Waterbirds around the world

A global overview of the conservation, management and research of the world's waterbird flyways

Edited by G.C. Boere, C.A. Galbraith and D.A. Stroud

Assisted by L.K. Bridge, I. Colquhoun, D.A. Scott, D.B.A. Thompson and L.G. Underhill

EDINBURGH, UK: THE STATIONERY OFFICE
Changes in migration patterns and wintering areas of south Swedish Greylag Geese Anser anser

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ABSTRACT
Neck-banding of Greylag Geese Anser anser started in south-western Scania, southern Sweden, in 1984, as a part of a Nordic programme to carry out a detailed study of the migration routes of Greylag Geese from different regions of the Nordic countries. By 2002, 2 347 Greylag Geese had been neck-banded in Scania, and these had resulted in about 14 000 readings of neck-bands from abroad. During the course of the study, there was a northward shift in the main winter quarters from a majority of the geese wintering in south-western Spain to a majority wintering in The Netherlands. During the same period, the timing of the autumn and spring migrations also changed. In 2002, the median arrival date of geese staging in The Netherlands in autumn was about 40 days later than in 1986, while in spring, the geese returned to their breeding areas in Scania about 20 days earlier. The implications of these changes for the population dynamics of the species are discussed.

INTRODUCTION
The population of Greylag Geese Anser anser in Sweden, as in most other countries in north-west Europe, has increased markedly during recent decades (Nilsson et al. 1999). Thus the September totals in Sweden are now close to ten times higher than they were when the counts started in 1984 (L. Nilsson unpubl. data). The increasing Greylag Goose populations during the late 1970s and early 1980s led to the establishment of many new concentrations of geese in a number of agricultural areas in the Nordic countries, and this gave rise to conflicts with agricultural interests. In response to this, the Nordic Council for Wildlife Research (NKV) started a neck-banding programme in the Nordic countries in 1984. The main aim of this programme was to study the migration patterns and local movements of Greylag Geese in the four Nordic countries (Andersson et al. 2001). The presence of a large number of neck-banded Greylag Geese in the population was used to study various aspects of the ecology of the geese, especially in south-western Scania, in southern Sweden (see, for example, Nilsson et al. 2001, Nilsson & Persson 1993, 1994, 1996, Nilsson et al. 1997).

When the neck-banding programme started in 1984, the majority of the marked geese migrated from the Nordic countries to staging areas in The Netherlands and then continued on to the traditional wintering areas in the Marismas of Quadalquivir in southern Spain (Andersson et al. 2001, Paludan 1973, Lund 1971). Some geese remained throughout the winter in The Netherlands in the first year of the study, but this proportion increased during the period of the study. There were also differences in the migration patterns and wintering areas between the various Nordic study populations. The Nordic project was terminated in the early 1990s (Andersson et al. 2001), but neck-banding programmes continued in Norway and south-western Scania, southern Sweden.

This paper provides an updated review of the migration patterns of Greylag Geese from south-west Scania since the joint Nordic analysis (Andersson et al. 2001) and, more specifically, attempts to elucidate the changes that have occurred in the migration patterns and wintering areas of the Greylag Geese from Scania, and to analyse these changes in relation to different aspects of the population ecology of the species.

METHODS
Families of flightless Greylag Geese were captured by driving them into nets at four different breeding lakes in a study area in southern Scania in southernmost Sweden. The study area and methods of capture have been described in other reports from the study (Andersson et al. 2001, Nilsson & Persson 1994). During the period 1984-2002, a total of 2 321 Greylag Geese were neck-banded in the study area, comprising 388 adults and 1 733 yearlings.

Intensive observations were undertaken in the study area to establish the presence and return rate of the marked geese on an annual basis and to establish their breeding success. In some years, intensive checks were also undertaken as a part of other local studies. Observations were made in the staging and wintering areas by a network of more than a thousand voluntary observers who regularly checked their local areas. National marking programmes in the various countries along the migration route also co-operated in the study. Furthermore, during several years of the present study, Hakon Persson was undertaking a special study of the geese in Spain.

RESULTS
Of the 2 321 geese which were marked, 98% of the adults and 86% of those marked as young birds were seen after marking. A total of 467 adults (81% of all those marked and seen after marking) and 1 086 birds marked as yearlings (73%) were encountered abroad, providing information on migration patterns and wintering areas. The largest numbers of observations of marked birds were in The Netherlands, followed by Spain (Fig. 1).

Small numbers of Greylag Geese from Scania were recorded in The Netherlands during the summer, especially during the first years of the study, when Oostvaardersplassen in Flevoland was still the major moulting site for Greylag Geese from Scania (Nilsson et al. 2001). During the first two periods of the study (1984-1990 and 1990-1996), the main migration into The Netherlands occurred in October, but in the period 1996-2002, the main arrival occurred in November (Fig. 2). Peak numbers were recorded in October in the first study period, and in November and December in the second and third periods, respectively. Throughout the study, there has been a significant trend in the later arrival of Scanian Greylag Geese in The...
During the first part of the study, Scanian Greylag Geese had already arrived in their wintering areas in southern Spain in October, after a short stay in The Netherlands (Andersson et al. 2001), but the main arrival occurred later in later years (Fig. 4). Over the years, there has been a gradual shift in the winter distribution of Scanian Greylag Geese. A higher proportion of

However, it is more difficult to establish the true peak in the occurrence of marked geese in south-west Spain, as the birds often move into areas in the Marismas where the reading of neckbands is very difficult.

Fig. 1. Percentages of neck-banded Greylag Geese Anser anser from south-west Scania, southern Sweden, that were seen abroad (as a percentage of those seen after marking).

Fig. 2. Monthly distribution of observations of neck-banded Greylag Geese Anser anser from south-west Scania, southern Sweden, seen in The Netherlands during three time periods. Each individual is included only once per month and year.

Fig. 3. Median arrival time (in ten-day periods from 1 August) in The Netherlands of neck-banded Greylag Geese Anser anser from south-west Scania, southern Sweden (R= 0.92, P<0.001).

Fig. 4. Monthly distribution of observations of neck-banded Greylag Geese Anser anser from south-west Scania, southern Sweden, seen in Spain during three time periods. Each individual is included only once per month and year.

Fig. 5. Percentage distribution of Greylag Geese Anser anser from south-west Scania, southern Sweden, in their wintering areas in 1986-2001.

Fig. 6. Median arrival time (in ten-day periods from 1 January) of neck-banded Greylag Geese Anser anser in the breeding/marking areas in south-west Scania, southern Sweden (R= 0.67, P<0.001).
the geese remain throughout the winter in the Dutch Delta area, and fewer birds migrate to Spain (Fig. 5). Some geese now spend the winter on the German North Sea coast, and a wintering tradition has even been established in Sweden, where there has been a wintering population of about 5,000 birds in January in the last few years (L. Nilsson unpubl. data).

The spring migration has also changed. The median date of arrival at the breeding areas is now about one month earlier than it was in the earliest period of the study (Fig. 6).

**DISCUSSION**

The changes in the migration pattern of the Scanian Greylag Goose population are not unique. Within the Nordic Greylag Goose Project, a similar change has been noted in the Norwegian population, with the geese now arriving at the staging areas in the Netherlands later than was formerly the case (A. Föllestad & L. Nilsson unpubl. data). Similarly, in Sweden, there has been a marked northward shift in the distribution of autumn staging Taiga Bean Geese *Anser fabalis fabalis* in recent years (Nilsson 2000).

The changes seen in the migration pattern of the Greylag Goose, as in other species, can most probably be related to the recent trend in milder winters and earlier springs. In Sweden, the last really cold winter was in 1987; winters since then have been mild or with only short cold periods, at least in southernmost Sweden (Swedish Meteorological Institute Monthly reports). In the province of Scania, mean February and March temperatures show an increasing trend since the goose project started in 1986, but the situation is better described as a marked change in winter temperatures after the cold winter of 1987, with much milder temperatures since then.

Even if milder winters and earlier springs are important factors behind the change in migration patterns, changes in agriculture may also be of importance (Nilsson & Persson 2000). In Sweden, there has been an increase in the acreage of autumn-sown cereals in recent years, offering the geese good feeding conditions after the ploughing of stubble fields and root crops.

It is interesting to speculate what effects these changes in winter distribution and migration pattern can have on the Greylag Goose populations. Nilsson & Persson (1996) found a significantly higher survival rate for Greylag Geese wintering in the Netherlands than for those wintering in Spain. This difference was most probably related to differences in hunting pressure, but it was also found that drought conditions in the Marismas led to higher mortality rates in some years. The difference in the length of the migration is probably of minor importance.

The geese wintering in the Netherlands showed a higher breeding success than the geese wintering in Spain (Nilsson & Persson 1996). The recruitment rate of young geese into the breeding population was, among other factors, also found to be related to the choice of winter quarters by the parents (Nilsson et al. 1997). Nilsson & Persson (1994) found a significant relationship between early arrival and high breeding success, and this could be related to the location of the winter quarters, as geese wintering in the Netherlands are in a better position to return early to the breeding areas in Scania than geese wintering in Spain.

To conclude, the results demonstrate the importance of continuing the neck-banding programmes in Europe, in order to monitor and analyse ongoing and future changes in the migration patterns and wintering distributions of European geese in relation to a variety of underlying factors.

**ACKNOWLEDGEMENTS**

The Nordic marking programme was started by the Nordic Council for Wildlife Research (NKV), which also funded the programme during the early years. Further support was obtained from the Swedish Environmental Protection Agency, the Carl Trygger Foundation for Scientific Research and the Öresunds Bro Consortium. The catching and marking of the geese was undertaken by Hakon Persson. The study would not have been possible without the participation of over a thousand voluntary observers in many countries who reported their neck-band readings.

**REFERENCES**


