

**MID WINTER MOVEMENTS OF GEESE IN THE NETHERLANDS  
AS A RISK TO AVIATION SAFETY.**

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**Abstract.**

Recent tracking radar observations by the Royal Netherlands Air Force along the West Coast of The Netherlands have shown that weather induced mass movements of geese may pose a serious threat to aviation safety. Mid winter movements of geese are fairly well known to field ornithologists in and around the Netherlands, but so far nobody realised at what scale (nation wide) and altitude (up to 1 km high) these flights occur. Coupled with the tenfold increase in goose numbers during the last decades this certainly is a reason for concern. In this paper we summarise the knowledge on numbers and movements of wintering geese into and within the Netherlands. We explore the possibilities to understand the causes and thus predict the mobility of the geese.

Thanks to (colour)ringing and neck-banding programs a lot of information is available about flying strategies based on decisions the birds take. Such decisions are both individual choices related to food availability, competition and hunting as well as collective choices based on sudden changes in snow and frost conditions. The paper claims that it is feasible to model and reliably predict mass mid winter movements of geese by integrated research in order to improve flying safety.

**Key Words:** Migration, Weather, Geese, Local movements, Radar, Forecasting, Conservation

## Introduction

Geese are relatively large birds that migrate in flocks. Therefore encounters between geese and aircraft are likely to result in serious collisions. Due to its mild climate and its physical geography the Dutch lowlands have always been a prime wintering area for geese.

Six species of geese frequent the Netherlands in large numbers, each with a species-specific time-pattern.(Fig.1) (Rooth *et al.* 1981).

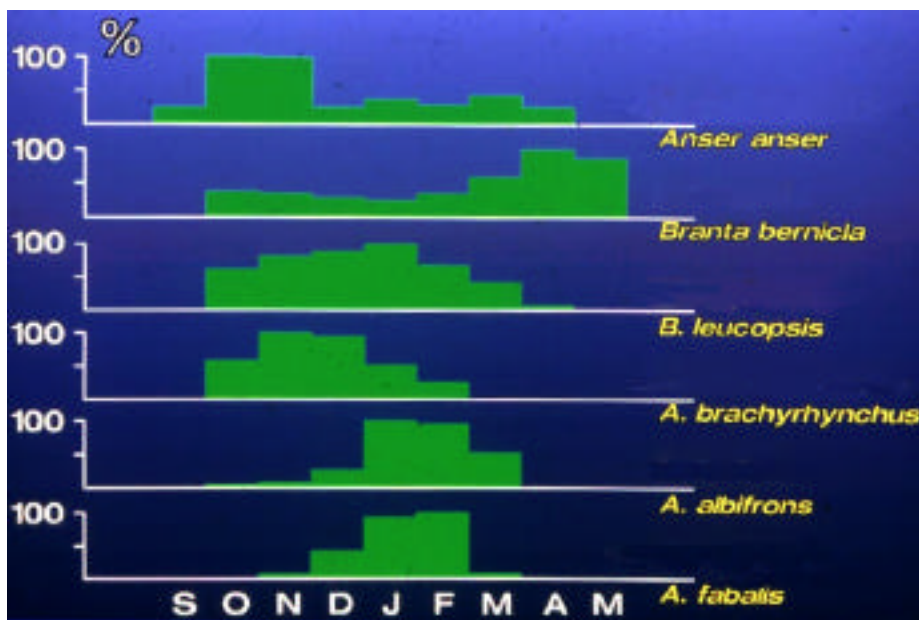


Figure 1. Goose phenology in the Netherlands. The 100 % level indicates the peak month of occurrence of each of the six goose species in the Netherlands. During the other months the percentage of the average number of geese present during that peak month is indicated (from Rooth *et al.* 1981). Grey lag Geese (*Anser anser*) peak in the autumn, while on migration to southern Spain, whereas typical wintering species like the Greater White-fronted Goose (*Anser albifrons*) and the Bean Goose (*Anser fabalis*) only visit the Netherlands in large numbers in midwinter. In case of the Greater White-fronted Goose, the most numerous winter visitor in the Netherlands the 100 % level related to 500,000 birds in the early 1990s (Koffijberg *et al.* 1997). Barnacle Geese (*Branta leucopsis*) and Pink-footed Geese (*Anser brachyrhynchus*) are present larger numbers over a longer time-span, because they already arrive in the early autumn. The smallest species the Brent Goose (*Branta bernicla*) passes through quickly and in relatively low numbers in the autumn, but is particularly abundant in April/May during spring staging.

The largest (3.2 Kg) species is the Greylag Goose (*Anser anser*), which also nests in the Netherlands, but is present in large numbers in September till November, before migrating further southward to winter in France and Spain. The other five species are all nesting in the arctic regions of Eurasia, and arrive mainly in October (Brent Geese (1.3 Kg) *Branta bernicla*, Barnacle Geese (1.6 Kg) *Branta leucopsis* and Pink-footed Geese (2.5 Kg) *Anser brachyrhynchus*) or somewhat later in the season, in November/December (Greater White-fronted Geese (2.0 Kg) *Anser albifrons* and Bean Geese (3.0-3.5 Kg) *Anser fabalis*). (Bauer & Glutz von Blotzheim 1968).

Since the 1970s a marked increase in goose numbers has been observed in the Netherlands and in western Europe as a whole (Ebbinge 1985, Koffijberg *et al.* 1997, Madsen *et al.* 1999). The key reason for the recovery of goose numbers from their extremely low levels in the 1950s, is most likely their increased protection from hunting (Ebbinge 1991). Improved food conditions through intensified agriculture accounts for better quality winter food at higher densities and is proposed as an alternative explanation for the observed increase in population levels (van Eerden *et al.* 1996). However, that explanation cannot explain the high population levels early in the 20th century. Nevertheless, this latter hypothesis can explain the higher densities in which goose concentrations can occur for prolonged periods.

## Risks for Aviation

Clearly the risks for collisions with geese are dependent on the total number of geese, their flight movements and the height at which geese fly. In order to help avoid collisions knowledge on the following three subjects is of great importance:

- distribution of geese in space and time,
- their movements in relation to weather conditions, and
- future population developments.

Such knowledge could help to indicate when certain areas have to be avoided by aircraft in order to avoid collisions.

Re-routing of air traffic will, however, not always be an acceptable solution, and therefore it is likely that one has to take active measures as well to control the presence of geese in certain areas.

Such measures could even include control the total population levels by hunting or other lethal methods.

Such measures, too, require a sound understanding of the behaviour and population dynamics of geese.

## Goose movements

Movements of geese can be categorised into three major classes:

- daily commuting between roosts and feeding grounds (up to 50 km)
- intermediate movements (50 – 200 km)
- true migration (200 – 1500 km)

**Daily commuting** in wintering or staging areas is usually very predictably confined to daybreak and evening twilight, when geese fly at low altitudes varying from 10 – 100 metres to and from their feeding grounds. Usually geese are diurnal and spend the night on roosts like bodies of shallow water or sandbanks, where they are safe from ground predators. However, during moonlit nights geese can also reverse this pattern and spend the night on the feeding grounds and roost during the daytime. Then, flight movements are less predictable and upcoming cloud cover can suddenly trigger flights in the middle of the night to the roost.

**Intermediate movements** resulting in a redistribution of geese over their wintering areas are usually triggered by a change in weather or food abundance. Such movements were also thought to take place at fairly low altitudes, but recent radar studies by van Belle et al. (in prep.) have shown that during such movements geese can fly at much higher altitudes of 1 km or higher ( $\geq 3,000$  feet).

During **true migration**, during which up to 5,000 km can be covered in total, single stretches of up to 1,500 km can be covered during one flight. Such long flights are strongly wind dependent, and favourable tailwinds are preferred (Hochbaum 1955, Ebbinge 1989). In the late 1960s it was already described how such long flights could be carried out at altitudes of 1,500-2,000 metres (van Straaten & van den Bergh 1969).

Recoveries of shot Greater White-fronted Geese, that were all ringed in the Netherlands in previous winters, clearly show how during autumn migration declining temperatures push the geese westward from Russia to northern Germany and the Netherlands (Fig.2).

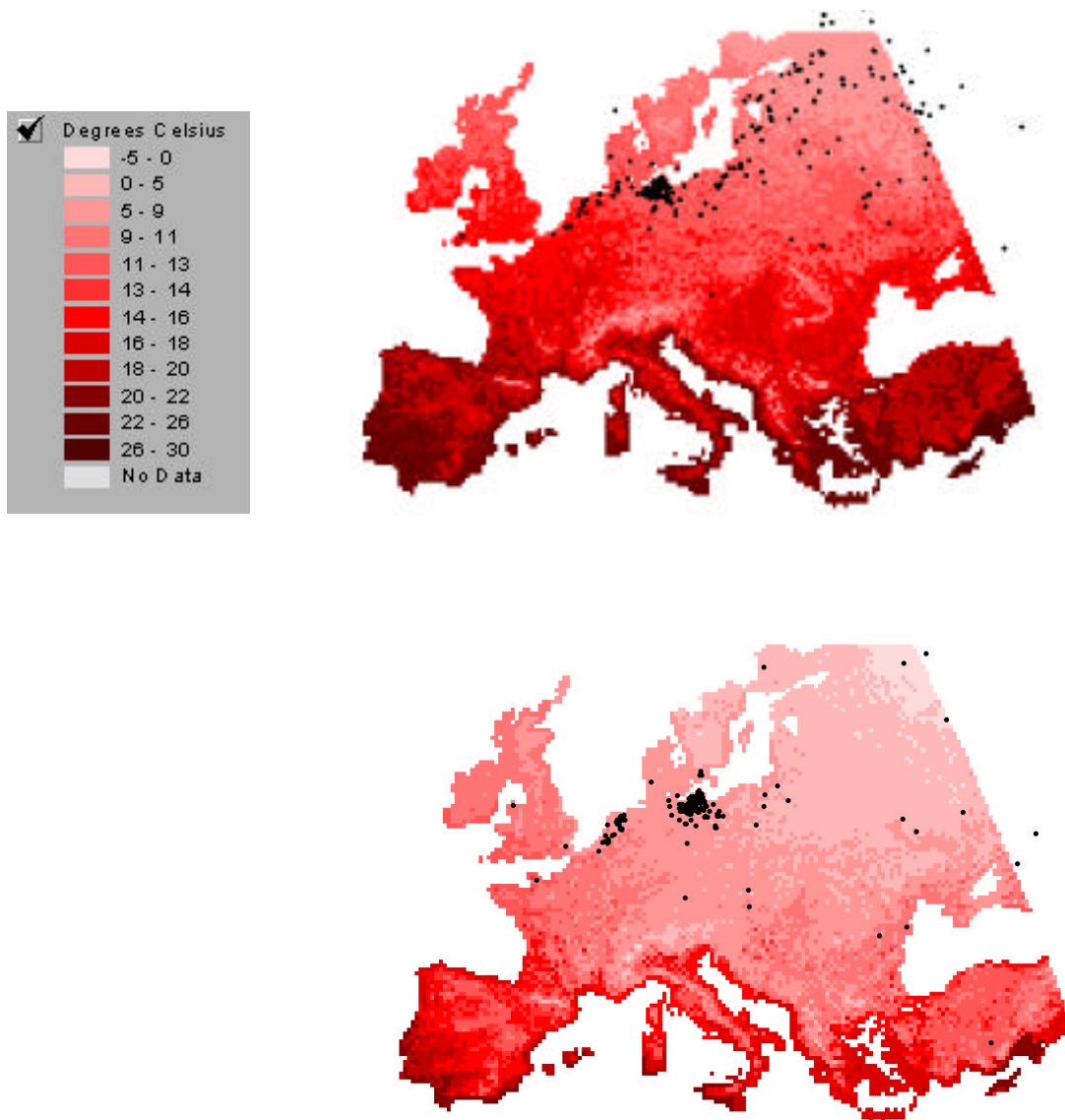
## Research techniques.

Basically research techniques can be divided into two complementary groups:

- collecting information without marking individual birds, and
- collecting information using marked individuals

### Unmarked individuals

Under the first category the internationally co-ordinated goose censuses by Wetlands International, which include the national **censuses** co-ordinated by SOVON in The Netherlands are extremely important, as they provide information on where and when large concentrations of geese can be found.



*Figure 2. Distribution of recoveries of Greater White-fronted Geese in October (upper chart) and November (lower chart) against the mean temperature during that month. The temperature data (see legend) are extrapolated from meteorological stations in Europe. All geese have been ringed as wintering birds in the Netherlands between 1958 and 1999. Only reports of shot birds with accurate information on the date at which they had been shot have been included.*

These censuses also provide information on population sizes.

**Observational studies** on migration intensity provide extra information on when and where flocks of geese migrate. Such studies are clearly of more direct importance for aviation.

An important addition to the latter research technique is the use of **radar** to study migration intensity in much greater detail. Fig. 3 shows that goose flocks are identifiable using tracking radars and precise estimates regarding ground speed (i.c. 27 m/s) and flight height (i.c. 1199 metres) can be obtained.



*Fig. 3. Picture of migrating goose flock made by tracking radar on 15 December 1999 near IJmuiden. Ground velocity (27 m/s) as well as flight height (1199 metres) are indicated.*

## Marked individuals

### Metal rings

The second category of research techniques includes classical ringing (banding) using metal rings, that usually only provide two observations per individual: the place and time of capture and the place and time of recovery, usually – in case of geese – by being shot and reported.

In the Netherlands Alterra (and its predecessors I.T.B.O.N., R.I.N. and IBN-DLO) have been ringing geese since the late 1950s. The bulk of ringed geese are Greater White-fronted Geese and Bean Geese of which about 50,000 individuals have been marked. Fig. 2 shows the recoveries of shot Greater White-fronted Geese in October and November in relation to the mean temperature. Such maps are, of course not only dependent on the temporal and spatial distribution of the birds, but also on the distribution of the hunters who collect the data. Only if hunters and hunting seasons are evenly distributed the shot birds provide us with an unbiased picture of the real distribution of the geese.

### Colour-rings

Since the 1980s Alterra has also co-ordinated programmes using engraved colour-rings on Brent and Barnacle Geese. These engraved colour-rings make the marked birds identifiable by telescopes in the field at distances of up to 300 metres. A network of volunteer observers has made these research programmes very effective indeed, rendering multiple re-sightings of the same individual. Table 1 shows how effective this method is, when compared to the use of metal rings. Over a period of 6 years 99 % of the colour-ringed Barnacle Geese were at least once reported, compared to only 4 % of the metal ringed birds. However, the amount of staff time to handle the more than 20,000 sightings of 576 birds marked, is a major problem for running such marking programmes. As can be seen in Table 1 over the same time span 966 metal ringed birds yielded only 45 recoveries.

*Table 1. Comparison of the results using metal-rings or colour-rings on Russian Barnacle Geese during a study form 1978 – 1984 (see Ebbinge et al. 1991)*

	Metal-ring	Colour-ring
Number ringed	966	576
Found dead	20	9
Retraps/resightings	25	20230
Never reported	924	5
% reported	<b>4.3</b>	<b>99.1</b>

Again the spatial distribution of the observers, and in particular the accessibility of the terrain heavily bias the information one gets using this method, but in western Europe, and in particular in The Netherlands extremely good results are possible.

### Radio-tracking

Individuals can also be tracked by VHF-radios or satellite transmitters using small backpacks with 30 gram radios. This is a very costly method, but satellite telemetry has the great advantage that the results are not biased because of limited observer distribution. However, here too, the world is not perfect, and biases regarding the probability of being detected still occur. E.g. in the high arctic one gets less distorted information than in western Europe.

## **Future research and analysis to make weather-dependent predictive models**

To make useful models to predict the timing and intensity of goose migration at short notice, the relationship between weather patterns and migration activity should be established using the large amount of existing information on weather situations (temperature and wind being of great importance) and the above mentioned existing data sets on both individually marked birds and direct and radar observations of migratory movements.

The resulting predictions should then be tested using newly collected observations. Such observations should at best include radar observations and the tracking of individuals by satellite telemetry for longer distance migration, whereas VHF-radio telemetry would be a cheaper and more cost-effective approach to obtain such data for more restricted, local movements. Moreover it should be investigated how geese can be relocated from areas near airports, and possibly even how goose populations can be controlled at a desirable level. A level that both serves the international obligations to protect migratory species and the moral obligation to minimise hazards to aircraft and thus human lives.

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