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# Numbers of Mute Swans and Whooper Swans in Sweden, 1967–2000

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**Abstract.**—Mute Swans (*Cygnus olor*) and Whooper Swans (*Cygnus cygnus*) in Sweden have been monitored as part of the International Waterbird Census (IWC) since 1967. For the Whooper Swan, midwinter indices show fluctuations around a slowly increasing trend. Country-wide surveys in 1971–72, 1988–89, 1995 and 2000, however found a more substantial increase in numbers, with national totals estimated at 2,000, 4,000, 8,000 and 8,000 individuals, respectively. The difference between the trends indices and the results of the country-wide surveys is attributable to the birds using more terrestrial habitats since the early 1980s, which are less well covered by the IWC. In 1995, 33% of the swans were found on land, compared to 43% in January 2000. For the Mute Swan, the midwinter indices showed a significantly increasing trend from 1970 to 2000, whereas autumn indices from September counts fluctuated around a more or less stable level, but with a decrease in the last few years. Country-wide midwinter counts recorded about 8,000 Mute Swans in 1973, 13,000 in 1988–89 and over 15,000 in January 1993.

**Key words.**—*Cygnus cygnus*, *Cygnus olor*, distribution, field feeding, Mute Swan, population trend, south Sweden, Whooper Swan, winter numbers.

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At present, internationally important numbers of Mute Swan and Whooper Swan breed and winter in Sweden, with national winter totals accounting for at least 10% of the continental northwest European population (Delany *et al.* 1999). When regular waterfowl counts started at a national level in Sweden in 1959–60 (Nilsson 1976), the Mute Swan was a regular breeding species in the southern part of the country, whereas the Whooper Swan was still regarded as a rare breeding species of remote areas in the far north (Blomgren 1974). Large flocks of migrating Whooper Swans were a regular feature of some sites in southern Sweden at that time, but these had bred elsewhere, probably further east.

Numbers of both species of swan have been monitored in Sweden since 1967 as a part of the International Waterbird Census (IWC) coordinated by Wetlands International in mid January each year. For the Mute Swan, national counts in September have also provided autumn trends in numbers since 1973. As the proportion of Whooper Swans in Sweden covered by the IWC decreased markedly over the years, apparently due to a change in the swans' feeding habits from aquatic vegetation towards more terrestrial feeding (noted during the regular goose counts undertaken in south Sweden since

1977–78), additional country-wide midwinter surveys were organized in Sweden, as in a number of other European countries (Nilsson 1997; Laubek *et al.* 1999; Cranswick *et al.* 1997).

Whereas trends in wintering numbers have been monitored annually through the IWC, information about numbers breeding is less detailed. The general distribution of the two species in the country has been well described in the national Bird Atlas (Svensson *et al.* 1999). For the Mute Swan, some regional surveys have been published but there have been no national breeding surveys. For Whooper Swans, a national breeding survey was undertaken in 1997 (Axbrink 1999), with a less complete survey made in 1985 (Arvidsson 1987). Additionally, regional aerial surveys were made of the main Whooper Swan breeding areas in the north of the country in 1972–75 (Haapanen and Nilsson 1979; Nilsson *et al.* 1998).

The results of the midwinter counts (IWC) up to and including 1989 have been published previously (Nilsson 1975; Nilsson 1991), as has the 1995 national Whooper Swan survey (Nilsson 1997). In this paper, I analyze the whole series of midwinter Mute Swan and Whooper Swan counts, and thus update former analyses of swan trends in Sweden (Nilsson 1991; Nilsson 1997).

## METHODS

The methods and coverage of the Swedish January IWC survey and September counts have been described in earlier publications (Nilsson 1975, 1991). Whereas January indices could be calculated for both species, September indices are only available for the Mute Swan. During the early years, the aim during the midwinter counts was to cover as many important sites as possible. After a two-year build-up phase, extensive coverage was obtained in 1969–78, and country-wide surveys aiming at near-complete coverage were undertaken in 1971–73. From 1979 onwards counts were undertaken annually on a sample of about 700 sites, dispersed across the southern part of the country, where areas of open water and wintering waterfowl were known to be present, the same sites being covered each year. The sites counted were selected to cover all areas with internationally important waterfowl concentrations (international importance being defined as 1% of the total population being counted at that site; c.f. Delany *et al.* 1999), and to obtain representative coverage of different wintering habitat for waterfowl in the country. For the Mute Swan, it is estimated that more than 50% of the numbers present in winter were covered annually in the January counts, whereas about 20% of Whooper Swans in Sweden were counted on the IWC sites in 2000 (L. Nilsson, unpubl. data). A new program of country-wide surveys was undertaken during the winters 1987–1989. September waterfowl counts were made at a sample of about 200 sites annually in the southern part of the country from 1973 onwards (Nilsson 1984). Their main aim is to monitor trends in numbers for species that leave the country during the winter, but they also provide for a series of September indices for the Mute Swan.

Indices were calculated by pair-wise comparisons of the totals for all sites counted in two consecutive years (Ruger *et al.* 1986; Nilsson 1975, 1991). The total for Year 2 was expressed as a percentage of the total for Year 1, and the percentage obtained was then recalculated in relation to an index of 100 set for the selected base year (1973). To avoid a bias towards extreme years, the series of primary indices were recalculated so that the means of the indices for the 34 years of the January IWC survey and for the 27 years of September counts, equaled 100 in each case.

In January 1995 and 2000, special surveys were organized to cover all aquatic and terrestrial sites holding Whooper Swans in Sweden (Nilsson 1997), as part of a coordinated international Whooper Swan census across Europe (Laubek *et al.* 1999; Cranswick *et al.* 2002). To achieve this, all former counters and many other ornithologists, including members of bird clubs and report committees were contacted. In 2000 information about the survey was also distributed by a special swan homepage on the Internet with links to all local bird clubs, web-pages and the media, and thus to the general public to obtain information about formerly unknown swan sites. During the special Whooper Swan counts, data on the habitat used by the birds was also collected.

## RESULTS

## Mute Swan

The Mute Swan is widely distributed over a large number of sites in southern Sweden,

both during September and in January (Fig. 1a, b). September flocks include post-molt birds, which occur both inland, for instance at Lake Tåkern, and on the coast in the southern part of the Öresund. In January, most Mute Swans are found at the coasts both in the archipelagos and along areas of open coast, especially in areas with extensive growth of Eelgrass (*Zostera* spp.), one of their main foods.

The midwinter indices show a significantly increasing trend over the 34 year period of midwinter counts (linear regression analysis,  $r = 0.82$ ,  $b = 3.45 \pm 0.42$ ,  $F_{1,32} = 67.8$ ,  $P < 0.001$ ; Fig. 2), the level being around index 50 for the first five years, compared to indices fluctuating about the 150 level in the 1990s. Although the overall index series shows a significantly increasing trend since 1967, this increase can be divided into parts showing different stages in the development of Mute Swans wintering in Sweden. During 1967–1972 the index was more or less stable around a low level. A much higher index was noted during some of the mild winters of the 1970s, but a new low level occurred in the cold winter of 1979. Thereafter there was a steady increase to January 1990, followed by an unusually high index in 1991. During the 1990s fluctuations were more marked than in previous years. This increase was also reflected in the results of the country-wide surveys, which yielded 8,000 Mute Swans in 1973, 13,000 in 1988–89 and over 15,000 in the 1993 survey of water areas in Sweden.

The September indices however, describe a different pattern for the Mute Swan in Sweden (Fig. 2). The general trend for the period 1973–1999 is one of decline (linear regression analysis,  $r = 0.57$ ,  $b = -1.51 \pm 0.44$ ,  $F_{1,25} = 11.9$ ,  $P < 0.002$ ), with high indices recorded before the cold 1979 winter, fluctuations around a lower but stable level in the 1980s, then a marked decrease from 1994 to 1999. The September figures, however, are heavily influenced by counts of some large concentrations of post-molt swans, and the low indices in the last few years can be due to local changes on a few important sites. When comparing the distribution maps from the September and January counts, it should be

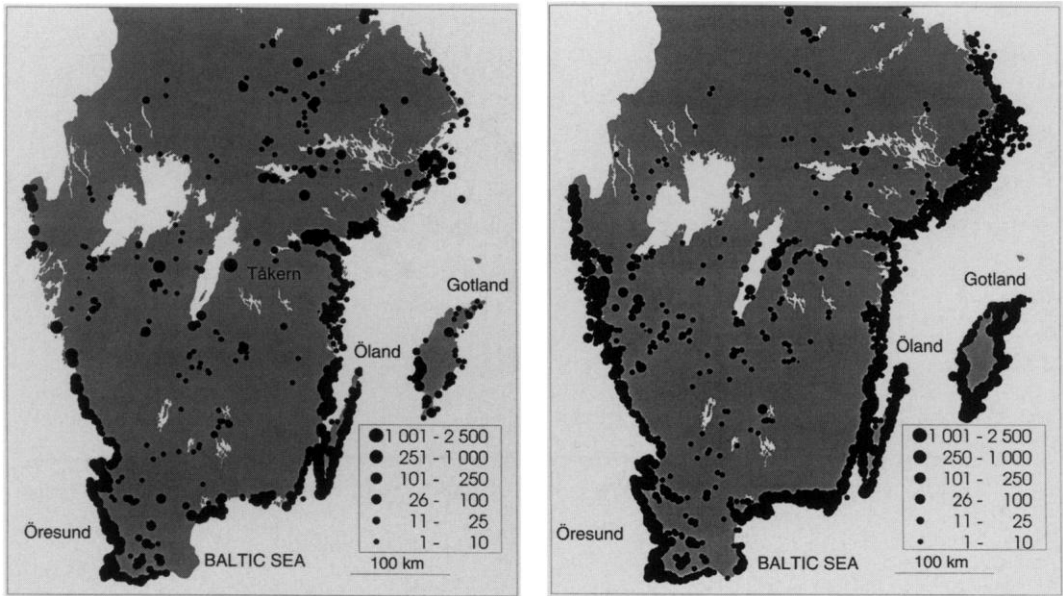


Figure 1. Maximum counts of Mute Swans on different sites in south Sweden in (a) September and (b) January.

noted that the January counts include a number of years with country-wide surveys, whereas the coverage in September is much less comprehensive, especially on the east coast.

### Whooper Swan

In January, the Whooper Swan is widely distributed across Sweden (Fig. 3), occurring both in inland and coastal areas. In contrast to the Mute Swan (Fig. 1), the Whooper Swan has more or less been absent from the archipelagos on the east coast with the exception of the southeast corner, where the archipelago had different characteristics to the islands further north, with extensive areas of *Zostera* vegetation in shallow areas that often are ice-free in mild winters. Important concentration areas were found on the west coast and on the islands Öland and Gotland in the Baltic Sea. Further inland, there is also a marked concentration of Whooper Swans in the western part of the country, where flocks of several hundred swans are found along some of the rivers.

The midwinter indices show a significantly increasing trend over the study period (linear regression analysis,  $r = 0.34$ ,  $b = 0.76 \pm 0.37$ ,  $F_{1,32} = 4.18$ ,  $P < 0.05$ ), although the in-

crease was slow and there were marked annual fluctuations in the indices. There is no consistent pattern in the relation to cold winters, however, with low indices being found in some cold winters, such as 1979 and 1982, whereas relatively high indices were found in other cold winters such as 1985 and 1987.

An increasing proportion of Whooper Swans have used terrestrial habitats in more recent winters and therefore were not covered by the IWC counts, which were confined to wetland habitats. During the first country-wide surveys in 1971–73, around 2,000 Whooper Swans were counted. The next survey in 1987–89 showed an increase with about 3,500 Whooper Swans counted in 1988 and the total numbers wintering in Sweden was estimated at 5,000 individuals taking uncovered sites into consideration (Nilsson 1997). In 1987, a very cold winter, about 2,500 were counted in a survey with good coverage. The IWC indices indicated fluctuations around a steady level for the period between 1987 and 1995, whereas the special country-wide survey in January 1995 showed a very marked increase in wintering numbers from about 5,000 to at least 8,000 birds (7,439 swans actually counted). The numbers counted in January 2000 was 7,022, giving an estimated total

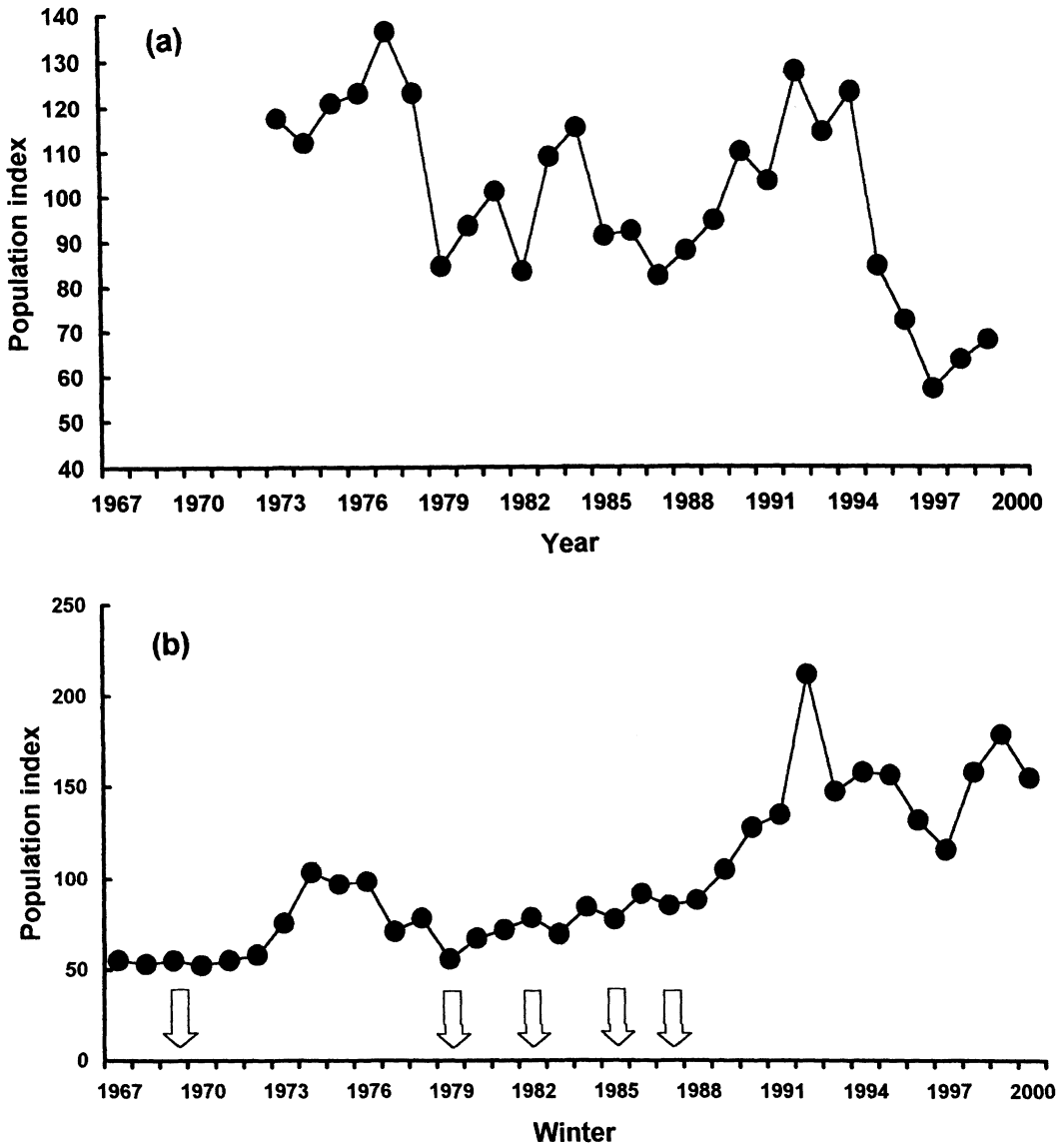


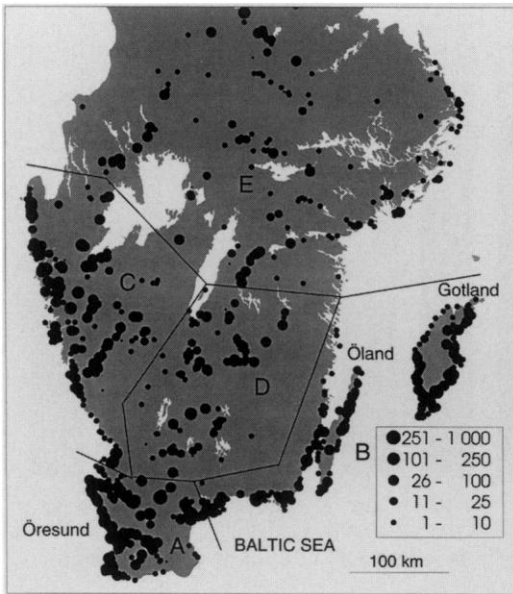
Figure 2. Population indices for Mute Swan in south Sweden: (a) September and (b) January. Cold winters (mean monthly January temperatures for a standard sample of ten stations in south Sweden  $<5^{\circ}\text{C}$ ) are marked with arrows. Winter indicates the year in December for indices in the following January (i.e., 1967 indicates the 1967–68 winter).

of about 8,000 Whooper Swans in Sweden, similar figures to the previous country-wide survey in January 1995.

One of the reasons for the discrepancy between the Whooper Swan indices, based on the IWC, and the observed development of numbers wintering in Sweden was the relatively new tendency for Whooper Swans to feed in terrestrial habitats. In January 1995, about 30% of the Whooper Swans were found on terrestrial habitats (Nilsson 1997).

In January 2000, which was also a mild winter, 43% of the Whooper Swans were found on the fields. When the waterfowl counts started, only small numbers of Whooper Swans were found on land and in these cases they were close to water (Nilsson 1997).

There was marked regional variation in field choice by Whooper Swans in both January 1995 and January 2000 (Fig. 5, Table 1). In Scania, the proportion using terrestrial habitats was lower in January 2000 than in

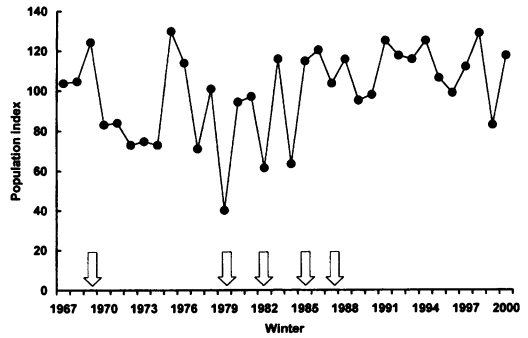


**Figure 3.** Maximum counts of Whooper Swans at different sites in Sweden in January. The map also shows the different regions used in the analysis of field choice in Table 1: A = Scania, B = Southeast, C = West coast, D = South inland and E = Central.

January 1995, (40% and 70% respectively), whereas in all other regions the proportion using terrestrial habitats was higher in 2000 than in 1995. The main field types used by the Whooper Swans were winter cereals, grassland and winter oilseed rape. Rape was used primarily in Scania, which is the main growing region for this crop.

#### DISCUSSION

The midwinter counts indicate increases in wintering numbers of both Mute Swans and Whooper Swans in Sweden from 1967–2000, this increase being part of a general increase in wintering populations for both species in northwest Europe (Delany *et al.* 1999). In the Mute Swan, this increase was also reflected in the results of the country-wide surveys, whereas in the Whooper Swan trends derived from the IWCs did not correspond to the four-fold increase in swans counted during the country-wide surveys from the early 1970s to 1995, or the doubling of numbers since the mid 1980s, probably because the increasing number of field-feed-



**Figure 4.** January indices for Whooper Swans in south Sweden. Cold winters (mean monthly January temperatures for a standard sample of ten stations in south Sweden  $< -5^{\circ}\text{C}$ ) are marked with arrows.

ing Whooper Swans were not covered by the IWC counts.

#### Mute Swan

There have been no country-wide surveys of breeding Mute Swans with which to compare the indices from the September and January counts. The Swedish Bird Atlas (Svensson *et al.* 1999) gives some historical data, with an estimate of about 310 pairs for the region around Lake Mälaren in south central Sweden in 1921. There was then slow growth in the number of breeding pairs until a more substantial increase between 1950 and the mid 1970s, during which period there was also a marked spread in breeding distribution northwards. Recent reports indicate a decrease in inland breeding by Mute Swans during the 1980s and 1990s, whereas numbers breeding on the coast, especially in the archipelagos, has continued to increase (Svensson *et al.* 1999). According to the Bird Atlas (Svensson *et al.* 1999), numbers now breeding in Sweden are estimated at between 4,000 and 7,000 pairs.

The different trends for inland and coastal breeding, at least in some Swedish districts, can explain the discrepancy between the September and January Mute Swan indices. In January, most Mute Swans are concentrated on the coast, whereas only small numbers that do not have much influence on the indices, remain inland. Moreover, large areas especially in the inner archipela-

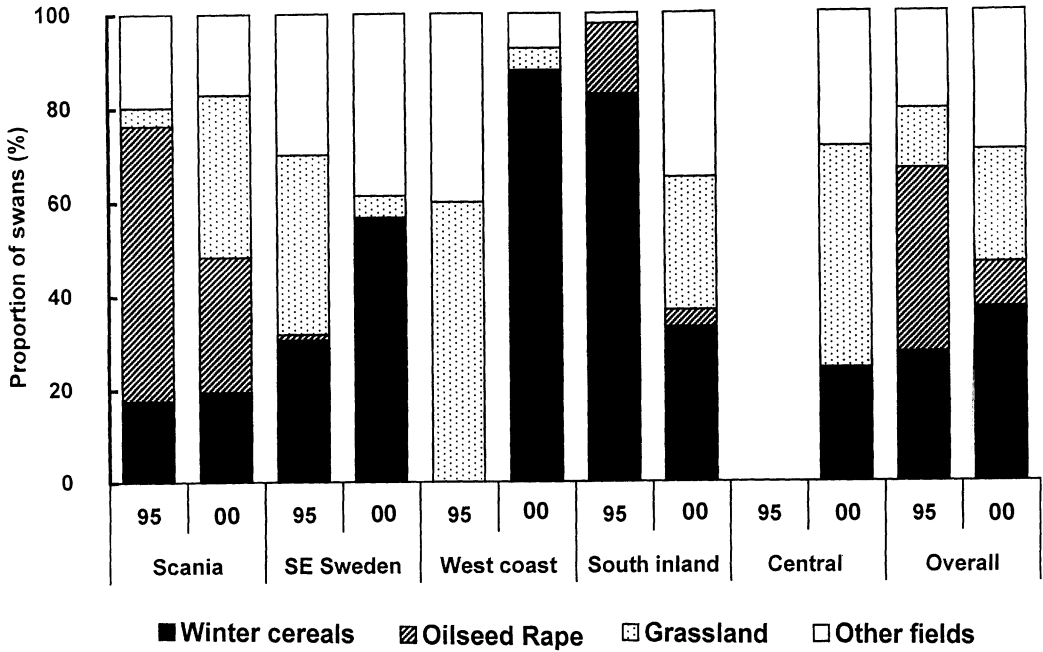


Figure 5. Field choice of Whooper Swans (as percentage of all Whooper Swans counted on land) at country-wide surveys in south Sweden in January 1995 and 2000. The different districts are shown in Fig. 3. The proportion of swans on terrestrial habitats is given in Table 1.

gos freeze in winter, and the swans then concentrate on areas of open water included in the IWC counts. The September counts, on the other hand, have a good coverage of inland areas and some coastal sites mostly used by post-molt swans, but the extensive archipelagos are not covered. Thus the September counts measure changes in the numbers breeding inland, whereas the January indices measure trends for all Mute Swans wintering in Sweden.

#### Whooper Swan

The increase in Whooper Swans wintering in Sweden is in line with an increase in the numbers breeding in Sweden (Arvidsson 1987; Axbrink 1999; Haapanen and Nilsson 1979; Nilsson *et al.* 1998), and with the increase in the northwest European population as a whole (Laubek *et al.* 1999). When the winter surveys considered here commenced, Whooper Swans bred only in the

Table 1. Field feeding by wintering Whooper Swans in different parts of south Sweden, recorded during the international swan censuses of January 1995 and January 2000. For the different areas in south Sweden see Fig. 3. The totals given here are lower than total counts for the regions because some observers did not report on habitat choice.

Area	January 1995		January 2000	
	Percentage of swans on land	Total swans counted	Percentage of swans on land	Total swans counted
A. Scania	68.1	2,214	40.5	2,076
B. SE Sweden	34.7	1,188	62.3	1,258
C. West coast	12.3	1,215	25.3	498
D. South Inland	19.0	1,773	46.7	2,031
E. Central	0.0	879	21.7	849
Overall total	33.1	7,269	43.0	6,712

northernmost parts of Sweden, with just a few occasional pairs found nesting further south (Nilsson *et al.* 1998; Axbrink 1999; Svensson *et al.* 1999). In 1972–75, aerial surveys were undertaken in the two northernmost provinces, Västerbotten and Norrbotten (118,000 km<sup>2</sup>), constituting about a third of the total area of Sweden (Haapanen and Nilsson 1979). Numbers breeding in these two provinces was estimated at 310 territorial pairs (120 nests). A repeat aerial survey was made in 1997 (Nilsson *et al.* 1998), resulting in an estimate of 2,800 pairs (1,800 nests) for the same two provinces, with a marked spread of Whooper Swans from the inland core areas over the entire study area. In 1997 the Swedish Ornithological Society organized a survey of Whooper Swans breeding across Sweden, which yielded an estimate of 3,800 pairs for the country (Axbrink 1999), including the results of the aerial survey referred to above. Arvidsson (1987) had estimated that 500 pairs bred in Sweden in 1985, but this was certainly an underestimate, at least when the two northernmost core provinces are considered (Haapanen and Nilsson 1979), and numbers were probably closer to 700 pairs or more.

The five-fold increase in Whooper Swans breeding in Sweden between the mid 1980s and late 1990s thus appears to be much more substantial than the doubling in the numbers counted in winter over the same period. The main breeding area in Sweden is in the northernmost part of the country, however, and swans from these regions mostly migrate west to winter on the Norwegian coast (Mathiasson 1991; Preuss 1981), whereas banding programs in Finland indicate swans wintering in the south of Sweden are from breeding grounds further east (Laubek 1998).

During the first decades of the 20th century the Whooper Swan was a rare species with a restricted distribution in the large mires of northernmost Sweden. When the species was protected from hunting by a governmental act in 1926, numbers breeding in Sweden was estimated at only about 20 pairs. The increase in numbers following legislation to protect the birds was slow until the 1960s, with the swans still occurring mainly on large mires in the northern part of the country. Even if the

main reason for the increase in Whooper Swan numbers in Sweden and in other parts of northern Europe is the protection that has allowed the species to spread south over the boreal forest zone and its lakes and mires, it is likely that the rate of increase in recent years has also been influenced by changes in agriculture which has provided new feeding areas for the swans (Nilsson 1997; Laubek *et al.* 1999) as well as for goose populations (Nilsson and Persson 2000).

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