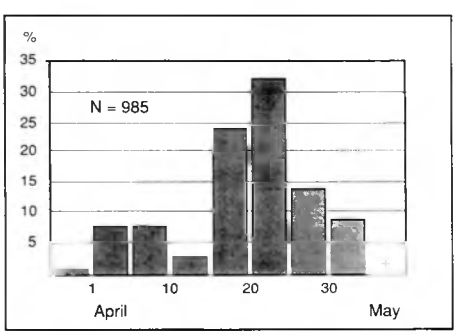

Figure 2. The bimodal pattern of the migration in spring 1988 in Suomenselkä, close to the western coast of Finland. According to Ihantola (1988).

land in relation to the distance from the wintering area in Denmark shows that the Whooper Swan population migrates through Finland in two waves (Fig. 3). The first wave moves 350 km per day and the second much slower, only about 40 km per day.

The reports on the migration in local journals often give the date when the highest numbers of Whooper Swans were seen. The years 1984 and 1985 were analyzed. The regression line equations of second wave birds' migration through southern Finland were:

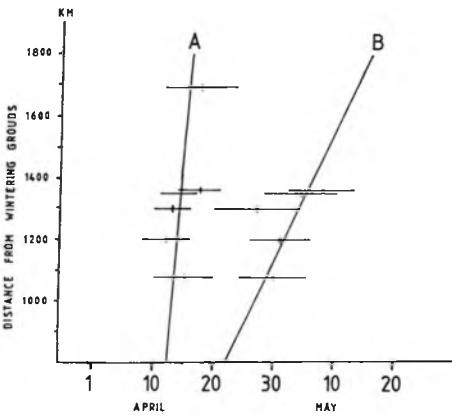

Figure 3. The migration speeds of the first (A) and the second wave (B) birds. The regression lines are calculated according to the observations from different parts of Finland in 1980. The distance is measured from Odense in Denmark, which seems to be in the middle of wintering grounds according to Atkinson-Willes (1981).

in 1984 $y = -489{,}9 + 30.1x$ ($r=0.66$) and
in 1985 $y = 85.2 + 18.0x$ ($r=0.85$) when
y is distance from wintering grounds and x the date.

In these years the speed of the second wave birds have been 30 and 18 km/day respectively.

As the distribution of first and second wave birds follows in both cases normal curve, the numbers in each wave can be counted, although the waves overlap to some extent. In recent years first wave birds have accounted for 24 +/-15 % of all birds. The first wave birds comprised a significantly higher proportion of the population during 1946-56 than they had during 1956-65 (57 % versus 21 % respectively; $\chi^2 = 98.4$, $P<=0.001$).

The Whooper Swans migrate through all parts of southern Finland. Although the numbers in Fig.4 are not totally comparable, since neither observation intensity nor the size of areas are controlled, it is apparent that in coastal areas many more birds are recorded.

Arrival at the breeding area and beginning of the breeding season

The first Whooper Swans have arrived at

Table 1. The growth of numbers and the flock size in April and early May.

Date	1-10.IV	11-20.IV	21-30.IV	1-10.V
Total number of birds	8	51	72	67
Average flock size	3	6	7	11

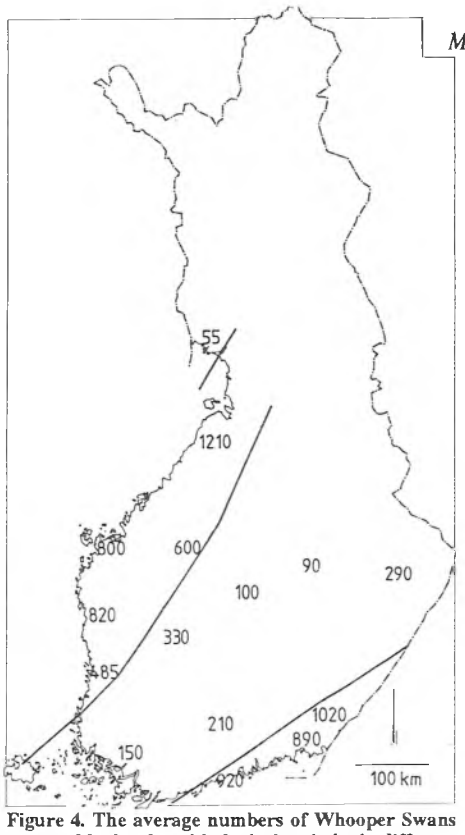

Figure 4. The average numbers of Whooper Swans reported by local ornithological societies in different parts of the country. Figures are from years 1978-1982.

Kuusamo between 29 March and 11 April in different years. At that time and for several weeks later the only open waters are the rapids, some rivers, brooks or even small springs which they use. The number of birds grows steadily during the first three weeks of April as shown in Table 1. The average flock size increases over time. About 75 % of all birds are recorded in flocks of five birds or more, but the most common flock size is two birds, i.e. about 40 % of all flock observations (Table 2).

The Whooper Swans begin to visit their old nesting sites in late April and early May. At first these visits are occasional, later on daily and may involve flights of several kilometres each way. During their early visits although the nest mound can be totally covered by levelled snow, they can still localize the old nest mound exactly. The nest mounds melt earlier than their surroundings and the birds try to rebuild them as soon as they can loosen any material. In Kuusamo the average daily temperature reach +5° C by 15 and 20 May. By that time there is free water at least in the shallow areas of lakes and ponds mainly because of flooding. From that time breeding birds begin to stay permanently on the nesting site and breeding commences (see also Haapanen *et al.* 1973b).

Discussion

Migration

Although the bimodal pattern can be seen in most primary data published there are some where it is not apparent (e.g. Lehto & Rauhala 1979).

Our hypothesis is that the bimodal pattern of the spring migration is caused by different migration times of the breeding and non-breeding Whooper Swans. There are several facts to support this idea.

The early arriving birds attempt to try to move onto a nesting site as early as possible and they can find their old nest mound under the levelled snow. In the early part of the migration the most common flock size is two birds, apparently a pair (Jahnukainen 1963).

The percentage (24 +/-15) of the population in the first wave is only a little smaller than the percentage (30 %) of the breeding birds in the population (cf. Haapanen *et al.* 1973a, Haapanen 1991). As the first wave birds move faster than the second wave birds, the probability of observing them is lower, too.

The bimodal pattern could also be caused by the differences in the breeding or wintering grounds of subpopulations.

Studies by Nilsson (1970) and Nilsson *et al.* (1982) show that close to the wintering areas in south Sweden the spring migration does not show a bimodal pattern. This is in accordance with our observations. The two waves seem to separate from each other first on the way north east.

A difference between breeding grounds does not seem plausible either. The bimodal pattern is found in all parts of Finland, not just on the southern coast, where north Russian breeders are most likely to be seen. In northern Russia the

Table 2. The Whooper Swan flocks in Kuusamo in April and early May.

Flock size	1	2	3	4	5-10	11-20	21-40	mean	median
Number of flocks	2	11	3	4	4	2	4		
Number of birds	2	22	9	16	34	31	84	7	14

first Whooper Swans are seen in April, long before the lakes are free from ice (Dement'ev & Gladkov 1967). The north Russian population probably migrates a shorter way south of Finland. In Matsalu Bay in Estonia much larger numbers of Whooper Swans are seen than in Finland (c.f. Kastepold & Paakspuu 1985).

Neck banding would provide a good method to solve these problems of timing of the migration, and location of breeding and wintering grounds.

The low proportion of second wave birds in 1946-1955 would support the suggestion that the production of the population was very poor. This was the period when the population was close to extinction (Haapanen *et al.* 1973a). Banko (1960) found the same thing in his study on Trumpeter Swans *Cygnus c. buccinator*. The proportion of non-breeding birds was very low, when the population he studied was on a low level.

Arrival in northern Finland and movement to the summer habitat

Haapanen *et al.* (1973b) have shown that the arrival of Whooper Swans in northern Finland takes place so early that the birds cannot move directly to their breeding sites.

The food resources of these pre-breeding habitats are probably of minor value. Those energy resources gained before the spring migration must be important. Brazil (1981) found that Whooper Swans spent more time feeding just before departure from wintering grounds. Also food available during the first part of spring migration may be of importance. There are important resting sites in southern Sweden (Nilsson & Nilsson 1978) and in Estonia (Renno 1968, Kastepold & Paakspuu 1985).

The first part of the spring migration is apparently a slow move northwards with the development of spring (Joensen 1974, Nilsson 1970, 1977). Based on the observations in southern Sweden and those of our own it seems apparent that when the first wave birds have reached about 60°N they begin to move very fast directly to their summer range. In northern Finland they reach these areas at least 2-3 weeks and some even 5-6 weeks before they move to the summer habitat. In southern part of the country (south from 64°-65°N) they can directly move to their summer habitat in normal years (Haapanen *et al.* 1973b).

Finns have always known of early arriving Whooper Swans on rivers. They are referred to in the Epic Kalevala and in The Swan of Tuonela music composed by Jean Sibelius in 1893.

The second wave birds migrate through Finland roughly with the +5°C isotherm at which time they can find open water in flooded shallow lakes. It is not necessary for them to use a special spring habitat.

Bean Geese, *Anser fabalis*, arrive at Kuusamo later than the Whooper Swans, in late April or early May (Waaramäki 1970). Having fed on hay fields in large numbers in Liminka area (65°N) (Lampio 1984), they still arive at Kuusamo well in time for very early breeding.

According to Thomas (1983) the Lesser Snow Geese, *Anser caerulescens*, gain their energy and protein reserves in the wintering area and in good feeding areas during the migration. The same situation pertains for other holarctic geese (Thomas 1983) and the Whooper Swan, as well.

A Whooper Swan pair can find their old nest mound site, although the mound is totally covered by levelled show. This suggests they know the site from earlier years. Since Whooper Swans have stenotopic habitat requirements (Haapanen *et al.* 1977), the selection of the breeding site must take place in conditions when the quality of territory can be assessed.

When a new site is occupied by a Whooper Swan pair, in many cases it does not breed although it defends the territory one or even two summers before breeding starts. A non-breeding pair has been seen to build a nest even in the middle of summer.

Adaptive value of the bimodal migration pattern

As a consequence of the bimodal migration pattern the non-breeding part of the population, about 70% of the whole (Haapanen *et al.* 1973a), does not compete for the scanty food resources available in poor conditions before breeding. It also allows the breeding birds to occupy the best nesting and feeding sites of a region. It still seems unreasonable for a breeding pair to arrive even six weeks before breeding starts although it may give it better chances to occupy the best nesting sites.

The non-breeding population can utilize those apparently moderately good food resources found in shallow waters of flooding lakes and ponds.

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