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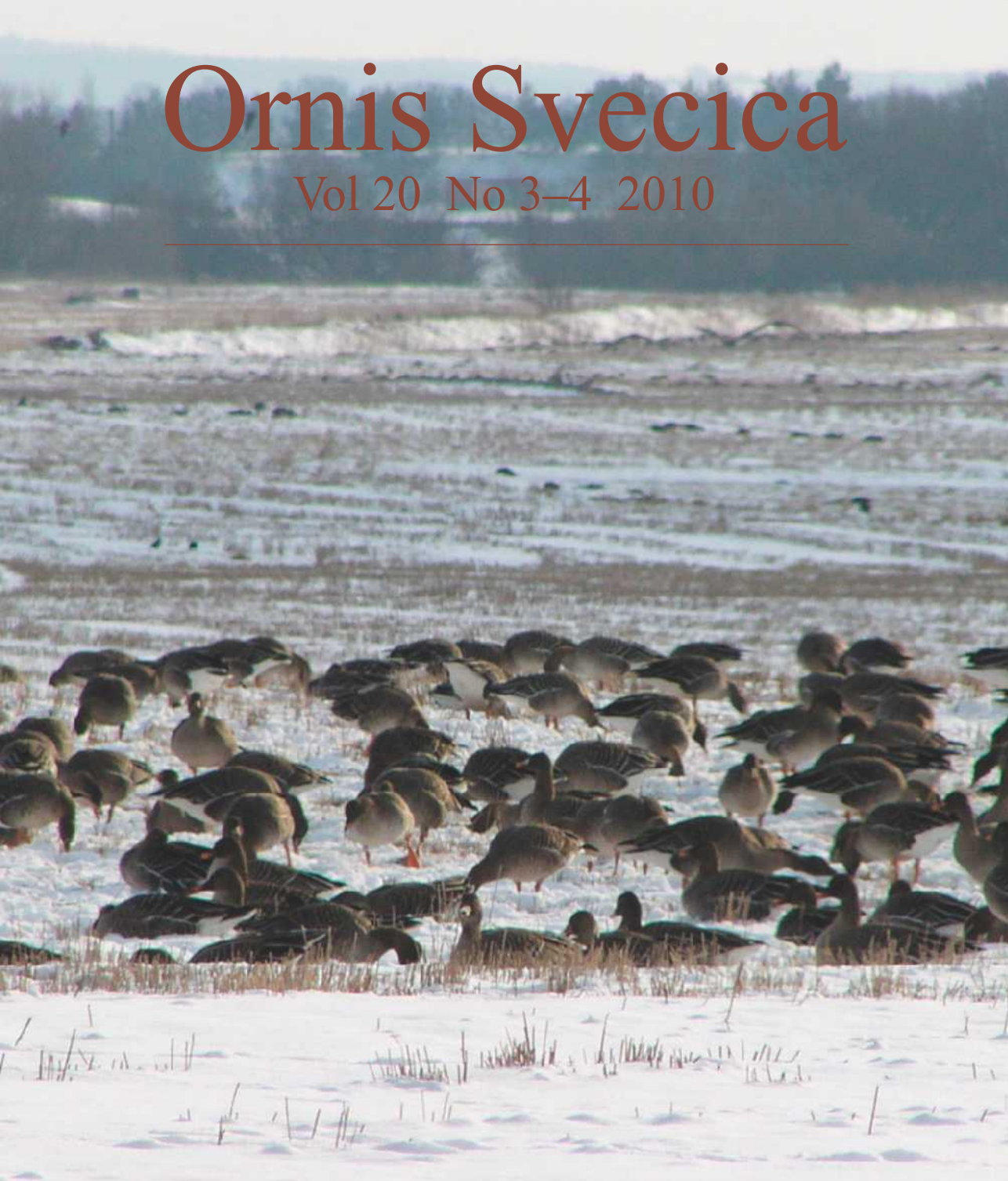

Expanding Goose Populations and their Management

Proceedings of the 12th Meeting of the Goose Specialist Group
9–14 October 2009, Höllviken, Sweden

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the Goose Specialist Group
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Expanding Goose Populations and their Management

Convener
Leif Nilsson

Editor
Sören Svensson

Organized by Department of Ecology, Lund University
Supported by Swedish Association for Hunting and Wildlife Management

Expanding Goose Populations and their Management – Introduction

BART EBBINGE

Chairman of the Goose Specialist Group

It is a great pleasure to write this introduction for the proceedings of the 12th meeting of the Goose Specialist Group in Höllviken, 9–14 October 2009, which was so well organised by Leif Nilsson and his team of the University of Lund, and sponsored by the Swedish Association for Hunting and Wildlife Management (Svenska Jägareförbundet). It was great to see 98 members and interested persons from nineteen different countries gathered together in Höllviken, Sweden during a meeting at a very well chosen venue.

It was gratifying to see the discussions that strengthened the contacts between researchers that often work together in remote arctic places. Our special guests from China and North America were impressed by the special open and friendly atmosphere during this meeting.

The meeting was a very lively one and focused in particular on the Bean Goose, a species for which Sweden is especially important. In particular, the size of the Taiga subspecies *Anser fabalis fabalis* is in serious decline as underlined by a presentation by "Mr. Bean" Thomas Heinicke. Despite the fact that the main theme of the conference was "The expanding goose populations and their management", we should keep in mind that not all goose populations are thriving. For the first time also studies were presented that addressed the problems of "naturalized", "exotic" or Neozoan goose populations that are spreading in more and more European countries and locally causing problems.

The meeting also gave rise to a board that energetically will support our activities in the future in a much more ambitious way. The eight members of this new board are Tony Fox, Thomas Heinicke, Konstantin Litvin, Jesper Madsen, Johan Mooij, Ingunn Tombre, Berend Voslamber and Bart Ebbinge (chairman). We have to resettle our relationship with Wetlands International and the IUCN-Species Survival Commission, and in particular make sure that the network responsible for the mid-winter counts in Europe will be improved. The meeting proposed the creation of a Goose MetaDatabase as a "one-stop-shop" source for all information on goose abundance and distribution in the western Palearctic.

Another ambition is to seek for possibilities to update the famous "Goose book" entitled *Goose populations of the Western Palearctic*, so carefully edited by Jesper Madsen, Gill Cracknell and Tony Fox, in which all populations of geese that winter in Europe and Middle Asia have been covered. It was published in 1999, and given the huge changes in goose numbers recently an update is of great importance. Who would ever have thought it possible that the Russian population of Barnacle Geese, that numbered only 20,000 in 1960 and 270,000 in the "Goose book", now numbers 770,000 individuals and gave rise to breeding populations outside the Russian arctic in the Baltic and even in the Netherlands. The overview paper in these proceedings can be seen as a first start.

Another decision of the meeting was to revive the *Goose Bulletin* and an editorial board

consisting of Johan Mooij (editor-in-chief), Fred Cottaar, Tony Fox and Berend Voslamber has by now already produced two issues which have been mailed to all members, and can also be downloaded from our website www.geese.org/gsg. This revived *Goose Bulletin* serves as a platform of information exchange for goose researchers and those interested in goose management.

After the conference during a three-day excursion by bus to the more important goose-sites in south Sweden (Tåkern, Kvismaren, Östen, Hornborgasjön and Getterön) Leif and Christina Nilsson showed us impressive flocks of Taiga Bean Geese.

Finally I would like to thank the editorial board of Ornis Svecica for publishing the results of our meeting in this special volume, so that we will never forget this meeting.

Bart Ebbinge, Chairman Goose Specialist Group IUCN-Species Survival Commission/ Wetlands International, Alterra Centre for Ecosystem Studies, Wageningen University and Research Centre, P.O. Box 47, NL-6700 AA Wageningen, the Netherlands. E-mail: Bart. Ebbinge@wur.nl

Photo of the participants. *Foto på deltagarna.*

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Current estimates of goose population sizes in western Europe, a gap analysis and an assessment of trends

Aktuella skattningar av gåsbeståndens storlek i västra Europa, analys av kunskapsluckor och utvärdering av trender

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Abstract

We estimated the size of 30 defined populations of geese wintering in the Western Palearctic (including five released or reintroduced populations of three species). Fourteen populations were accurately estimated from almost full count coverage or robust sampling and ten were well estimated based on more than 50% of their total being counted. An estimated 5.03 million geese wintered in January 2009, up on 3.10 million in January 1993. Only two populations numbered less than 10,000 birds (Scandinavian Lesser White-fronted Goose and Svalbard/Greenland Light-bellied Brent Goose, the former being critically small within restricted range). Eighteen populations numbered 10,000–100,000, eight 100,000–1,000,000 and the largest 1.2 million individuals. Of 21 populations with known longer term trends, 16 are showing significant exponential increases, 4 are stable and one declining. Amongst these same populations, five are declining since the 1990s. Long term declines in productivity were found in 7 out of 15 populations. Amongst most of the 11 populations for which data exist, there were no significant long-term trends in annual adult survival. Improved monitoring, including demographic, is required to retain populations in favorable conservation status.

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Introduction

There are 15 recognised species of geese, ascribed to two genera (*Anser* and *Branta*) in the world, of which 8 are considered to occur naturally in the Western Palearctic region. Amongst these, there are 27 recognised "populations" or "flyways", mostly as defined in Madsen et al. (1999). Knowing about the distribution and abundance of geese is important for a number of reasons. Firstly, international legislation and conventions (such as Ramsar, Bonn and Biodiversity Conventions) require such information as indicators of biodiversity and wetland health, most notably to provide population estimates as a basis to providing "1% criteria", whereby a site regularly supporting 1% or more of a waterbird population qualifies as being of international importance under the Ramsar Convention on Wetlands. Secondly, given many geese are popular quarry species, international legislation (such as the European Union Birds Directive) requires hunting of birds be undertaken in a manner that "does not jeopardize conservation efforts in their distribution area". The African-Eurasian Waterbird Agreement (AEWA) also requires that "Parties shall ensure that any use of migratory waterbirds is based on an assessment of the best available knowledge of their ecology and is sustainable for the species as well as for the ecological systems that support them". Thirdly, many (but by no means all) goose populations have become increasingly reliant on agricultural land upon which to feed, especially during the non-breeding season, when the geese predate monocultures of specially bred high-quality forage grasses, cereals and root crops, bringing conflict with farmers. Geese therefore have long had a particular association with people which means that we have more information relating to their abundance over long time scales than for many other avian species. Here, we exploit this association and knowledge to update our estimates of the population size and trends of Western Palearctic geese from those of Delany & Scott (2006), highlighting the gaps in our current knowledge and areas in need of particular improvement.

Methods

Defining populations

We define goose populations to aid the administration of their effective conservation management rather than in any strict biological sense. For this reason, we use the traditional definitions of bio-geographical populations (after Scott & Rose 1996, Madsen et al. 1999, Delany & Scott 2002) which are units within species that share breeding, staging and wintering areas (summarised in Table 2).

Assessing total population size

The goose populations that nest in the arctic from north-eastern Canada across to northern Siberia and throughout Europe as far south as Turkey all gather to winter in the Western Palearctic region. Because breeding areas are vast and generally inaccessible, summering densities low, and geese are generally more concentrated into smaller areas outside of the breeding season, population assessment surveillance has traditionally taken place outside of the breeding period. Goose numbers are assessed through a variety of methods, which makes the assessment of annual total numbers and changes over time difficult to compile. Generally, counting was originally initiated on a local or national basis, and mechanisms to coordinate these efforts internationally have followed as knowledge about flyway interactions and migration routes have become known, mainly as a result of ringing recoveries and/or resightings of marked individuals. Counts on the ground generally involve observers with considerable experience of counting relatively large numbers of birds, assessing flocks and flock size and assigning mixed groups to species. Counting roosting flocks coming to or from major night time roosts has advantages, because whilst large aggregations make assessment difficult (because of the specialist ability needed to count large groups of moving birds), this technique minimises double counting and missed birds involved with counting similar and often highly mobile numbers scattered over large feeding areas by day. National surveys are now generally coordinated by research institutes, government or non-governmental organisations that are responsible for co-ordination, quality control, collation, analysis and reporting of the data, often to the responsible statutory agencies involved in nature conservation monitoring. However, physically, the counts on the ground are invariably undertaken largely by networks of highly experienced volunteers, supplemented where necessary by relatively few professionals.

Uniquely amongst avian surveillance programmes, a few populations have been surveyed annually since before the 1950s, most notably in north-western Europe, whereas coverage in eastern and south-eastern parts of the range is more recent and less extensive. Nevertheless, to date 60 coun-

tries have contributed mid winter counts of geese via the Wetlands International (WI) International Waterbird Census (IWC) which contains most of the existing available data.

Traditionally, the mid-January IWC were the main source of data on geese, because other waterbirds were counted on their winter quarters at that time, resulting in large numbers of observers motivated to go out and count birds on wetlands at that time. Unless affected by hard-weather movements, turnover of geese between staging sites at this time also ensures fewer duplicated or missed counts. However, for many reasons, this method may not be suitable for all species and where it is considered more accurate assessments of total population size can be achieved during autumn or spring (when geese may be more concentrated into fewer staging areas and therefore easier to count); special coordinated population assessment counts have been undertaken at other times (e.g. Greenland White-fronted Goose *Anser albifrons flavirostris* in late March). Increasingly, climate change is affecting the timing and intensity of migration and this too is beginning to affect decision-making relating to the best time to assess population size on the non-breeding areas (e.g. the Iceland Greylag Goose *Anser anser* traditionally counted in October, but now because of delayed arrival is increasingly assessed in November and December, Mitchell 2009). For some populations, complete annual coverage is too costly so surveys are carried out at longer intervals (e.g. aerial survey is necessary to cover the Greenland Barnacle Goose *Branta leucopsis* population wintering in largely offshore islands in Ireland and Britain and this has been carried out at approximately 3–5 years intervals, Mitchell et al. 2008).

Historically, the Wetlands International/Species Survival Commission Goose Specialist group organised the collation of a database and via a network of national count coordinators and population coordinators produced population overviews in the major review of Madsen et al. (1999). Many of the mechanisms established prior to the review or at that time continue, providing a platform for the compilation of data on specific populations from different countries to provide an annual total. For example, in the case of the United Kingdom, populations such as the Iceland Greylag Goose and the Greenland/Icelandic Pink-footed Goose are reported annually by the Wildfowl & Wetlands Trust (Mitchell 2009) and to service internal goose management issues, the Dutch government has organised the collation of annual population estimates for key species wintering in that country to determine whether the rate of change amongst wintering goose numbers in the Netherlands is tracking those of the flyway population as a whole (Ebbinge 2009).

However, for several populations at the present time, no coordinated coverage is organised or achieved, with the result that our assessment of their population sizes is subject to considerable uncertainty (and the subject of other analyses presented in this volume). For some areas, published data are limited and in some cases, this means that the quality of the estimates presented in this assessment are poor, or at least poorer than for others. We have attempted to provide some guidance as to the relative quality of each of the estimates to guide their reliability and utility (see below), but also as a gap analysis to indicate areas that require attention to improve the quality of the available estimates in the immediate future.

Sources of population estimate data presented

Wherever possible, the data for a given species are collated by a responsible authority which has coordinated regular counts following common protocols to generate total counts in a reasonably exhaustive and consistent manner. In the UK, the Wildfowl & Wetlands Trust coordinates and compiles counts, and report on annual population estimates for Canadian Light-bellied Brent Geese *Branta bernicla hrota* (Robinson et al. 2004), Greenland White-fronted Geese, Pink-footed Geese (see Mitchell & Hearn 2004), Greylag Geese (see Hearn & Mitchell 2004) and Greenland and Svalbard breeding Barnacle Geese throughout their winter range and the quality of these estimates is considered high because of the effort put into coordinated coverage of known sites, the systematic and consistent coverage achieved and the accessibility and documentation relating to the compilation of the count data. Similarly Alterra in the Netherlands coordinates the assessment of the Russian Barnacle Geese (assisted by H. van der Jeugd), Greater White-fronted Geese *Anser albifrons albifrons*, Dark-bellied Brent Geese *Branta bernicla bernicla* and with the University of Lund in Sweden contribute to that of Greylag Geese in western Europe. The Danish National Environmental Research Institute at the University of Aarhus coordinates annual reporting of the Pink-footed and Light-bellied Brent Geese that nest in Svalbard. Cross-border coordination of counts of Red-breasted Geese *Branta ruficollis* in the Black Sea minimises double counting in Ro-

Table 1. The six data quality codes used in the presentation of the goose population estimates (modified after Thorup 2006).
De sex koder som används för att ange datakvalitet vid presentationen av skattningarna av gåsbeståndens storlek.

	Extent of knowledge *Kunskapsläge*	Data underlying estimate *Data bakom skattningen*
0	Expert guesses *Expertgissning*	None or very little *Inga eller mycket litet*
1	Poor data quality *Dålig datakvalitet*	Few actual counts, no representative counts and/or counts covering insignificant sections of the population *Få verkliga räkningar, inga representativa räkningar och/eller räkningar som täcker en ringa del av beståndet*
2	Partly based on good survey data *Delvis baserad på goda inventeringar*	Good well described counts and surveys, allowing extrapolation with some confidence, at least for a significant (c.5%) part of the population *Goda och väl beskrivna räkningar som tillåter extrapolering med viss tillförsikt, åtminstone för c. 5% av beståndet*
3	Some regions well covered providing more than 50% of the total estimate counted *Vissa regioner väl täckta för mer än 50% av den totala skattningen*	Counts cover a significant (5–50%) proportion of the estimated total population *Räkningarna täcker 5–50% av det totalt skattade beståndet*
4	Good coverage for more than 50% of total estimate *God täckning för mer än 50% av den totala skattningen*	At least half of the estimated population counted *Minst halva det skattade beståndet räknat*
5	Full coverage, count likely to be within 10% of true total *Full täckning, troligen mindre än 10% av beståndet oräknat*	Almost all of the estimated population accounted for from regular coordinated counts *Nästan alla skattade bestånd täckta med regelbundna koordinerade räkningar*

mania, Ukraine and Bulgaria, but weaker coordination with other wintering resorts for this goose means that some improvement in annual estimation of this population could be achieved. For other populations, there is little or no coordination, with the result that the estimates of population size are informed assessments based on independent assessments of the available data. For some states, this means an average of recent mid-winter counts, whether complete over a series of years since 2000 or not, taking no account of the effects of hard winters or other factors causing movement between states within and between winters. Wherever possible, we rely upon expert assessments amongst the authors and specific recent reviews to provide accurate population estimates and, where possible, trends. Following Thorup (2006) we have felt the need to apply some guidance as to the data quality underlying the population estimates, based both on the quality of available data from each national scheme and the extent to which the estimates are based on real and regular counts undertaken as a surveillance programme, rather than the estimates of experts. For this reason we have adopted a very slightly modified version of Thorup's (2006) 6 point data quality codes (Table 1) which we have applied to the population estimates presented throughout this analysis.

Sources of population trend data

Where a reasonable time series exists for the populations presented, we assessed the rate of change in numbers by regressing the logarithmically transformed annual population estimate on year to give an annual (percentage) rate of change for the population. Wherever possible to contrast recent trends with longer term ones, we have attempted to fit such models to data (i) over the longest time period possible to the present and (ii) since the mid to late 1980s. Data sources for these population estimates are provided in the tabulation, along with the time series for which the analysis is available. These are mostly provided from populations that have a

population estimate data quality code in excess of 3, given regular census of a more than half of the total population involved in the analysis. We here present the annual rate of change for significant regression models of population size on year, but in summary consider populations increasing by up to 3% per annum "increasing" and those increasing by 3.1%–6% as "rapidly increasing", those by >6.1% as "very rapidly increasing", those with no trend as "stable" and those showing a significant decrease as "decreasing".

Sources of annual population productivity and survival

For several of the species, there exist annual assessments of the percentage of young birds in the winter population. First winter individuals of most species of geese can be separated from older adult birds on the basis of plumage, and these characteristics are widely known and accepted (see Cramp & Simmons 1977). Knowledge of the relative breeding success in the population as a whole is an important demographic parameter (along with annual adult survival) for interpreting population change, so it was felt useful to present long term trends in this measure for those goose populations for which this statistic was available. The sampling of such data is fraught with problems, since family parties frequently assort themselves differently from those of non-breeding groups that typically contain very few young because of the tenacity of family groups that remain separate from large groups, at least during the first winter of life. Family parties tend to dominate optimal feeding opportunities, and are frequently more numerous on the outer edges of goose flocks for instance. Skilled and trained observers therefore try to sample age ratios in goose flocks in a manner that accounts for such potential sources of error and bias, but in presenting the age ratio data here, we take no account of how sampling problems may contribute to bias in these data. Rather we trust that the use of consistent techniques across many years provides an internal comparability within the data, providing trends that are not the result of systematic bias in the gathering of the annual age ratios. Finally, some groups and researchers have began using capture-mark-recapture techniques, generally using conspicuous collars or leg rings which can be re-read in the field without the need for recapture, to generate annual adult survival rates for some populations. Many of these studies have been published and so these are referenced as sources, but as with the time-series relating to trends in age-ratios, we here present these data on the assumption that the studies have been undertaken in a fashion that does not incorporate serious bias or error (either amongst the capture of individuals and their subsequent re-sighting, recapture or re-encounter) and specifically into the estimation of long term trends in annual adult survival. In presenting trends in reproductive success and annual adult survival rates, we differentiate between no trend (i.e. time does not significantly account for variance in the models), the significant contribution of time to modelling change (i.e. a significant increase or decrease) and a situation where the trend is unknown (time series too short or no significant contribution to the models).

Results

Estimated population sizes

The greatest conservation concern naturally involves the numerically rarest of the goose species in the region. Of these, the population at greatest risk of imminent extinction is the Scandinavian Lesser White-fronted Goose population, the smallest of all stocks in the Western Palearctic poised on the brink of extinction and subject of a major EU Life-Nature project (Tivanen et al. 2009), numbering very many less than 1000 individuals (Table 2). Only one other population, the Svalbard Light-bellied Brent Goose, has an estimated population size of less than 10,000 individuals (Table 2). Two further populations, the Greenland White-fronted and Russian Lesser White-fronted Geese, number fewer than 25,000 individuals in total, after which there follow five more populations with less than 50,000 individuals in all (Table 2). Four (possibly five) populations exceed half a million individuals.

Adequacy of count coverage

Twenty three out of the 29 populations considered here are secured a 4 or 5 estimate precision score, implying that for the vast majority of the population, we have adequate, or in many cases, very good coverage, totals and trends being based upon counts which cover more than half of the total populations in the majority of cases. Such coverage is extremely heartening in supporting effective interpretation of trends over longer time scales. There is a clear regional element to coverage quality, generally the very best coverage has been achieved over the longest time horizons in north and west Europe, whilst coverage is less good and

Table 2. Status of the goose populations as assessed in 2009. Each population is defined by its breeding and winter range. Population size estimate for the mid-1990s (Madsen et al. 1999) and at the present time (with the time of the last estimate; all years in the 2000s). Q is the data quality code, see Table 1.
Status för gåsbestånden enligt bedömning 2009. Varje bestånd definieras av sitt häcknings- och vinterområde. Beståndsskattning för 1990-talet (Madsen m.fl. 1999) samt enligt senaste räkningar (med år för denna skattning; alla år på 2000-talet). Q är kvalitetskoden för data, se Tabell 1.

Population and count month *Bestånd och räkningsmånad*	Breeding range *Häcknings-område*	Winter range *Vinter-område*	Estimate 1990s *Skattning 1990-talet*	Most recent estimate *Senaste skattning*	Q
Bean Goose					
Taiga (1)	Scandinavia/Russia	Baltic/Scotland	100,000	63,000 (8/9)	4
Tundra I (1)	Scandinavia/Russia	Baltic/N. Sea	600,000	522,000 (7/8)	4[1]
Tundra II (1)	Russia	C. Europe	n/a (part of above)	28,500 (7/8)	4
Pink-footed Goose					
Iceland (10/11)	Iceland/Greenland	UK	250,000	350,000 (8/9)	5
Svalbard (11/1)	Svalbard	NW Europe	37,000	63,000 (8/9)	5
White-fronted Goose					
"Baltic-North Sea" (1)	Russia	NW Europe	600,000	1,200,000 (7/8)	4[2]
"Pannonic" (1)	Russia	Central Europe	10,000-40,000	110,000 (7/8)	4
"Pontic/Anatolian" (1)	Russia	Greece/Turkey/ Black Sea	350,000-700,000	200,000	1
"Caspian" (1)	Russia	Caspian	n/a	n/a	0
Greenland (3/4)	Greenland	Ireland/UK	33,000	23,200 (8/9)	5
Lesser White-fronted Goose					
Reintroduced	Sweden	Netherlands	n/a	120	4
Fennoscandia (3/5/10/11)	Fennoscandia	S/SE Europe	100-150	60-80 (8/9)	5
Russia (10/11)	Russia	Black/Caspian Sea	15,000	10,000-21,000 (8/9)	4
Greylag Goose					
Iceland (11/12)	Iceland/Greenland	Scotland	80,000	98,000 (8/9)	5
Scotland (8/2)	Scotland	Scotland	9,000	35,000 (8/9)	5
UK Feral (9)	UK	UK	22,000	50,000 (8/9)	5[3]
NW Europe (9/1)	NW Europe	NW/SW Europe	200,000	610,000 (7/8)	4
C Europe (1)	C Europe	N Africa	25,000	56,000 (6/7)	3
Black Sea	Black Sea	Black Sea	85,000	85,000	1
SW Asia	W Siberia/Caspian	Caspian, Iran & Iraq	100,000+	100,000+	0
Canada Goose					
UK (1)	UK	UK	64,000	89,000 (2000)	5[3]
Scandinavia (1)	Scandinavia	NW Europe	60,000	90,000 (8/9)	4
France/NL/Belgium, Germany (1)	France, Belgium, NL	France, Belgium, NL	n/a	41,000 (8/9)	4
Barnacle Goose					
Greenland (3)	E Greenland	Ireland/UK	40,000	70,500 (7/8)	5
Svalbard (11)	Svalbard	Scotland	23,000	30,000 (8/9)	5
Russia/Baltic, North Sea (1/3)	Russia/Baltic	NW Europe	267,000	770,000 (7/8)	5
Brent Goose					
Russia (DB) (1/5)	Russia	W Europe	300,000	245,900 (6/7)	5
NE Canada (LB) (10)	NE Canada	Ireland	20,000	40,000 (8/9)	5
Svalbard (LB) (11/1/5)	Svalbard/Greenland	NW Europe	5,000	7,600 (8/9)	5
Red-breasted Goose					
Russian (1)	Russia	Black Sea	70,000	44,000 (8/9)	3/4[2]

[1] Germany, Netherlands 5
[2] Improving *Under förbättring*
[3] Annual index *Årligt index*

therefore interpretation of trends less easy based on the data to hand, in the eastern part of Europe and the eastern Mediterranean and Black Sea Regions, where count coverage could be considerably improved. This may not be especially a problem for the estimates presented here. For instance, for the Pannonic White-fronted Goose and Central European Tundra Goose, the count data are probably adequate to generate estimates of population size from those states providing good counts. Although data may be missing from some other states, these are known to be unlikely to constitute more than a few thousand birds, although this does not lessen the need to strength count networks and cross-border collaboration. The situation is not so good for the Central Greylag Goose population, where the cumulative sum of average counts from Czechia, Slovakia, Austria, Hungary, Italy, Croatia, Serbia, Tunisia and Algeria have been taken to provide an estimate of numbers present. However, Greylag Geese are now wintering regularly in Poland and ringing recoveries show that this species in some parts of Eastern Germany and Bavaria partly also belong to this population rather than the northwest European population. It is important that more concerted efforts assess the definitions of these flyways (using ringing and other techniques) and to design and coordinate count networks in a way that most effectively monitors their development in the future.

Short- and long-term trends in abundance

Most populations (16 out of 21 for which there are good data) show positive long-term trends, four were stable and the Scandinavian Lesser White-fronted Goose has shown significant long-term decline (see Table 3 for a complete breakdown of these data). The situation is similar in the shorter term (18 populations showing increases since the early 1990s), but two other populations (Greenland White-fronted and Dark-bellied Brent Goose) show significant declines, both since the mid 1990s. In the short term, increases have been less rapid than in the longer term, suggesting some slowing of the rate of expansion in several populations in very recent years. Nevertheless, with the notable exceptions of the Lesser White-fronted Goose and Svalbard Light-bellied Brent Goose populations, it is apparent that most goose populations are sufficiently numerous (>10,000 individuals), widespread and of favourable conservation status in the Western Palearctic at the present time. Amongst the most numerous and still increasing stocks, the Baltic/North Sea White-fronted Goose (1.2 million) is perhaps most evident in the NW European Greylag and Russian Barnacle Goose populations, both numbering well in excess of 500,000 individuals and increasing by at least 8% per annum (Table 3).

Trends in reproductive success and annual adult survival rate

Fifteen Western Palearctic goose populations are sampled annually for the proportions of young in their number, and for most of these, data are available from more than 25 years (several much longer, Table 4) With the notable exceptions of the Svalbard Pink-footed Goose (14.4% young, 1980–2008) and Greenland White-fronted Goose (13% young, 1982–2008), most *Anser* genus goose populations show a long term mean annual proportion of young above 20% and an overall long term decline in this statistic over time (Table 4). Although the *Branta* geese typically exhibit a lower proportion of young in their population in autumn (generally less than 18%), most of these populations show declines or stable trends in reproductive output (Table 4).

At least 18 Western Palearctic goose populations have an associated banding scheme of some kind that provides marked individuals to support a capture-mark-recapture estimation of annual adult survival (Table 4). Data from the *Anser* species show annual survival to be generally lower (75–86%) than amongst *Branta* species (84–95%), a factor partly reflecting their relative exposure to hunting in recent decades, but also compensated for in terms of differential long term productivity.

Discussion

Monitoring coverage

We are fortunate indeed to be able to benefit from the tremendous legacy left by the pioneers who started to establish mechanisms to monitor waterbird populations following the Second World War in Europe in response to the concern about the viability of stocks of migratory waterbirds, including geese, at that time. These foundations have provided us with contemporary data series relating to goose abundance which now stretch back over more than 50 years. Such time series relating to wild populations remain rare in biology and therefore of increasing value as the series accumulate. Because geese are long-lived, these long and reliable time series give a unique insight into the development of populations on a large geographical

Table 3. Trends in the size of the goose populations as assessed in 2009, given in the short and longer term (different lengths of time series available limits inter-population comparisons). Rate of change is the slope of the logarithmically transformed annual total population estimates against time.
Populationstrender bedömda 2009. Förändringens hastighet är lutningen för de logaritmerade årliga värdena för beståndsstorleken mot tiden.

Population	Long term trend *Långtidstrend*	Short term trend *Korttidstrend*	Source[1] *Källa*
Bean Goose			
Taiga (1)	?stable	decline since 1999	1
Tundra I (1)	?increasing	+4.4% since 1989	1
Tundra II (1)	?decreasing	decline since 1989	1
Pink-footed Goose			
Iceland (10/11)	+3.9% since 1950	+2.8% since 1995	2
Svalbard (11/1)	+3.3% since 1965	+4.4% since 1995	3
White-fronted Goose			
"Baltic-North Sea" (1)	+7.7% since 1958	+2.9% since 1995	4
"Pannonic" (1)	not available	not available	WI
"Pontic/Anatolian" (1)	not available	not available	WI
"Caspian" (1)	not available	not available	WI
Greenland (3/4)	+1.1% since 1983	–3.0% since 1999	5
Lesser White-fronted Goose			
Scandinavia (3/5/10/11)	–4.6% since 1993	–5.0% since 2000	6
Russia (10/11)	?stable	?stable	6
Greylag Goose			
Iceland (11/12)	+2.6% since 1960	+1.0% since 1995	2
Scotland (8/2)	not available	+10.8% since 1997	7
UK Feral (9)	+8.6% 1976-1991	+9.4% since 1988	7,8
NW Europe (9/1)	+8.5% since 1980	+9.1% since 1995	4,9
C Europe (1)	not available	+6.8% since 1995	WI
Black Sea	not available	not available	WI
SW Asia	not available	not available	WI
Canada Goose			
UK (1)	+9.3% since 1988	+9.3% since 1988	8
Scandinavia (1)	+10.8% since 1977	+10.3% since 1998	10
France/NL/Belgium/Germany (1)	not available	+14.0% since 1999	15
Barnacle Goose			
Greenland	+3.5% since 1956	+3.7% since 1987	7
Svalbard	+6.6% since 1956	+2.3% since 1987	7
Russia/Baltic/NorthSea	+7.8% since 1960	+7.8% since 1995	4,11
Brent Goose			
Russia (DB)	+6.1% since 1956	–1.4% since 1991	4
NE Canada (LB)	+2.2% since 1960	+8.3% since 1995	12
Svalbard (LB)	+3.5% since 1965	+2.8% since 1995	13
Red-breasted Goose			
Russia	+4.2% since 1954	–4.6% since 1995	14

[1] Sources: 1. Heinicke, T. (unpubl.); 2. Mitchell (2009); 3. Madsen, J. (unpubl.); 4. Ebbinge (2009); 5. Fox et al. (2009a); 6. Aarvak, T. (unpubl.); 7. WWT/Mitchell, C.; 8. Rehfisch et al. (2002); 9. Nilsson, L. (unpubl.); 10. Based on November counts in Sweden and Germany, Nilsson, L. and Heinicke, T (unpubl.) - totals do not include NL and B; 11. Henk van der Jeugd (unpubl.);12. WWT/Kendrew Colhoun (unpubl.); 13. Preben Clausen (unpubl.); 14. Red-breasted Goose International Working Group/Sergey Dereliev (unpubl.); 15 Hustings et al. (2009), Voslamber et al. (2010), Anselin & Devos (2005), Fouque & Schricke (2010); WI indicates data interpolated from Wetlands International International Waterbird Count database.

Table 4. Trends in productivity and survival amongst the goose populations. Key: TP=Trend in productivity, TS=Trend in survival. The trends are given as declining (–), increasing (+) or not significant (0).
Ungproduktion och överlevnad för gåspopulationerna. TP=trend för ungproduktionen, TS=trend för överlevnaden. Trenderna anges som minskande (–), ökande (+) eller ej signifikant (0).

Population	Mean % young (range available) *Medel % ungar (mätperiod)*	TP	Banding started *Märkning började*	Survival % (range available) *Överlevnad % (mätperiod)*	TS	Ref[2]
Bean Goose						
Taiga	?	?	(1970s)	not analysed	?	a
Tundra I	19.8 (1981-2008)	–	(1970s)	not analysed	?	b
Tundra II						
Pink-footed Goose						
Iceland	20.3 (1950-2008)	–	(1980s)	81 (1987-2001)	0	1
Svalbard	14.4 (1980-2008)	–	(1980s)	86 (1989-2002)	0	2
White-fronted Goose						
"Baltic-North Sea"	27.5 (1957-2007)	–	(1990s)	75 (1958-1969)	+	3
"Pannonic"						
"Pontic/Anatolian"						
"Caspian"						
Greenland	13 (1982-2007)	–	(1970s)	82 (1982-2007)	+	4
Lesser White-fronted Goose						
Fennoscandia[1]	51.1(1981–2008)	–	(1995)	Yes, unpublished	?	5
Russia	?	?	(2000s)	No	?	
Greylag Goose						
Iceland	20.7 (1960-2008)	0	(1990s)	72 (1992-2001)	0	1
Scotland	29 (1998-2006)	0	(1980s)	74 (1998-2006)	0	6
UK Feral	not available	?	(local)	not analysed	?	
NW Europe	not available	?	(1970s)	75–85 (1984-2004)	-	7
C Europe	not available	?	(1970s)	?	?	
Black Sea						
SW Asia						
Canada Goose						
UK	not available	?	(1980s)	not analysed	?	
Scandinavia	?	?	(1980s)	?	?	
France/NL/Belgium/Germany						
Barnacle Goose						
Greenland	11.6 (1959-2007)	–	(1960s)	not analysed	?	8
Svalbard	15.7 (1958-2006)	–	(1970s)	90 (1975-1993)	0	9
Russia/Baltic/NorthSea	15.8 (1974-2008)	0	(1970s)	95 (1984-1996)	0	10
Brent Goose						
Russia (DB)	17.7 (1956-2006)	0(–)	(1970s)	84 (1973-1990)	-	11
NE Canada (LB)	14.7 (1960-2008)	0(–)	(1980s)	not analysed	?	12
Svalbard (LB)	12.9 (1980-2008)	0(–)	(1980s)	87 (1991-1999)	0	13
Red-breasted Goose						
Russia	25.5 (5yrs 1996–2005)	?	(not since 1990s)	?	?	14

[1] the Valdak population

[2] References: a. SOVON: supplied by Leo van den Bergh and others, some question over correct determination of race; b. SOVON: supplied by Leo van den Bergh and others, considered reliable; 1. Frederiksen et al. (2004); 2. Kery et al. (2006); 3. Ebbinge (1991); 4. GWGS unpublished data; 5. Tivanen et al. (2009); 6. Trinder et al.(2009); 7. Pistirius et al (2007), Nilsson & Persson (1993), Voslamber et al. (2007); 8. WWT/Carl Mitchell; 9. WWT and Black et al. (2007); 10. Larsson et al. (1998); 11. Ebbinge (1992); 12. WWT; 13. Clausen et al. (2001); 14. Red-breasted Goose International Working Group/Sergey Dereliev (unpubl.)

scale, especially as the extent of good and reliable coverage increases.

It is clear that the geographical coverage achieved is best in the north and west of Europe, with the UK, North Sea and Baltic regions being especially highly organised in achieving extensive coverage of all the populations occurring there. After the excellent coverage achieved in the prelude to the publication of the major review of Madsen et al. (1999), coverage in central and eastern Europe has not been maintained at the same level as in earlier years, with the result that although the national schemes of nations such as Czech Republic, Austria and Hungary continue to deliver very high quality nationally coordinated goose surveillance schemes, gaps are beginning to appear in coverage in other states, making confident compilation of population totals difficult in recent years, with the result that we cannot be confident about determining the size of the "Pannonic" White-fronted Goose and Central European Greylag Goose populations. The situation is no better in the eastern Mediterranean and the Black Sea, where coverage is probably extremely good, but coordination and reporting to any centralised database facility in recent years has fallen into disrepair.

As a result of this unfortunate situation, we lack good robust population estimates and trends over recent decades for 5 populations, namely the Pontic/Anatolian and Caspian White-fronted Goose populations and the Central European, Black Sea and SW Asia flyway populations of the Greylag Goose. Our woefully inadequate knowledge of their distribution and abundance necessitates urgent action. In addition, we could improve the count data quality which underpins the Red-breasted Goose monitoring programme, not least because of the apparent declines in their number since the late 1990s. Finally, the network could further benefit with improvements in planning, coordination and collaboration of counting protocols to improve our knowledge of all populations of Bean Geese, the Baltic/North Sea White-fronted Goose, Russian Lesser White-fronted Goose and all continental Greylag Goose populations.

It was very evident from the results of this exercise to collate the count data that there is a very urgent need to re-establish the close working relationship that existed in the 1990s between the Goose Specialist Group, the IWC database, the population experts involved in collating goose population monitoring data and the IWC and GSG national coordinators that former coordinated the counting and reporting of the goose surveillance systems.

Timing of monitoring

Traditionally, much of the goose monitoring has been focussed upon the mid-January counts which are the focus of the IWC. However, it is very clear that more accurate population size assessments are achieved by counting at other times, especially in spring or autumn when geese may be more concentrated, or for some other reason are easier to count. As is evident from Table 2, 17 of the 29 populations considered here are now monitored at times other than mid-January. It is important in considering future monitoring programmes for those populations for which we currently have poor, inadequate or no coverage should be designed with a view to selecting the best possible period for monitoring a given population.

Overall status and trends

Our assessment suggests that there are now 4.77 million geese wintering in the Western Palearctic (excluding the introduced, feral, escaped and reintroduced populations of the region), in excess of 5.04 million geese in all, up substantially on 3.1 million estimated in January 1993 (Madsen et al. 1996) and 3.3 million at the time of the Madsen et al. (1999) review. We are more confident that whilst some of the increases can be accounted for by improvements in coverage, the vast majority of this increase is the result of increases in the numbers of most populations. Those making a particular numerical contribution to overall increases since Madsen et al. (1999) are an extra 700,000 Baltic/North Sea White-fronted Geese, 433,000 extra Russia/Baltic/NorthSea Barnacle Geese, 410,000 more NW European Greylag Geese and another 100,000 Iceland Pink-footed Geese (Table 2). Sixteen out of 21 populations for which we have good data show significant increases both since the 1950s and 1960s, but also in the shorter term since the early 1990s (Table 3). Only the Scandinavian Lesser White-fronted and Svalbard Light-bellied Geese number less than 10,000 individuals and both show unfavourable conservation status, the former being highly threatened because of the critically small population size and range. Although Greenland White-fronted Geese have shown recent declines (as a result of a series of very low reproductive years, Boyd & Fox 2008), under protection from hunting in Iceland, numbers have shown some signs of recovery, at least not declining so rapidly (Fox et al. 2009a). Red-breasted Geese have shown rather dramatic de-

clines in number in recent years, and it is clear that this population needs conservation attention, both to appraise the necessary level of monitoring and to address the causes of the declines in abundance if this proves to be the case. Taiga Bean Geese may also be showing signs of decline, but urgent attention needs to be paid to improving count coverage before we can be truly confident of the current population size, distribution and trends, discussed in greater depth elsewhere in this volume (Heinicke 2010). Dark-bellied Brent Geese are also showing very recent declines in number after a prolonged period of increase under protection from hunting exploitation on the winter quarters. The reasons for this are not currently obvious, although poor reproduction in recent years has played some part since the collapse of the "boom and bust" reproductive cycle linked to changes in abundance of the lemming predators on the breeding grounds (e.g. Ebbinge & Spaans 2002). Because of their numerical size, all these populations are not threatened with extinction, but clearly investigation of the causes behind the declines could flag up potential appropriate conservation management actions that could potentially restore these populations to favourable conservation status.

With these exceptions, all of the other wild goose populations in the Western Palearctic which are monitored well enough to generate long term trends show uninterrupted exponential increases in number, with few signs of slowing their rate of increase. Studies of breeding and wintering habitat availability have only really been carried out on large spatial scales for the Svalbard Pink-footed Goose population (Jensen et al. 2008 and Wisz et al. 2008a respectively), but these suggest that, under current scenarios, there are adequate unexploited habitats to support further expansion of that particular goose population, although clearly such habitats are finite and may change in relation to contrasting economic pressures on land use in Europe (Wisz et al. 2008a). In Svalbard, grazing Pink-footed and Barnacle Geese can cause changes in plant community structure and productivity and increase carbon dioxide release from the tundra (Loonen & Solheim 1998, Van der Wal et al. 2007) potentially affecting the availability of quality habitat through some density dependence regulatory mechanism (Wisz et al. 2008b). Likewise, competition between expanding formerly alloptaric goose populations may bring about increased overlap in distributions, habitat and ultimately diet, enhancing competitive interactions between populations, although in studied situations, this seems unusual and impacts at the population level are hard to demonstrate (e.g. Kristiansen & Jarrett 2002, Fox et al. 2009b). The declines that we note here in reproductive output may be the first demographic signs of such factors impinging on the expansion rate of these populations. However, the art of forecasting the future development of goose population size is difficult, and the recent history is littered with poor or inaccurate forecasts of how populations will increase or otherwise in the future. What is clear is that herbivorous geese have shown themselves very adept at adapting to exploiting the rich monocultures of specially bred cereal, root and grass crops which our agricultural domination of temperate landscapes provide in vast amounts in contemporary Europe, and we should therefore be prudent and expect that the increases we have seen amongst the more common species in very recent years to continue, at least in the very near future. This is likely to continue to bring new challenges with regard to resolving ever increasing conflicts between maintaining population distribution and abundance and reconciling economic loss to farmers and other interests. For this reason, it would appear essential to continue the rich tradition of monitoring of these organisms as we have done in the recent past, but by supplementing an improved coordinated network of counters integrated into an effective database system with improved demographic monitoring to enable us to understand the population processes involved in determining the observed trends.

The nature of future monitoring

Just in the relatively short time since the publication of Madsen et al. (1999), the network of coordinated goose counters throughout Europe has lost a large degree of its international coordination. This has been offset to some extent by the continuation of national count schemes that continue to gather data for domestic purposes. However, the results of this analysis clearly show that gathering local data may not be the best way to compile flyway-wide surveillance data for tracking specific populations. This is especially the case where cross-border coordination is essential to avoid missed or double-counted birds, as is the case regarding Red-breasted Geese in Bulgaria and Romania, where efforts to coordinate counting in the two states have been highly successful in recent years. Former close collaboration between count networks was essential between Poland and Germany and between France and Germany, as elsewhere, is especially impor-

tant because night time roosts are inevitably along rivers and floodplain systems that lie along shared international boundaries. Counting roost aggregations brings its own problems, not least if inexperienced observers are confronted with very large goose aggregations that can be visually confusing and risk lack of identification or misidentification of species. The synthesis here also underlined our complete loss of goose count coverage since the 1990s, for example in many parts of Poland, where coverage was formerly good. It is very evident from the first tentative steps here to identify where the gaps in the current count network exist, and it is important that Wetlands International in partnership with the Goose Specialist Group attempt to review the coverage and the strategic need for reestablishment and refreshing of the goose count network throughout the region. Given the increasing problems of identifying discrete populations, this needs some assessment of flyway definitions (e.g. through ringing, telemetry, genetic or other methods for establishing how individual migration routes contribute to describing the flyways of populations). Even having established relatively robust count systems, we still need to interpret simple changes in distribution and abundance – are they to do with changes in mortality, survival, emigration, immigration or a combination of all these? These questions require demographic monitoring, much of which is already in hand for some populations, based on long-term age ratio sampling and capture-recapture marking studies. In particular, we consider it essential that current marking schemes (which have been very successful in generating resightings from observers) be continued and greatly extended to generate data on individual survival and reproductive success that can provide invaluable demographic monitoring data that enables us to interpret observed changes in numbers. We also encourage those schemes which hold such data to analyse these datasets to further extend our current understanding of goose stocks in the Western Palearctic and their future development. Finally, it important that urgent consideration is given to extending the existing monitoring of goose populations to other introduced (i.e. both native and alien) goose species, as invasive and alien taxa are being recognised as a biodiversity issue. What is clear is that we need to review the status of goose monitoring in the Western Palearctic and to develop clear proposals for how to improve the current system to better meet current and future needs.

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Trends in goose numbers wintering in Britain & Ireland, 1995 to 2008

Trender för antal gäss som övervintrar i Storbritannien och Irland 1995–2008

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Abstract

Twelve migratory and native goose populations winter in Britain and Ireland and up to date information on their abundance and distribution is provided. Seven populations are increasing: Barnacle Goose (Svalbard, current estimate 26,900 birds), Barnacle Goose (Greenland 70,500), Pink-footed Goose (288,800), North West Scotland Greylag Goose (34,500), Re-established Greylag Goose (50,000), Light-bellied Brent Goose (East Canadian High Arctic 34,000) and Light-bellied Brent Goose (Svalbard 3,270). Two populations appear stable: Taiga Bean Goose (432 at two sites) and Icelandic Greylag Goose (98,300). Three populations are decreasing: European White-fronted Goose (2,760) due to short stopping in mainland Europe, Dark-bellied Brent Goose (82,970), due to a recent population decline (due to poor breeding success) and short stopping, and Greenland White-fronted Goose (24,055) due to recent poor breeding success and, up to 2006, hunting. An estimated 120,000 migratory geese wintered in Britain and Ireland in 1960 compared to 500,000 in 2008. Despite many goose species demonstrating high degrees of site faithfulness (responding to safe roosts and regular food supply), shifts in winter distribution of several goose populations have occurred (notably Icelandic Greylag Goose).

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Introduction

Of the eight species of geese (*Anser and Branta*) considered naturally occurring in the Western Palearctic region, 27 "populations" or "flyways" were defined in Madsen et al. (1999). Of these, 12 populations occur in Britain and Ireland. Canada Geese *Branta canadensis* were introduced in Britain from the 17th century and, as a non-native species, are not considered in this review. Geese wintering in Britain and Ireland come from a wide breeding area including north west Canada, Greenland, Iceland, Svalbard, Fennoscandia and northern Russia. The breeding areas are vast and generally inaccessible and population assessments have traditionally taken place during the non-breeding season.

Information on goose abundance and distribution is important for four primary reasons: (i) international legislation and conventions to which the UK is a signatory require such information as evidence that the state of biodiversity is being maintained; (ii) for supporting site-based conservation measures using the "1% criterion" (see Madsen et al. 1999); (iii) many geese are quarry species and international legislation requires hunting to be sustainable; (iv) many goose populations have become reliant on agricultural land, especially during the non-breeding season, which brings them into conflict with farmers (see Fox et al., this volume). This assessment updates abundance data since the review by Madsen et al. (1999) for geese belonging to the 12 populations that winter in Britain and Ireland.

Methods

We used traditional definitions of bio-geographical populations (after Madsen et al. 1999) and terminology (see also Table 1), defining units within species that share breeding, staging and wintering areas in a manner that is helpful for their conservation management. Britain and Ireland provide the winter quarters for almost all geese from six populations, c. 95% of two populations, 40–60% of two populations and c. 1% of two populations (Table 1).

Goose counting in Britain and Ireland is well organised at the national level (see Mitchell et al. 1997). Experienced observers either count roosting flocks coming to or from night time roosts or check daytime feeding areas. For some populations, complete annual coverage is too expensive, with surveys carried out at less frequent intervals. For example, Barnacle Geese (Greenland) *Branta leucopsis* winter on remote offshore islands in Ireland and Britain, necessitating aerial survey, which has been carried out at approximately five year intervals (Mitchell et al. 2009). For three populations, where no specific national surveys are carried out, geese are counted via the Wetland Bird Survey (WeBS) . Since this fails to cover all of the populations, an indexing technique is applied to track relative changes in numbers from incomplete data (see Holt et al. 2009). For these populations, national totals are given (i.e. the number of birds counted from an incomplete survey). For each population, we present brief summary information on abundance and distribution up to 1995 (covered in detail in Madsen et al. 1999), a review of abundance and distribution from 1995 to 2008 and suggest possible causes of any recent changes.

Data sources

The data presented here originate from a range of different sources. Wherever possible, the data for a given population are collated by a responsible group which has co-ordinated regular counts following common protocols to generate population estimates in a reasonably comprehensive and consistent manner. The groups involved in the co-ordination, compilation and reporting of goose numbers are given in Table 1. The Wildfowl & Wetlands Trust (WWT) produces an annual summary of the latest goose monitoring activities (*GooseNews*) and also publish this material online. This augments summary information collected by the WeBS scheme (e.g. Holt et al. 2009).

Population trend data

We assessed the rate of change in abundance by regressing the logarithmically transformed annual population estimate on year to give an annual (percentage) rate of change. We attempted to fit such models from 1960/1961 to 2008/2009 and from the last 14 years (1995/1996 to 2008/2009). Data sources for the abundance estimates are provided, along with the time series for which the analysis is available. Time periods of assessment refer either to a winter (e.g. 1995/1996) or year (1995 = winter 1995/1996). In line with current practice (e.g. Kershaw & Cranswick 2003) we present the mean of the highest winter counts from the most recent five years as the estimate of the population size.

Results

Taiga Bean Goose *Anser fabalis fabalis*

The Bean Goose was regarded as a common winter visitor to northern Britain and East Anglia during the 19th century, and the commonest goose species in many localities in the former region (Berry 1939). Widespread declines began in the 1860s, so by the early 20th century, only a few pockets remained (Owen et al. 1986). In the Yare Valley, Norfolk, a flock winters on undisturbed wet marshes and old, rough grazing meadows. Numbers declined from over c. 200 birds in the 1940s to 50–60 birds in the early 1960s, followed by a slow increase to c. 200 in the late 1970s and subsequently to over 400 birds (maximum 485 in 1990/1991). In Scotland, a regular flock of Bean Geese finally disappeared from the Dee Marshes, Galloway, in the early 1990s, where geese had been recorded from the late 1940s (maximum 240 in 1954/1955), whilst the numbers wintering on the Slamannan

[1] WeBS is a partnership of the British Trust for Ornithology (BTO), Royal Society for the Protection of Birds (RSPB) and the Joint Nature Conservation Committee (JNCC), in association with the Wildfowl & Wetlands Trust (WWT).

[2] www.wwt.org.uk/research/monitoring

Table 1. Approximate percent of goose population/flyway wintering in Britain and Ireland, terminology in this paper and in "Madsen" (Madsen et al. 1999), organisations/groups co-ordinating count data provided in this review and quarry status in Britain and Ireland.
Ungefärlig procentandel av gåspopulation som övervintrar i Storbritannien och Irland, organisation eller grupp som sammanställt de data som presenteras i denna uppsats samt populationens jaktbarhet i Storbritannien och Irland. Quarry = jaktbar; Non-quarry = ej jaktbar. För artnamn se sammanfattningen.

Terminology used in the text *Terminologi i denna uppsats*	Terminology in "Madsen" *Terminologi i "Madsen"*	Percent of population *Procent av beståndet*	Co-ordinating organisation/group *Samordnande organisation/grupp*	Quarry status *Jaktbarhet*
Taiga Bean Goose	Taiga Bean Goose	<1%	Bean Goose Action Group (BGAG) & RSPB	Non-quarry
Pink-footed Goose	Pink-footed Goose: Iceland/ Greenland	~100%	WWT/Joint Nature Conservation Committee (JNCC)/Iceland Institute of Natural History (IINH)	Quarry
European White-fronted Goose	White-fronted Goose	<1%	WeBS Partnership	Quarry
Greenland White-fronted Goose	Greenland White-fronted Goose	~100%	Greenland White-fronted Goose Study (GWGS)	Quarry[1]
Icelandic Greylag Goose	Greylag Goose: Iceland	~95%	WWT/JNCC/IINH	Quarry
NW Scotland Greylag Goose	Greylag Goose: Scotland	100%	WWT/Scottish Natural Heritage (SNH)	Quarry
Re-established Greylag Goose	Greylag Goose: Feral, UK	100%	WeBS Partnership	Quarry
Barnacle Goose (Greenland)	Barnacle Goose: Greenland	100%	WWT/SNH	Non-quarry[2]
Barnacle Goose (Svalbard)	Barnacle Goose: Svalbard	100%	WWT/SNH	Non-quarry
Dark-bellied Brent Goose	Dark-bellied Brent Goose	~40%	WeBS Partnership	Non-quarry
Light-bellied Brent Goose (East Canadian High Arctic)	Light-bellied Brent Goose: Canada	~95%	Irish Brent Goose Research Group (IBGRG)	Non-quarry
Light-bellied Brent Goose (Svalbard)	Light-bellied Brent Goose: Svalbard	40–60%	Natural England/WeBS Partnership	Non-quarry

[1] In England & Wales only, although affects very few birds and is subject to local voluntary bans. *Bara i England och Wales och påverkar mycket få fåglar samt är föremål för lokala frivilliga jaktförbud.*
[2] The Scottish Government permits lethal scaring on Islay. *Skotska regeringen tillåter att skrämma gäss genom att döda på Islay.*

Plateau, Falkirk area increased since their discovery in the early 1980s.

The distribution in the late 2000s is restricted to these two regular wintering flocks, with sporadic occurrences elsewhere. In Norfolk, numbers have slowly declined to around 100–150 birds, possibly as a result of birds remaining on the continent to winter (short-stopping), whilst in Scotland, numbers have slowly increased to over 250 birds (maximum 300 in 2007/2008) although no interchange between the two sites is suspected. The result of the decline in the Norfolk flock and an increase in the Slamannan flock has been that the number wintering in Britain has stabilized at c. 400 birds,

somewhat lower than the peak in the late 1980s and early 1990s (Figure 1a). Periods of hard weather on the continent may cause additional movements into Britain, often in late January and February; these can comprise *A. f. fabalis* and/or Tundra Bean Geese *A. f. rossicus*.

Pink-footed Goose *Anser brachyrynchus*

Confusion with the Bean Goose makes it difficult to assess how common the Iceland/Greenland Pink-footed Goose population was in Scotland before the 20th century, although it is considered to have been a scarce winter visitor (Berry 1939). Regular autumn counts started in the early 1950s (systematic from winter 1960/1961). During the early autumn, c. 90% of the population can be counted on as few as 30 roost sites (Mitchell & Hearn 2004). The censuses provide an accurate assessment of abundance (Frederiksen et al. 2004) and suggest that the population had increased from c. 60,000 birds in the early 1960s to c. 225,000 in the mid 1990s. The winter distribution is essentially the east and south of Scotland, north west and east England. Range contraction in the wintering quarters from the early 1950s to the early 1970s (with increases in numbers in east central Scotland) was reversed from the late 1980s, with increasing numbers using agricultural land in Lancashire and, notably, sugar beet tops in north Norfolk (Gill et al. 1997). Resightings of individually marked birds have shown dispersal from Scotland into Lancashire and Norfolk, followed by late winter movements northwards through England and southern Scotland to important staging areas in east and north east Scotland and the Moray Firth (Fox et al. 1994).

Since the mid 1990s, numbers have continued to increase (maximum 351,188 in 2008/2009, Figure 1b). Despite an eight-fold increase in numbers, the early autumn distribution of Pink-footed Geese in Britain has largely remained congruent with earlier years (Figure 2a), with birds particularly loyal to roosts. As the population has increased, numbers at many individual roost sites have similarly increased, especially in the south of the winter range; sites in north and east Norfolk, for example, holding c. 152,500 birds in December 2004 and sites in south west Lancashire holding c. 90,000 birds in November 2008. However, a few roosts have seen dramatic decreases in use. Dupplin Loch, Perthshire, for example, held 62,000 birds in October 1994 (a quarter of the then population estimate), but the five year mean for 2004/2005 to 2008/2009 was only c.700 birds.

European White-fronted Goose *Anser albifrons albifrons*

The north west European population has grown substantially (Fox et al., this volume), but the number wintering in Britain has declined (Table 2). WWT counts since 1946/1947 show that the British total remained relatively stable through the 1950s and early 1960s (c. 8,000 geese) and increased to more than 10,000 between 1967 and 1970 (Figure1c). Thereafter, there was a decline, with temporary peaks (of up to c. 9,500) when severe weather forced more birds into Britain (e.g. 1978/1979). The principal resort was Slimbridge on the Severn Estuary, in south west England, which formerly held internationally significant numbers (Hearn 2004).

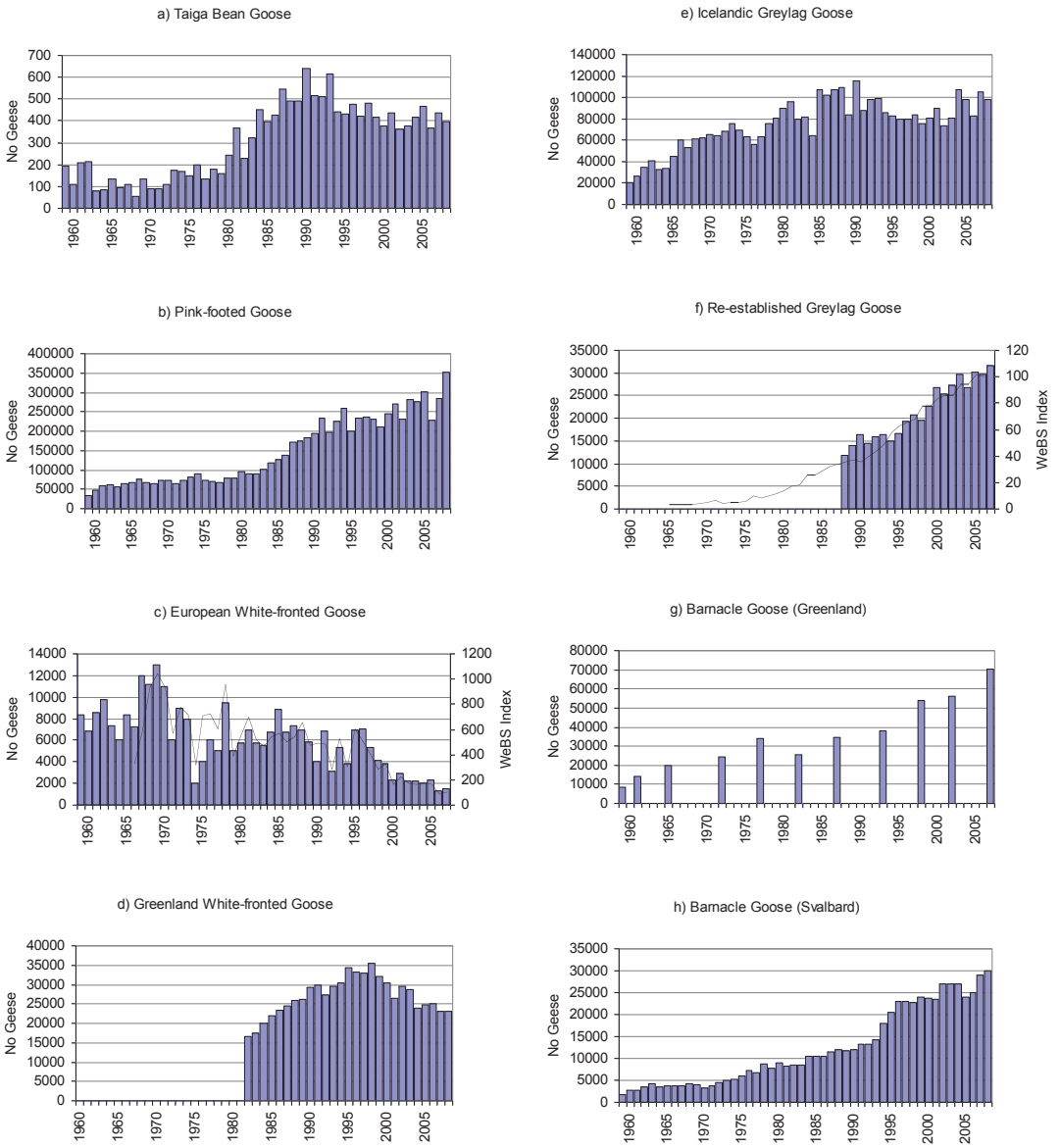
By the late 2000s, fewer than 3,000 birds were wintering in Britain (Figure 1c). Slimbridge, with an average of just 667 birds (2003/2004 to 2007/2008), remained an important British site, with about one quarter of the total wintering there. Among other important British sites are Heigham Holmes, Norfolk (c. 600 geese), the Swale Estuary, Kent (c. 400) and Holkham, Norfolk (c. 400); (see Holt et al. 2009). Only eight sites now support nationally important numbers (>58 birds), compared to 13 sites in 1995/1996 (Figure 2b).

Trends at individual sites in recent decades have varied, particularly between sites in west and east Britain. Slimbridge is the only site in west Britain that still supports European White-fronted Geese; wintering flocks at all other sites (e.g. the Avon Valley, Hampshire) disappeared in the 1990s, or earlier. In contrast, sites in eastern Britain mostly show stable or increasing numbers, with several sites having only been consistently frequented since the 1990s (e.g. Heigham Holmes, Norfolk, North Warren, Suffolk, and Dungeness, Kent). This suggests that whilst western sites have been affected by the short stopping exhibited by this population, the 20-fold population increase has resulted in a number of areas in eastern Britain supporting new, but small, flocks of geese, perhaps as sites in the Netherlands reach carrying capacity.

Greenland White-fronted Goose *Anser albifrons flavirostris*

Greenland White-fronted Geese migrate though south and west Iceland in the autumn to winter exclusively on the northern and western fringes of Britain and Ireland. The existing range reflects the natural distribution of ombrogenous bogs and wetlands which were its former traditional wintering

Figure 1.



areas, although several flocks use farmland habitats which were colonised during the 1930s (e.g. some areas in Kintyre, south west Scotland). At the two most important wintering areas of Wexford (south east Ireland) and Islay (south west Scotland) the birds have increasingly used intensively managed grasslands, as elsewhere, although at some winter sites the species still favours landscapes characterised by peatlands and low intensity agriculture. Series of regular counts are available from Islay since 1965 and Wexford since 1968 as well as several other sites. Using counts and other information, Ruttledge & Ogilvie (1979) suggested that the population of between 17,500 and 23,000 birds in the 1950s had fallen to perhaps as few as 14,300 by the late 1970s. Monitoring of the whole popula-

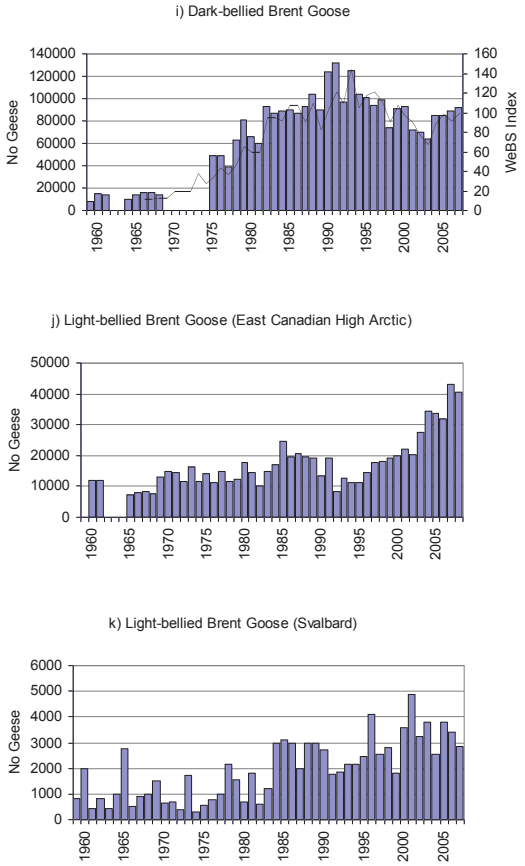


Figure 1. Maximum winter counts of geese in Britain and Ireland 1959/1960 (1959) to 2008/2009 (2008). WeBS Index is shown for three populations, see text. See Table 2 for sources of count data.
Högsta antal gäss räknade i Storbritannien och Irland 1959/1960 (1959) till 2008/2009 (2008). För tre populationer visas WeBS index, se texten. Se Tabell 2 för datakällor. För artnamn se sammanfattningen.

tion through a count network covering all known wintering sites began in 1982/1983, since when numbers increased from 16,000–17,000 to 29,000–30,000 in 1993/1994, an annual increase of 5.2%.

Numbers reached a peak of c. 35,600 birds in winter 1998/1999, but have decreased since then to an average of 24,055 (2004/2005 to 2008/2009, Figure1d). Their present distribution has not changed since Ruttledge & Ogilvie (1979) and Fox et al. (1998), and principally remains restricted to the north and west of Scotland and the west and north midlands of Ireland, with the notable exception of Wexford Slobs (Figure 2b). Since the review of Fox et al. (1998), five formerly regularly occupied sites in Scotland and nine in Ireland have become abandoned, adding to the contraction of range caused by former extinctions documented in Ruttledge & Ogilvie (1979) and Fox et al. (1998).

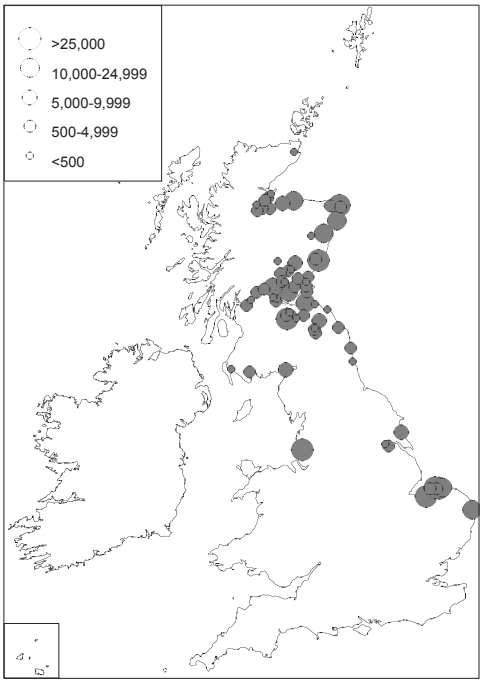
Icelandic Greylag Goose *Anser anser*

Wintering Greylag Geese were uncommon in east and south Scotland throughout the 19th century (Berry 1939), but had become more numerous at several sites by the 1930s. This was followed by a period of steady increase in the middle of the 20th century, especially so in the 1950s. Regular autumn counts started in the early 1950s and suggest that the population increased from c. 36,000 birds in the early 1960s to c. 110,000 individuals in the late 1980s. However, in the early 1990s, numbers declined and c. 86,000 were counted in 1994/1995. A northward contraction of the range began as long ago as the 1900s (Berry 1939) and continues to the present day. From the 1960s to the 1980s, the importance of north and east Scotland increased considerably, with a number of autumn roosts (e.g. Dinnet Lochs, Loch Eye, Loch of Skene) supporting both greater numbers and a greater proportion of the total population. In Ireland, c. 6,000 birds, of Icelandic origin, were thought to winter in 1949, mainly at the Wexford Slobs. Subsequently, the population declined in the 1950s and 1960s to c. 700 birds in 1967 before increasing again. By January 1995, an all-Ireland count of c. 4,700 wintering Icelandic Greylag Geese was reported (Boland & Crowe 2008).

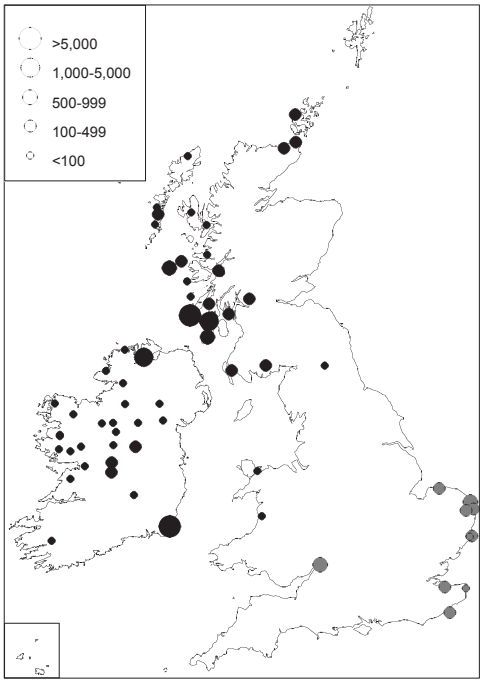
Since the mid 1990s, overall numbers continued to decrease reaching a low of c. 73,100 birds in 2002/2003, but since then have increased again, averaging c. 98,300 during 2004/2005–2008/2009 (Figure1e). The northward range shift continued and, since the mid 1990s, increasing numbers have wintered on Orkney; by 2008/2009, c. 60,000 Greylag Geese were counted on the islands amounting to over half of the total winter population (Figure 2c). In winter 2007/2008, c. 1,500 Greylag Geese were recorded in southern Iceland, the first time Greylag Geese had been recorded over-wintering there (A. Sigfusson, pers. comm., Mitchell 2009). In Ireland, numbers remained similar at c. 4,000–6,000 birds in the early 2000s, although there is thought to have been a recent decline, with only c. 2,200 recorded in 2008/2009.

Figure 2.

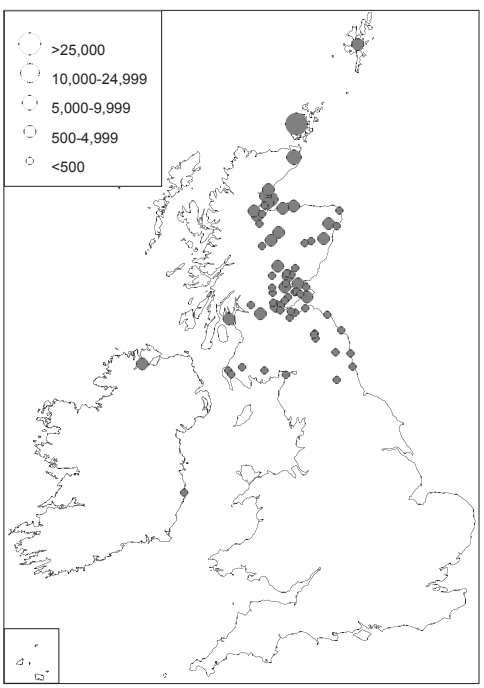
a) Pink-footed Geese



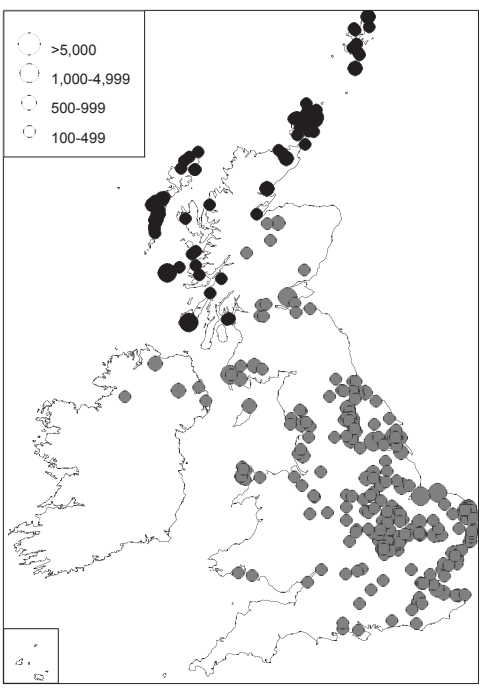
b) White-fronted Geese



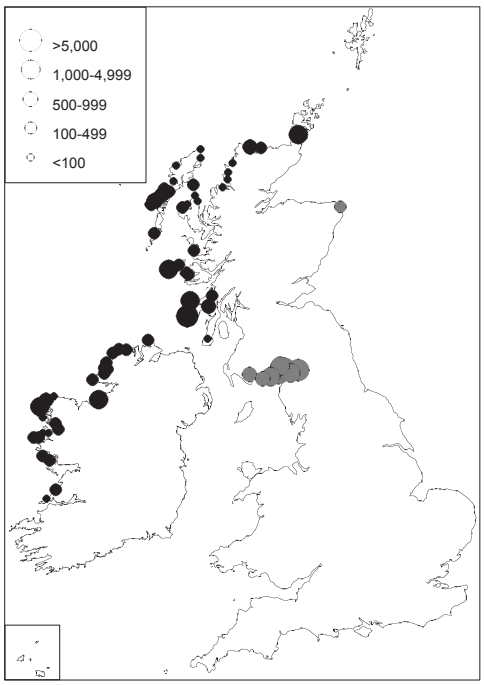
c) Icelandic Greylag Goose



d) North west Scotland/Re-established Greylag Geese



e) Barnacle Geese



f) Brent Geese

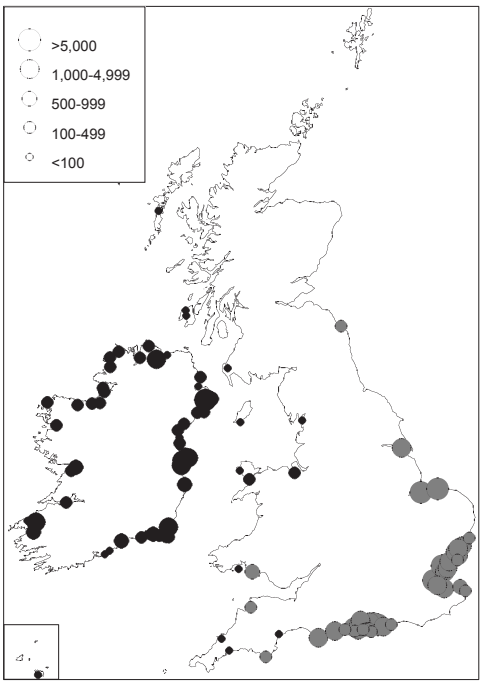


Figure 2. Distribution of geese in Britain and Ireland based on five year mean peak counts 2003/2004–2007/2008 (unless ofherwise indicated): (a) Pink-footed Geese, (b) White-fronted Geese; Greenland White-fronted Geese (black symbols) based on counts in spring 2009 and European White-fronted Geese (grey symbols), (c) Icelandic Greylag Goose, (d) North west Scotland/Re-established Greylag Geese; North west Scotland native birds (black symbols)/Re-established Greylag Geese in Scotland (grey symbols) based on counts in summer 2008 and 2009 and Re-established Greylag Geese in England, Wales and Ireland (grey symbols), (e) Barnacle Geese; Greenland Barnacle Geese (black symbols) based on counts made in March 2008 and Svalbard Barnacle Geese (grey symbols), (f) Brent Geese; Light-bellied Brent Goose (East Canadian High Arctic, black symbols) based on counts in 2007/2008–2008/2009 and Dark-bellied Brent Geese (grey symbols); Light-bellied Brent Geese (Svalbard) primarily winter at Kindisfarne and are not shown.

Gässens utbredning i Storbritannien och Irland: (a) spetsbergsgås; medelvärden för högsta antal 2003/2004–2007/2008, (b) bläsgås: grönländska (svarta symboler, räknade våren 2009) och europeiska (grå symboler, medelvärden för högsta antal 2003/2004–2007/2008), (c) isländsk grågås, medelvärden för högsta antal 2003/2004–2007/2008, (d) övriga grågässs: nv. Skottlands ursprungliga (svarta symboler) och återetablerade grågässs i Skottland (grå symboler) enligt räkningar somrarna 2008 och 2009 samt återetablerade grågässs i England, Wales och Irland (grå symboler) enligt medelvärden för högsta antal 2003/2004–2007/2008), (e) vitkindade gäss: från Grönland (svarta symboler) enligt räkningar i mars 2008 och från Svalbard (grå symboler) enligt medelvärden för högsta antal 2003/2004–2007/2008, (f) prutgäss: ljusbukade från högarktis i östra Kanada (svarta symboler) enligt räkningar 2007/2008–2008/2009 och mörkbukade (grå symboler) enligt medelvärden för högsta antal 2003/2004–2007/2008.

Table 2. Population estimates (mean winter peak and maximum count 2004/2005–2008/2009), data sources and trends for geese wintering in Britain and Ireland. For six populations, the number of birds wintering in Britain and Ireland form only a part of the flyway total – see Table 1.
Beståndsuppskattningar (medelvärde för högsta vinterantal samt högsta antal någon vinter med året då detta inträffade) för gäss som övervintrar I Storbritannien och Irland. För sex bestånd utgör de fåglar som övervintrar i Storbritannien och Irland endast en del – se Tabell 1. I de högra kolumnerna anges långtidstrend och korttidstrend med perioden för trenden. För artnamn se sammanfattningen.

Population	Present *Senaste*	Maximum year *år*	Coverage *Täckning*	Source *Källa*	Long term trend	Short term trend
Taiga Bean Goose	432	471 2008/9	Annual, complete	BGAG, RSPB, WWT [5]	+3.8% 1960–2008	–0.1% 1995–2008
Pink-footed Goose	288,800	351,200 2008/9	Annual, complete	Mitchell (2009)	+4.0% 1960–2008	+2.8% 1995–2008
European White-fronted Goose	2,760 [1,2]	2,350 [1] 2005/6	Annual, trend	Holt et al. (2009)	–2.9% 1960–2007	–13.2% 1995–2007
Greenland White-fronted Goose	24,055	25,168 2006/7	Annual, complete	Fox et al. (2009)	+1.1% 1983–2007	–3.0% 1999–2007
Icelandic Greylag Goose	98,300	107,200 2004/5	Annual, complete	Mitchell (2009)	+1.8% 1960–2008	+1.8% 1995–2008
NW Scotland Greylag Goose	34,500 [3]	34,500 [3] 2008/9	9 years, complete	Mitchell et al. (2010)	n/a	n/a
Re-established Greylag Goose	50,000 [4]	50,000 [4]	Annual, trend	Mitchell et al. (2010); Holt et al. (2009)	n/a	+4.9% 1995–2007
Barnacle Goose (Greenland)	70,500	70,500 2007/8	5 years, complete	Mitchell et al. (2009); Walsh & Crowe (2008)	+3.1% 1961–2007	+3.0% 1998–2007
Barnacle Goose (Svalbard)	26,900	29,900 2008/9	Annual, complete	WWT [5]	+5.3% 1960–2008	+2.1% 1995–2008
Dark-bellied Brent Goose	82,970 [1,2]	91,604 [1] 2007/8	Annual, trend	Holt et al. (2009)	+4.3% 1960–2007	-1.1% 1995–2007
Light-bellied Brent Goose (East Canadian High Arctic)	34,000	39,000 2007/8	Annual, complete	Kendrew Colhoun pers. comm.	+2.4% 1960–2008	+8.9% 1995–2008
Light-bellied Brent Goose (Svalbard)	3,270	3,756 2005/6	Annual, complete	Holt et al. (2009)	+3.9% 1960–2007	+1.4% 1995–2007

[1] Based on count data from 2003/04–2007/08. *Räkningar från 2003/04–2007/08.*
[2] National totals. These do not represent population estimates, since WeBS does not cover the entire population. *Nationella totalräkningar som inte är beståndsuppskattningar eftersom WeBS inte täcker hela beståndet.*
[3] Based on survey carried out in Scotland in summer 2008 and 2009. *Räkningar utförda i Skottland sommartid 2008 och 2009.*
[4] Estimated; See text for calculation of Re-established Greylag Goose population estimate. *Uppskattat; se texten för beräkning av den återetablerade grågåspopulationens storlek.*
[5] www.wwt.org.uk/research/monitoring

North west Scotland Greylag Goose *Anser anser*
The Greylag is the only species of goose breeding in a native state in Britain and Ireland and formerly had a widespread but localised distribution. During the 19th century numbers began to decline, likely linked to the drainage and cultivation of the fens and excessive hunting, causing local extinction of the species. By the 1870s, Greylag Geese remained only in the Outer Hebrides with very small numbers in west mainland Scotland. The north west Scotland (or native) Greylag Goose population, as it became known, was thus the remnant of

the population formerly widespread over Britain, numbering less than 500 birds by the 1930s, their lowest numbers in historic times (Berry 1939). The numbers and distribution slowly increased, such that by the late 1980s, c. 1,500 were reported from Tiree & Coll, c. 1,580 from the Uists and c. 2,500 in Sutherland (Mitchell et al. 2000).

The first co-ordinated census found c. 10,000 birds within the then known range of the population in 1997 (Mitchell et al. 2000). Greylag Geese first bred on Orkney and Shetland in the mid 1980s (although the provenance of the breeding birds in Shetland is unknown) and breeding numbers on both island groups have increased markedly since (Mitchell et al. 2010). Numbers of re-established Greylag Geese breeding in Scotland were also increasing (see below) and, by the early 2000s, separation of the two populations was based merely on historical geographic boundaries (Figure 2d). By 2008/2009, a second survey found c. 34,500 (range 33,370 to 36,200) Greylag Geese in the historical range of the north west Scotland Greylag Goose population (Mitchell et al. 2010), an increase of 245% since the 1997 census.

Re-established Greylag Goose *Anser anser*

Greylag Geese were re-established in Britain from the 1930s, mainly released by wildfowlers in areas of former occurrence. The majority were derived from within the North west Scotland Greylag Goose population range (see above) but it is possible that very small numbers of Iceland-bred geese, taken in winter, were also involved and it is known that a very small number of *A.a.rubirostris* were introduced into Kent. From the late 1950s, wildfowling organisations released Greylag Geese from existing re-established flocks in ten more counties in England and Wales and in smaller numbers in Scotland. Despite the disappearance of native habitat (natural fens, bogs and marshes) from much of Britain, although less so in Scotland, Greylag Geese adapted to modified or artificial habitats for both breeding and wintering. Owen & Salmon (1988) estimated there to be 13,000 to 14,000 re-established Greylag Geese in Britain in 1985/1986 and that numbers were increasing at c. 13% per annum.

By 2000, numbers were estimated at c. 24,500, increasing at c. 9.4% per annum (Austin et al. 2007). Trends within Britain are calculated using counts of birds during winter from the Wetland Bird Survey since the species is widespread and normally winters close to the breeding areas (Figure1f). The distribution of breeding Greylag Geese in the late 2000s now covers much of lowland Britain (Figure 2d). Using the estimated rate of increase in England and Wales (Austin et al. 2007) and an estimated c. 12,900 (range 10,690 to 15,550) geese in Scotland based on a separate survey in 2008/2009, it was estimated that the total number in Britain was likely to be c. 50,000 (Mitchell et al. 2010). With birds from the north west Scotland and re-established populations increasing and forming a near continuous range within Britain and Ireland, it is perhaps timely to consider these as belonging to a single population.

Barnacle Goose (Greenland) *Branta leucopsis*

The Greenland population of Barnacle Geese winters almost exclusively in north and west Scotland and west Ireland (Figure 2e). In Scotland, the wintering range extends throughout the Inner and Outer Hebrides and north to Orkney. In western Ireland, the main concentrations occur between the Dingle Peninsula, Co. Kerry, and Inishowen in north Co. Donegal. There have been 12 full international censuses since the first complete survey of wintering sites in 1959/1960, conducted at approximately five-yearly intervals, mostly in late March/early April (e.g. Mitchell et al. 2009, Walsh & Crowe 2009). Some wintering sites can be covered by ground counts, but the inaccessible nature of many sites (some are uninhabited, comparatively remote islands) requires aerial survey to achieve complete coverage. Annual ground counts at several accessible key sites in Scotland and Ireland occur (e.g. Islay, Tiree & Coll, South Walls (Orkney) and Inishkea Islands (Mayo, west Ireland)). Annual ground counts on Islay started in 1952/1953 because Islay holds a particularly high (and increasing) percentage of the total population. In 1959, Islay held one third of the total population, but by 2008, this had increased to 64%

The total population has increased more than eight-fold since the first full census in 1959; reaching c. 56,400 in March 2003 and c. 70,500 in March 2008 (Figure 1g). There have been only modest changes in winter distribution in Scotland in recent years. Some islands have ceased to hold winter flocks, usually associated with land use change, notably cessation of summer grazing. In Ireland, the distribution has also remained more or less unchanged, although the most southerly haunts have been abandoned (e.g. the Blasket Islands, the Wexford Slobs and Lurgangreen, Louth).

Barnacle Goose (Svalbard) *Branta leucopsis*

In the early parts of the 20th century, the Svalbard

Barnacle Goose was said to be a common bird on the Solway Firth, it not being uncommon to see flocks of 6,000 geese. However, by the 1930s a drastic decline had already occurred. In the mid-1940s, there was considerable disturbance from wartime activities and heavy shooting; the lowest ever count of 300 was in 1948. The geese were protected from shooting in Britain in 1954 and in Svalbard in 1955 and this, with the establishment of the National Nature Reserve (NNR) at Caerlaverock in 1957, led to a recovery in numbers to 3,000–4,000 birds in the 1960s. Further increases, to 13,000–14,000 birds in the early 1990s, followed the establishment of the WWT reserve at Caerlaverock in 1970 and the declaration of breeding sanctuaries on the main island sites in Svalbard in 1973.

The population had been predicted to level off at c. 12,000 birds based on the assumption that as the population grew the absolute number of young produced would not increase (Owen & Norderhaug 1977). However, numbers continued to steadily increase, with 29,900 counted in 2008/2009 (Figure 1h). The geese have a localised distribution in the non-breeding season, although the geese now make considerable use of the saltmarshes on the Cumbrian side of the Solway Firth from Anthorn to Skinburness Marsh and have extended their range westwards as far as Wigtown in Scotland. Even so, the breadth of the winter range from east to west is still only 50 km (Figure 2e). In addition, small numbers, generally less than 100 birds, occasionally over winter at Loch of Strathbeg, Aberdeenshire. The use of inland fields is still far less frequent on the south side of the Solway than in the north. The geese traditionally used the saltmarsh habitats of the Solway, moving to adjacent agricultural land within 5 km of the coast after arrival, utilising stubbles heavily in the autumn. The geese roost on sand- and mudflats adjacent to areas of saltmarsh. Three areas have been used extensively for feeding; the Caerlaverock area including fields and saltmarsh along the River Nith, Rockcliffe Marsh, and farmland around Southerness/Mersehead.

Dark-bellied Brent Goose *Branta bernicla bernicla*

Until the 1930s, the Dark-bellied Brent Goose was common along western European coasts, particularly associated with the vast eelgrass *Zostera* spp. beds which then existed. Following a wasting disease which decimated this food plant in the 1930s, flyway numbers declined from several hundred thousand to less than 20,000 birds. The first reliable population estimate was of 16,500 birds in the mid 1950s with approximately half of these in southern Britain (Salomonsen 1958). Numbers increased slowly until 1972, after which the total population reached c. 327,900 in 1991. Between 40 and 60% of the flyway population winters in Britain, depending partly on prevalent weather conditions in Britain and on the continent (Mitchell et al. 1994). Numbers in Britain increased from 40,000 to 60,000 birds in the late 1970s, in line with the increase of the overall population. Wintering sites are primarily distributed along the south east and south coasts of England, with eelgrass beds at Maplin Sands, off Foulness Island, and at Leigh-on-Sea key autumn staging areas. Ring re-sightings have revealed that considerable numbers of birds passing through this area move on to winter in France, while others move north to winter on Norfolk and Essex estuaries and west along the south coast of England (Ebbinge & St. Joseph 1992). As the population increased up to the 1990s, the distribution within Britain expanded, notably near to existing important sites on the Wash, Suffolk and Essex coasts but also west to south Wales and north as far as the Humber Estuary and Lindisfarne (Figure 2f).

Since the mid 1990s, the flyway population declined by about one-third to just under 200,000 birds (in 2003/2004), partly as a result of low breeding success, but then increased again to c. 250,000 in 2008/2009. The proportion wintering in Britain followed a similar pattern, declining to c. 64,400 in 2003/2004, but recovering to c. 91,600 in 2007/2008 (Figure 1i). However, the proportion of the global population wintering in Britain has declined from c. 50% in the 1950/1960s to c. 30–40% in the late 2000s, suggesting that some birds are short-stopping on the continent. In winters 2003/2004 to 2007/2008, the most important sites were the Wash (c. 21,400 geese), the Thames Estuary (c. 13,000) and Chichester Harbour (c. 9,300) (Holt et al. 2009).

Light-bellied Brent Goose (East Canadian High Arctic) *Branta bernicla hrota*

The size of the East Canadian High Arctic Light-bellied Brent Goose population was largely unknown before the 1950s. The first complete Irish census found c. 11,900 birds in 1960/1961. Counts during the 1960s varied between c. 7,300 (1965/1966) and c. 11,000–16,000 in the 1970s. There was a marked increase to over 24,500 birds in autumn 1985 followed by an apparent decline to as few as 8,300 geese in the early 1990s (survey coverage in the early and mid 1990s was relatively poor). Strangford Lough in Northern Ireland hosts

over 75% of the entire population during the late autumn and is by far the most important site for staging geese in the early autumn. Lough Foyle, on the north coast, acts as an increasingly important site for autumn arrivals as does the Tralee Bay/Castlemaine Harbour complex in the south west. As winter progresses, birds disperse around the coast of Ireland with notably high numbers at Dublin Bay and Wexford Harbour and Slobs (Figure 2f). Much smaller flocks also occur along the west coast of Britain, e.g. the flock established at Loch Ryan, Galloway, in the Channel Islands, north France (Normandy) and north west Spain (Robinson et al. 2004).

Numbers increased through the mid to late 1990s peaking at 39,000 in winter 2007/2008 (Figure 1j). This increase has resulted in higher mid-winter counts at many sites around Ireland, the establishment of flocks at previously unoccupied sites and is likely to be a driver for increased feeding on agricultural and amenity grasslands. Higher numbers in western Britain have occurred in recent years and the flocks in north France currently peak at 1,000–1,500 birds. Counts undertaken for the WeBS and Irish Wetland Bird Survey (I-WeBS) indicate that 25 sites in Ireland are internationally important for this population, regularly supporting at least 200 individuals.

Light-bellied Brent Goose (Svalbard) *Branta bernicla hrota*

The East Atlantic population of Light-bellied Brent Goose breeds on Svalbard, Franz Joseph Land and in north east Greenland. In late August to late September, they migrate down the west Norwegian coast to winter in Denmark and at Lindisfarne in north east England. In severe winters, when Danish waters become frozen, some birds also disperse to winter in the Netherlands. The population suffered a severe decline in size during the 1930s, at the time of the wasting disease affecting eelgrass beds, perhaps exacerbated by local hunting and egg collecting on Svalbard. This population may have been as large as 40,000–50,000 birds prior to the decline (Salomonsen 1958), with an estimated 20,000 birds thought to belong to this population wintering on the Moray Firth, north Scotland, in the early years of the 20th century (Owen et al. 1986). By the late 1940s and early 1950s, however, the whole population was estimated at c. 4,000 birds (Salomonsen 1958), declining to 1,600–2,000 birds in the late 1960s, the majority of which wintered in Denmark. Since 1980, annual co-ordinated counts have been made at the sites used by the geese in late autumn/mid-winter, and in Britain have shown a slow but steady increase from c. 1,500 birds in the early 1980s to c. 3,300 by the late 2000s. The only site regularly used in Britain since the 1960s is Lindisfarne (but see below).

Since the mid 1990s, Lindisfarne has been used by up to 50–70% of the entire population, despite a reduction in the frequency of cold winters. Numbers wintering there have largely increased in line with the population as a whole (estimated at c. 7,000 in 2008/2009), reaching over 4,000 birds in 1996/1997 and 2001/2002 (Figure 1k). Small groups are regularly seen along the east coast of Scotland and north England for brief periods, especially in the early autumn. These birds are thought to be on their way to Lindisfarne. Since the 1990s, however, two small winter flocks (generally less than 50 birds) have become established in Scotland; one at Nairn on the Moray Firth and another at the Eden Estuary (Mitchell & Ogilvie 2007).

Discussion

In the 1930s there was considerable concern over the number of geese in northern Europe with many populations at very low numbers due primarily to over-hunting. In Britain, successive conservation measures introduced after the Second World War (e.g. 1954 Protection of Birds Act, protection from hunting for certain populations, the introduction of nature reserves, the re-establishment of breeding Greylag Geese, the ban on the sale of goose carcasses, the 1981 Wildlife & Countryside Act) and changes in agricultural practices, some of which benefited grazing geese, led to an increase in numbers in many wild goose populations. In 1960, it was estimated that there were c. 120,000 migratory geese wintering in Britain and Ireland (Atkinson-Willes 1963). By 2008, that number had increased to half a million geese (Table 2).

For Pink-footed Geese, the key drivers for the sustained increase in abundance are considered to be the site safeguard of important winter roosts (from the 1980s), improved winter feeding conditions (notably in Norfolk), a relatively high mean breeding success rate of c. 20% (1950–2008) and a decline in overall mortality (Fox et al. 1989, Mitchell & Hearn 2004). As the population has increased, hunting mortality has not increased at the same rate, thus the proportion shot each year has declined. Autumn hunting of Pink-footed Geese in Iceland is relatively modest, compared to Greylag Geese, since the former are found in the more remote interior. Similar factors have operated on the

three Greylag Goose populations (Fox et al. 1989, Frederiksen et al. 2004, Hearn & Mitchell 2004). For the Icelandic Greylag Goose population, the decline to c. 73,000 in the late 1990s/early 2000s, was probably a result of an annual bag harvest of c. 25,000–40,000 birds in Iceland (Frederiksen et al. 2004) in addition to an estimated harvest of c. 20,000–25,000 in Britain (Frederiksen 2002). The increase and then stabilisation of numbers since the early 2000s (Figure 1e) may have partly been a result of the shift in distribution north to Orkney. It appears that this has resulted in a reduced annual harvest in Britain that has allowed numbers to recover (Trinder 2009, Mitchell 2009). For both the re-established and north west Scotland populations, a reduction in mortality (through limited hunting opportunities) and an average long term breeding success of over 20% means both populations have been able to re-occupy areas of former occurrence leading to rapid increases in abundance and distribution.

For Dark-bellied Brent Geese, European White-fronted Geese and possibly Taiga Bean Geese (in Norfolk) declines in the wintering populations in Britain are partly attributable to short-stopping, where geese winter closer to their breeding areas following an improvement in feeding conditions there and possibly winter conditions in north west continental Europe becoming less severe (Owen et al. 1986). The proportion of these global populations now wintering in Britain is lower than 30–40 years ago. In addition, for the Dark-bellied Brent Geese, lower breeding success since the 1980s has affected the overall population level.

Consistently low reproductive success since 1995 in Greenland White-fronted Geese, perhaps linked to weather conditions on the breeding areas (Boyd & Fox 2008) and/or competition with Canada Geese on the breeding grounds has failed to replace annual losses in the population which has been the demographic cause of decline in the overall population size since 1999. However, prior to 2006, up to c. 3,400 birds were also being shot annually in Iceland, although hunting of this population has now been stopped.

Under the EC Birds Directive, Barnacle Geese have been protected in Europe since 1981 and, as annual recruitment has generally exceeded mortality, numbers have increased. Large parts of the winter quarters in Scotland are farmland close to Special Protection Areas (SPAs) and farmers are paid to maintain feeding opportunities for the geese with little or no disturbance. However, the Scottish Government allows 'lethal scaring' as part of a goose payment scheme in Islay. It is estimated that up to c. 1,000 birds are shot there annually, and together with a further c. 3,000 shot annually in Iceland, this may yet reduce the rate of increase of the Greenland population. As both populations have increased, reproductive success has declined, which may also reduce the rate of increase.

Whilst the numbers of different geese have changed markedly in the last 80 years, there have been shifts in the distribution of some species too. Many goose flocks re-appear in familiar places year after year, demonstrating a high degree of site faithfulness. The geese are responding to a safe roost and regular food supply. Other flocks have shifted, some markedly. More Pink-footed Geese, in terms of numbers and the proportion of the population, are migrating to more southerly winter quarters in Lancashire and Norfolk, where the geese take advantage of waste sugar beet cuttings without causing agricultural conflict (see Gill et al. 1997). Conversely, the majority of Icelandic Greylag Geese have moved from wintering quarters in east and central Scotland to winter on Orkney, some c. 500 km closer to Iceland. Short-stopping along the migration route, to remain closer to the breeding grounds, has individual life history advantages with the first birds to arrive back on the breeding grounds often having better breeding success (e.g. Dalhaug et al. 1996). Likewise, despite the overall flyway population levels increasing in Dark-bellied Brent Geese and European White-fronted Geese, fewer birds now winter in Britain, the birds making shorter autumn migrations and staying to winter in Germany, the Netherlands, Poland and Denmark.

The East Canadian High Arctic population of Light-bellied Brent has been increasing steadily since the mid-1990s. This increase has been recorded during the near-synchronous autumn counts throughout the flyway but is also apparent in the increases of bird numbers at all established wintering haunts and the establishment of new wintering sites. The pattern may be related to a sustained period of above average productivity, perhaps related to improved conditions on the breeding grounds. The Svalbard population of Light-bellied Brent Goose is one of only two goose populations in the Western Palearctic numbering less than 10,000 birds (Fox et al., this volume), and Britain regularly hosts c. 50–70% of the entire population. Whilst the population is slowly increasing, there has been a recent decline in annual reproductive success which makes future population growth uncertain.

For most populations, the quality of the abun-

dance estimates for the UK and Ireland is considered to be high because of the effort put into co-ordinated coverage of known sites, the systematic and consistent coverage achieved, and the accessibility and documentation relating to the compilation of the count data. However, despite the organisation and collation of count data being part funded by governments, much of the monitoring is undertaken by a volunteer network and, faced with possible changes in economic circumstances, the continuation of this level of monitoring is fragile. For three populations (Dark-bellied Brent Goose, European White-fronted Goose and Re-established Greylag Goose) trends in abundance are monitored through an indexing scheme (as part of WeBS) and whilst trend data are considered accurate, national count totals often fall short of a total population estimate (see Holt et al. 2009). This is perhaps less of a problem for the Dark-bellied Brent Goose and European White-fronted Goose where a large proportion of the winter population is monitored through WeBS coverage, but for the Re-established Greylag Goose, with a relatively dispersed population, count totals could be substantially lower than the actual population size.

Large scale ringing initiatives are not currently being undertaken for any goose population in Britain or Ireland (although small scale schemes do exist for Barnacle Geese (both populations) and Greenland White-fronted Geese). In addition, unlike in some European countries, systematic bag data are not collected in Britain and Ireland. These knowledge gaps have major implications for assessing current population dynamics, in particular future Population Viability Analyses (PVAs), and possible future population levels, and thus European Union and other internationally agreed obligations to assess the sustainability of the management of these populations.

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Sammanfattning

De åtta arter av gäss inom släktena *Anser* och *Branta*, som förekommer naturligt i västra Paläarktis har delats in i 27 separata populationer eller flyttvägar. Av dessa förekommer tolv populationer i Storbritannien och Irland, och i denna uppsats ger vi en uppdaterad sammanställning av utbredning, antal och förändringar. Den inplanterade kanadagåsen behandlas inte. Storbritannien och Irland utgör övervintringsområde för nästan alla gäss från sex av populationerna, ca 95% från två populationer, 40–60% från två populationer och ca 1% från två populationer (Tabell 1).

Gåsräkningarna är väl organiserade med ett stort antal kunniga och tränade observatörer som räknar gäss antingen när de lämnar eller anländer till sovplatsen eller när de betar under dagtid. Flera populationer totalräknas årligen. Vitkindade gäss, som övervintrar på avlägsna öar, räknas dock bara med flyg vart femte år. Och tre populationer saknar heltäckning, men indexeras med hjälp av stickprov inom Wetland Bird Survey. Informationskällorna framgår av Tabell 1.

Resultaten presenteras med högsta antal varje vinter som diagram i Figur 1. Trender (långtids- och korttidstrender) anges i form av årlig procentuell förändring, vilken beräknats med regression av de logaritmerade antalsvärdena mot året (Tabell 2). I denna tabell ges också senaste beståndsskattning i form av femårsmedelvärdet för 2004/2005–2008/2009 samt det maximala antal som räknats under samma period. Gässens utbredning illustreras med kartor i Figur 2.

Taigasädgåsen (Figur 1a) var allmän på 1800-talet men minskade till två smärre flockar i slutet av 1900-talet. Dagens förekomst begränsar sig till

dessa två flockar, 100–150 fåglar i Norfolk och 250–300 i Skottland.

Spetsbergsgåsen (Figur 1b och Figur 2a) ökade i antal från 60.000 på 1960-talet till 225.000 på 1990-talet. Ökningen har fortsatt under 2000-talet och som mest har 350.000 fåglar räknats 2008/2009.

Den europeiska populationen av bläsgås (Figur 1c) har minskat fortlöpande från över 10.000 vissa år på 1970-talet till färre än 2000 de senaste vintrarna. De övervintrar i södra Storbritannien (Figur 2b).

Bläsgässen som kommer från Grönland via Island övervintrar främst på Irland och i västra Skottland (Figur 2b). Från de första räkningarna ökade antalet övervintrare till ett maximum på 35.600 fåglar 1998/1999 för att sedan sjunka till omkring 24.000 fåglar vid de senaste räkningarna.

Isländska grågäss övervintrar främst i östra Skottland (Figur 2c). Deras antal ökade stadigt från 1960-talet till 1980-talet men har sedan dess varierat mellan 70.000 och 100.000 fåglar (Figur 1e). Vintern 2007/2008 stannade 1500 gäss över vintern på Island, vilket är första gången.

Grågåsen är den enda naturligt häckande gåsen på de brittiska öarna och hade förr en vidare utbredning. I slutet av 1800-talet fanns dock bara en liten population kvar, bl.a. på Yttre Hebriderna. I dag är beståndet mera spritt över Skottland (Figur 2d) och har med bidrag från återetablering genom utsläpp ökat från som lägst 500 fåglar på 1930-talet till över 10.000 på 1990-talet. Sedan dess har grågåsbeståndet ökat ytterligare inom det ursprungliga området men det är inte längre möjligt att skilja individer från det ursprungliga beståndet från sådana som kommer från utsläppta gäss. I övriga Storbritannien återetablerades grågåsen nästan uteslutande genom utsläpp av jägare och den har fått vidsträckt spridning (Figur 2d). Beståndet uppgår i dag till över 30.000 efter en årlig ökningstakt på 9,4% (Figur 1f). Med det skotska beståndet torde det i dag finnas omkring 50.000 grågäss som både häckar och övervintrar i Storbritannien och Irland.

De vitkindade gässen från Grönland övervintrar nästan uteslutande i norra och västra Skottland och västra Irland (Figur 2e) och deras antal har ökat stadigt till numera omkring 70.000 individer (Figur 1g).

Vitkindade gäss från Svalbard var 1948 nere i en så liten vinterpopulation som 300 fåglar. De fredades i Storbritannien 1954 och på Svalbard 1955 och har sedan ökat på ett enastående sätt till 30.000 fåglar vid den senaste räkningen (Figur 1h). Övervintringsområdet är mycket litet och har en största bredd på bara 50 kilometer (Figur 2e).

Den mörkbukiga rasen av prutgås (som kommer från norra Eurasien) övervintrar i sydöstra England (Figur 2f) och ökade starkt från 1960-talet till ett maximum under 1990-talets första år för att sedan gå tillbaka till en nivå runt 80.000 de senaste räkningarna (Figur 1i).

Den del av den ljusbukiga rasen av prutgäss som kommer från högarktiska Kanada och övervintrar på Irland (Figur 2f) har ökat, men egentligen först under 2000-talet (Figur 1j), och uppgår nu till ungefär 40.000 fåglar.

De ljusbukiga prutgäss som kommer från Svalbard, Franz Josefs land och nordöstra Grönland via Norges kust har bara en övervintringsplats på de brittiska öarna, nämligen i Lindisfarne och antalet uppgår numera till runt 7000 (Figur 1k).

Med alla arter inräknade har det övervintrande gåsbeståndet ökat från 120.000 fåglar 1960 till 500.000 fåglar 2008. Denna utveckling beror på en rad faktorer, något olika för olika populationer. Till en del beror det på att Storbritannien fått del i de allmänna beståndsökningar som skett inom flera gåspopulationer. För detta har minskad jakt, reservatsbildning och förbättrad födotillgång spelat stor roll. För en del populationer är förändringarna bara lokala för de brittiska öarna genom att övervintringsvanorna förändrats. Således har nedgången för prutgås och den europeiska populationen av bläsgås orsakats av att fåglarna stannar redan på kontinenten och till mindre del når de brittiska öarna. För prutgåsen kan sjunkande ungproduktion dessutom ha påverkat den totala populationen. Den grönländska bläsgåspopulationen har länge uppvisat för låg reproduktion, vilket är huvudorsaken till många års nedgång, men sedan 1996 är jakten förbjuden under passagen på Island.

Många gåsflockar är trogna sina övervintringsplatser från år till år, men en del förändringar har också skett. Förkortad flyttning har redan nämnts, och det har noterats hos ytterligare några populationer. Merparten av de isländska grågässen övervintrar numera på Orkneyöarna som ligger 500 km närmare Island än deras tidigare vinterområden. Många spetsbergsgäss har däremot förlängt flyttningen söderut för att kalasa på rester från de stora sockerbetsodlingarna i Lancashire och Norfolk.

Det finns i dag inga större märkprojekt för någon gåspopulation i Storbritannien eller Irland. Inte heller insamlas någon systematisk statistik över antal gäss som fälls vid jakt. Dessa kända brister minskar vår förmåga att studera populationsdynamiken, särkilt möjligheten att genomföra sårbarhetsanalyser, förutsäga framtida beståndsutveckling och utvärdera effekten av skydd och skötselåtgärder.

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Numbers and distributions of geese in Hungary 1984–2009

Antal och utbredning av gäss i Ungern 1984–2009

SÁNDOR FARAGÓ

Abstract

Hungary has many areas of international importance for four goose species during migration and wintering. Monitoring of numbers started in November 1984 and has been carried out monthly in October–March since 1986/1987 at all important sites. The maximum count of Tundra Bean Goose has decreased from 100,000–120,000 birds in the 1980s and 1990s to about 15,000 today. Twelve sites are still of international importance. The maxima of Greater White-fronted Goose were below c. 50,000 in the 1980s. After a peak count of more than 150,000 in 1991/1992, maxima of c. 100,000 or more have been recorded in several subsequent seasons. Twenty-one sites are of international importance. The Lesser White-fronted Goose has declined drastically and after the 1997/1998 winter it is no longer recorded every month, and maximum has exceeded 53 birds only twice. Despite the small numbers, five sites are still of international importance. The Greylag Goose increased considerably both as a breeding bird and winter visitor. Currently the wintering population has stabilized with maximum counts of 25,000–30,000 birds. Seventeen sites are of international importance.

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Introduction

The Pannonic region is a highly significant wintering area for two goose species, the Tundra Bean Goose *Anser fabalis* and the Greater White-fronted Goose *Anser albifrons*, as well as an important migratory area for the Greylag Goose *Anser anser* in Europe. Before the marked decrease of the European population of the Lesser White-fronted Goose *Anser erythropus*, Hungary was an important area for the species. Other goose species (Red-breasted Goose *Branta ruficollis*, Barnacle Goose *Branta leucopsis* and Brant Goose *Branta bernicla*) occur only rarely (Philippona 1972, Ogilvie 1978, Fog 1982, Hudec 1984, van den Bergh 1985, Huyskens 1986, Rutschke 1987, Madsen 1987, 1991, Faragó et al. 1991, Faragó 1995, Derek et al. 1996, Madsen et al. 1999, MME Nomenclator Bizottság 2008).

Before the early 1980s there are few reviews of goose counts in Hungary (Sterbetz 1976, Lebret 1982, Sterbetz 1983). The IWRB organized the first goose symposium in Debrecen, Hungary, in 1981. Dr. István Sterbetz, director of the Hungarian Ornithological Institute and honorary chairman of the symposium, invited the author to participate. After the experience there, I started to organize the Hungarian Goose Monitoring (HGM) in 1984. This paper gives a summary of the results obtained during the quarter of a century that has elapsed.

Material and methods

Zoogeographically, the Carpathian Basin, or Pannonic region is separated from the Pontic region, which stretches to the west coast of the Black Sea, by the eastern range of the Carpathian Mountains. The distance between the two regions is not far, thus it is possible for the geese to move between the two regions (Faragó 1995).

The Hungarian Goose Monitoring (HGM) began in 1984 with counts in November, the month when peak numbers occur. Starting in 1986, monitoring

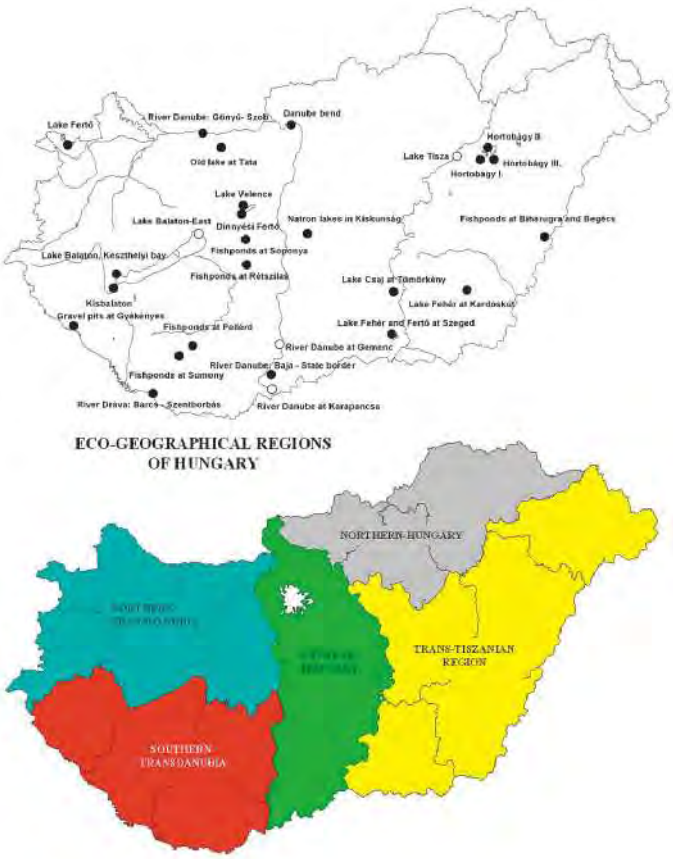

Figure 1. Observation sites/units of the Hungarian Waterfowl Monitoring (HWM) (above) and the eco-geographical regions of Hungary (below).
Observationsområden/enheter inom ungerska sjöfågelövervakningen (överst) och Ungerns ekogeografiska regioner (nederst).

was conducted on a monthly basis throughout the period October through March. In 1989–1995, we also counted the number of Greylag Geese in September, within the framework of the International Greylag Goose Counts (Faragó & Jánoska 1996). Since 1996 the census period was extended to nine months, from August to April, within the framework of the newly established Hungarian Waterfowl Monitoring (HWM; HGM is a part of HWM). Counts were made exclusively at the roosting sites. The counts were based on the geese leaving the roosts for the feeding grounds plus those remaining at the roost. I have shown that the methods that we use give reliable estimates of peak numbers (Faragó 1995).

The program includes all important roosting sites divided into 21 standard HGM sites (Faragó 2008a and Figure 1). Data from Hortobágy are treated as emanating from one site.

The observation sites are representative for each of the following five eco-regions: (1) Northern Transdanubia, (2) Southern Transdanubia, (3) Northern Hungary, (4) Central Hungary, (5) Trans-Tiszanian region (Figure 1). Consequently, the counts show the long-term population changes of the goose species at the national, regional and local levels.

Data-sheets were collected and processed at the Institute of Wildlife Management and Vertebrate Zoology of the University of West Hungary at Sopron (former Department of Wildlife Management of the Sopron University of Forestry and Wood Sciences) (Faragó 1998a).

The monthly counts also enable us to study distribution and trends for each phenological period. On the basis of the HGM counts we can determine: (A) seasonal and absolute maximum numbers, (B) phenology, (C) monthly dynamics of dispersion, (D) population trends, and (E) temporal changes of the predominance of the different species at the regional and national levels.

We publish the results in our periodical *Hunga-*

rian Waterfowl Publications (Faragó et al. 1991, Faragó 1998b, 1999, 2001a, 2002a, 2002b, 2005a, 2006, 2007a, 2007b, 2008b, 2010a, 2010b, Faragó & Gosztonyi 2003, 2009, Faragó & Jánoska 1996). We also publish them in thematic editions (Faragó 1995, Faragó & Jánoska 1996, Faragó 2008c). Hungarian results were also included in international reviews (Derek et al. 1996, Madsen et al. 1999).

The results that I give for each species are the absolute maximum observed during all the 25 years of investigation and the average of the maximum values observed in each season (25 seasons). (Maximum values have a particular role in defining population size). On the basis of the seasonal maximum values I determined the trends and drew the trend lines in the figures (with an Excel program). Population change was defined as the percentage difference between the starting and final values of the trend line. The calculation of the local trends was done in a similar way and the measure of change is demonstrated in maps with colour and width of arrows. The phenology of the goose species is shown in diagrams with the biggest and smallest monthly numerical value observed in each of the 9 months of August through April in all 25 seasons, and the monthly average values for the same 25 seasons. In the text I emphasise average values but also mention high monthly maximums.

Results

Tundra Bean Goose *Anser fabalis*

The Tundra Bean Goose is a relatively common migrating and overwintering species in Hungary. Within the framework of the HGM, the national maximum in one month was 196,750 individuals in November 1984. The average of the maximal values was 65,520.

The phenology is characterized by maximum of monthly average numbers in November and then a continuous decline until almost all birds have left in April (Figure 2). The monthly maximum numbers show a similar pattern apart from a peak in February caused by one single year. The number continuously decreases from the peak in November until spring migration in March with few remaining in April (Figure 2).

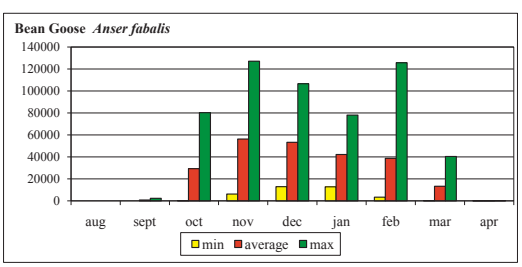

Figure 2. Phenology of Bean Goose in Hungary during the 25-year period: the observed minimum, average and maximum number of individuals in each month.
Sädgåsens säsongsförekomst under 25 år med observerat minsta, genomsnittliga och högsta antal fåglar varje månad.

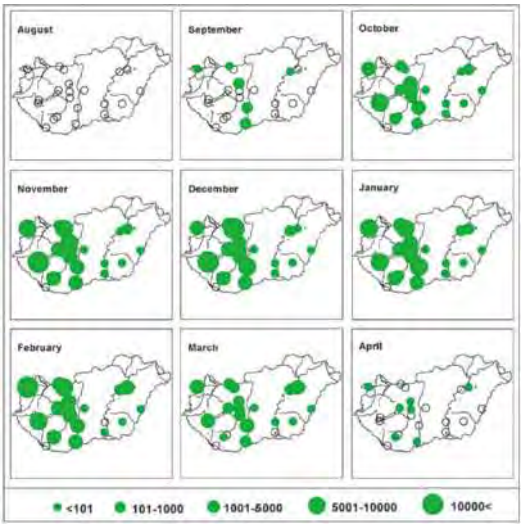

Figure 3. Monthly mean distribution pattern of *Anser fabalis* in Hungary.
Månatliga genomsnittliga utbredningen av sädgås.

The new investigations (Figure 3) support the earlier finding (Faragó 1995) that the Tundra Bean Goose predominantly appears in Transdanubia. During its peak in autumn, the highest number appears in Kisbalaton, Lake Velence and Dinnyési Fertő, fishponds at Soponya, Old Lake at Tata, Lake Fertő, Lake Balaton and the lower section of the River Danube. We observe the highest number in the same places in winter. Occasionally, however – with the increase of the number of the Greater White-fronted Goose – a significant number also appears in the Hortobágy. In spring the highest numbers are found in Lake Velence and Dinnyési Fertő, fishponds at Soponya, the Old Lake at Tata, Lake Fertő, and Kisbalaton. Hortobágy is also an important spring area for the species. We found a close connection and regional site exchange of geese between the site chains of Lake Fertő – Kisbalaton – the western basin of Lake Balaton – downstream of the River Dráva, and the Old Lake at Tata – Lake Velence and Dinnyési Fertő – fishponds at Soponya – eastern basin of Lake Balaton

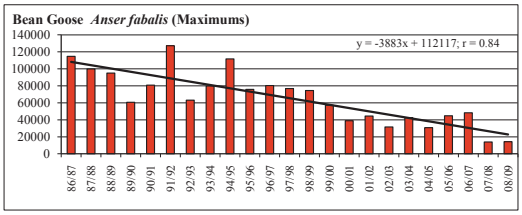

Figure 4. Seasonal maximum numbers and trend of *Anser fabalis* in Hungary.
Sädgåsens säsongsmaximum och trend.

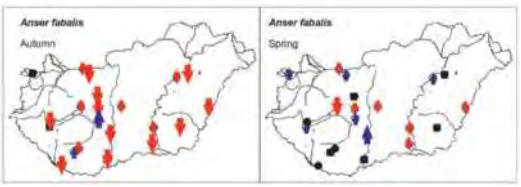

Figure 5. Local trends of *Anser fabalis* in autumn and in spring in Hungary.
Lokala trender för sädgås på hösten och våren.

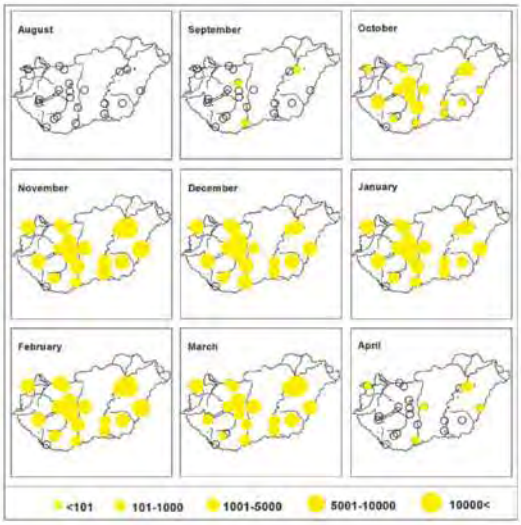

Figure 7. Monthly mean distribution pattern of *Anser albifrons* in Hungary.
Månatliga genomsnittliga utbredningen av blässgås.

– lower section of the River Danube in the wintering period (Figure 3).

On the basis of the yearly maximum numbers (most often the November count), the national population trend showed a significant, dramatic decrease of 76% in the period of examination (Figure 4). This decreasing trend can be attributed to a drastic decline of the autumn inflow of birds. However, the population in winter and spring showed a slight increase during the 25 years as was also found for some Transdanubian sites (Figure 5).

Greater White-fronted Goose *Anser albifrons.*
Greater White-fronted Goose is a common migrating and overwintering species in Hungary (Figure 6). The national absolute maximum was 165,771 in February 1992 and the absolute minimum was 0, which occurred in several years in August, September and April. The average of the maxima was 78,056.

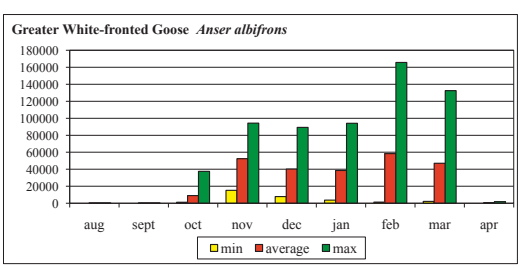

Figure 6. Phenology of Greater White-fronted Goose in Hungary during the 25-year period: the observed minimum, average and maximum number of individuals in each month.
Blässgåsens säsongsförekomst under 25 år med observerat minsta, genomsnittliga och högsta antal varje månad.

Its phenology is characterized by a moderate maximum in November and a more marked maximum in February and March. The minimum falls in December–January. The remaining April population counts were about 500 individuals on average (Figure 6).

Earlier studies of dispersion showed that the Greater White-fronted Goose is "the goose of the Great Hungarian Plain" (Sterbetz 1967, 1983) and this was confirmed by Faragó (1995). Our recent results demonstrate ever increasing numbers in Transdanubia over the last decade. During its peak in autumn, the highest number was observed in Hortobágy, the natron lakes at Kiskunság, Lake Velence and Dinnyési Fertő, Lake Fehér at Kardoskút, fishponds at Biharugra and Begécs, Lake Fehér and Fertő at Szeged, and Kisbalaton. Over 10,000 individuals were counted on several Transdanubian sites (fishponds at Soponya, Lake Fertő, Lake Velence and Dinnyési Fertő, River Danube at Gemenc). In spring the highest amounts were observed mainly on the Great Hungarian Plain with particularly high numbers in Hortobágy in February and March (Figure 7).

The annual maxima showed a positive trend (Fig-

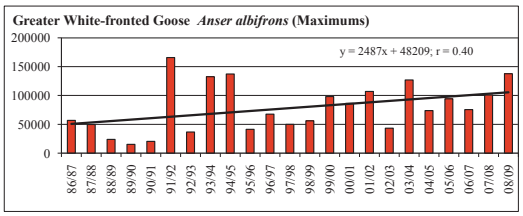

Figure 8. Seasonal maximal numbers and trend of *Anser albifrons* in Hungary.
Bläsgåsens säsongsmaximum och trend.

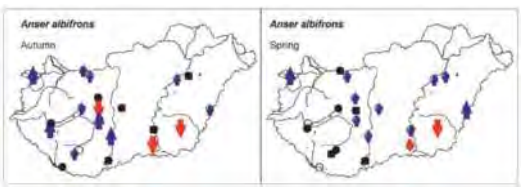

Figure 9. Local trends of *Anser albifrons* in autumn and in spring in Hungary.
Lokala trender för bläsgås under hösten.

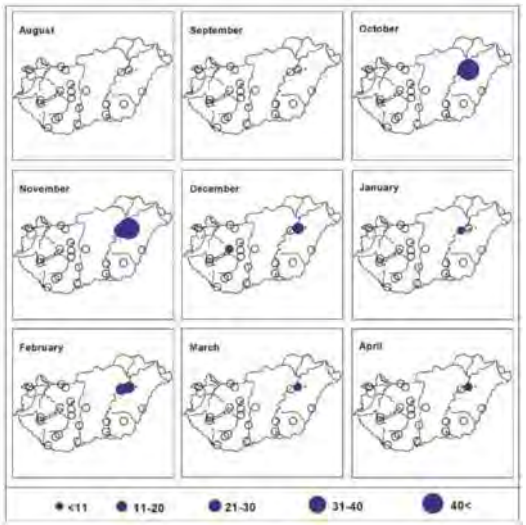

Figure 11. Monthly mean distribution pattern of *Anser erythropus* in Hungary.
Månatliga genomsnittliga utbredningen av fjällgås.

ure 8). Since 1994/1995, there has been an increase of 73%. Note that the yearly maximum values were as high as or even higher in three seasons in the 1990s than in the 2000s but despite this, the trend for the whole period becomes significant. The regional trends showed a slight increase in Northern-Transdanubia, Southern-Transdanubia, and Central Hungary, stability in Northern Hungary and slight decrease in the Trans-Tiszanian region in autumn combined with a mild increase in other periods. The local trends showed similar increases, but a steady decrease in the areas of Lake Fehér at Kardoskút and Lake Fehér at Szeged (Figure 9).

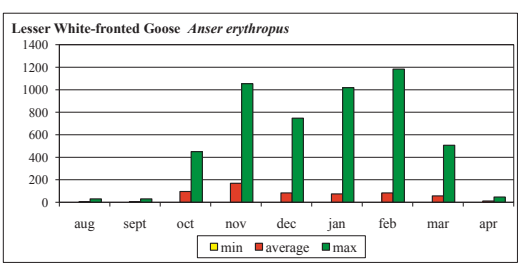

Figure 10. Phenology of Lesser White-fronted Goose in Hungary during the 25-year period the observed minimum, average and maximum number of individuals in each month.
Fjällgåsens säsongsförekomst under 25 år med observerat minsta, genomsnittliga och högsta antal varje månad.

Lesser White-fronted Goose *Anser erythropus*

The Lesser White-fronted Goose is rare on passage and even rarer as an overwintering species. Within the framework of HGM its national absolute maximum was 1183 in February 1994. The average maximum value was 279.

Its phenology is characterized by a maximum in November, a more modest maximum in February and a minimum in January. There were only a few birds in April (Figure 10).

As shown earlier (Sterbetz 1982, 1983; Faragó, 1995) the species occurred mainly in the Trans-Tiszanian region, where the most important sites were at Hortobágy, fishponds at Biharugra and Begécs and Lake Fehér at Kardoskút. Our results agree with those in these earlier studies. In the last 15 years most birds were found in the Hortobágy region (Figure 11).

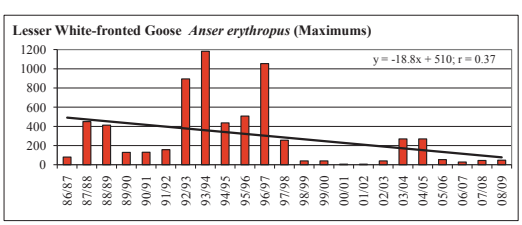

Figure 12. Seasonal maximal numbers and trend of *Anser erythropus* in Hungary.
Fjällgåsens säsongsmaximum och trend.

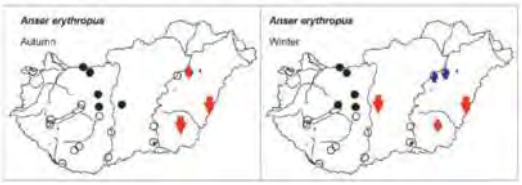

Figure 13. Local trends of *Anser erythropus* in autumn and in winter in Hungary.
Lokala trender för fjällgås på hösten och vintern.

Regional trends were shown only in Central Hungary and in the Trans-Tiszanian region. At the former site there was a mild decrease in all seasons and at the latter a slight increase in spring and a significantly decrease in autumn and winter. The local trends support the above because the amount in winter has mildly increased in Hortobágy in the last 15 years, even though the higher numbers probably occurred at the expense of other Hungarian areas (Figure 13).

Greylag Goose *Anser anser*

This goose species is an increasingly common breeder and also a common migrant (MME Nomenclator Bizottság 2008, Faragó 2001b). The national maximum was 46,184 individuals in November 2003. The average maximum value was 23,585.

Its phenology is characterized by a maximum in November, a smaller peak in February after a January minimum (Figure 14).

The earlier counts tell us little about the distribution, but according to Sterbetz (1976, 1983) the Greylag Goose paid visits to areas in the Great Hungarian Plain with larger shallow lakes during migration periods and overwintering. My own more recent surveys (Faragó 1995) demonstrated

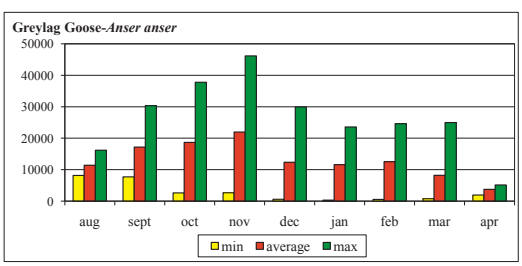

Figure 14. Phenology of Greylag Goose in Hungary during the 25-year period: the observed minimum, average and maximum number of individuals in each month.
Grågåsens säsongsförekomst under 25 år med observerat minsta, genomsnittliga och högsta antal varje månad.

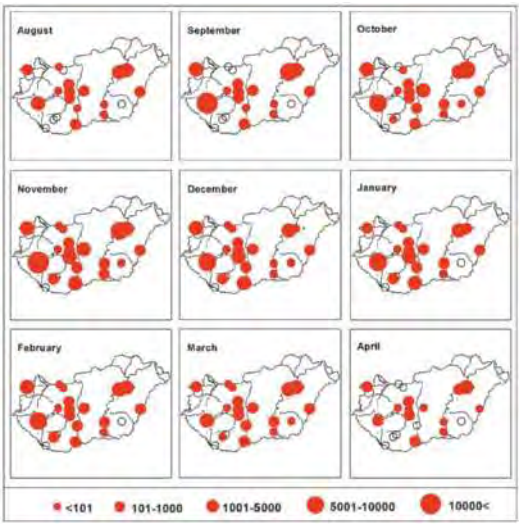

Figure 15. Monthly mean distribution pattern of Anser anser in Hungary.
Månatliga genomsnittliga utbredningen för grågås.

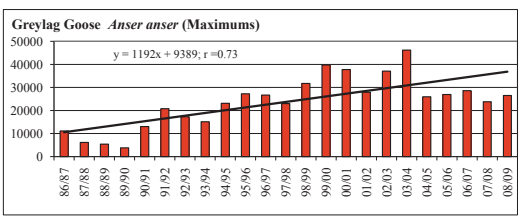

Figure 16. Seasonal maximal numbers and trend of *Anser anser* in Hungary.
Grågåsens säsongsmaximum och trend.

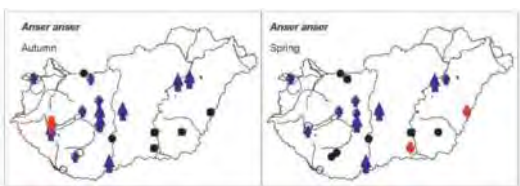

Figure 17. Local trends of *Anser anser* in autumn and in spring in Hungary.
Lokala trender för grågås under hösten och våren.

that up to the 1988/1989 season, a significant part of the observations also came from the Great Hungarian Plain. Today it can be found in wetlands all over Hungary but the majority (75%) is found in Transdanubia and only 25% on the Great Hungarian Plain. Since the early 1990s Kisbalaton plays a

prominent role in every period, particularly in the autumn, and Hortobágy is an important roosting site in autumn (Figure 15).

The development of the migrating population of Greylag Goose in Hungary is a real success story (Figure 16). As compared to the peak of 5000 individuals in the late 1980s, 10–15 years later the number peaked at 40,000–46,000 birds. However, during the five most recent seasons, maximum counts have declined to less than 30,000 birds.

The increasing tendency is observed in every period and every region of Hungary. The increase of the population was most significant in Transdanubia, while more modest in Central Hungary and the Trans-Tiszanian region. The local trend showed a slight decrease in Kisbalaton in autumn and at the fishponds at Biharugra and Begécs and Lake Fehér at Szeged in spring – primarily because of re-location between the areas (Figure 17).

Areas of international importance and future management

The wintering population of the Tundra Bean Goose in central and south-western Europe is about 600,000 individuals (Wetlands International 2006). The Ramsar 6 Criterion level of 1% is 6,000 birds, so the following 12 sites are internationally significant for this species in Hungary: Lake Fertő, Danube between Gönyű and Szob, Old Lake at Tata, Lake Velence, Dinnyési Fertő, fishponds at Soponya, fishponds at Rétszilas, Kisbalaton, fishponds at Sumony, Eastern-Balaton, Danube at Gemenc, Danube at Karapancsa, Hortobágy.

The wintering population of the Greater White-fronted Goose in central Europe is estimated at 10,000–40,000 birds (Wetlands International 2006). It should be noted that the recent Hungarian examinations showed a higher population, 100,000–120,000 birds. The most recent Ramsar 6 criterion level of 1% is 250 individuals, so according to this, 19 areas are international importance for this species in Hungary: Lake Fertő, Danube between Gönyű and Szob, Old Lake at Tata, Lake Velence and Dinnyési Fertő, fishponds at Soponya, fishponds at Rétszilas, Lake Balaton Keszthelyi bay, Eastern-Balaton, Kisbalaton, Gravel pits at Gyékényes, fishponds at Sumony, Danube at Gemenc, Danube at Karapancsa, natron lakes at Kiskunság, Hortobágy, Lake Tisza, Lake Fehér at Kardoskút, fishponds at Biharugra, and fishponds at Begécs, Lake Csaj at Tömörkény, Lake Fehér at Szeged and Szegedi Fertő.

The population sizes show a slight increase in Northern-Transdanubia, Southern-Transdanubia, and Central Hungary, stability in Northern Hungary and slight decrease in the Trans-Tiszanian region in autumn combined with a mild increase in other periods.

The wintering population of the Lesser White-fronted Goose in southeastern Europe and at the Caspian Sea has decreased to 8,000–13,000 individuals (Wetlands International 2006). The valid Ramsar 6 criterion level of 1% is 110 individuals, so 5 areas are international importance for this species in Hungary: Hortobágy, Lake Fehér at Kardoskút, natron lakes at Kiskunság, fishponds at Biharugra, fishponds at Begécs and Lake Tisza.

The Central European breeding population of the Greylag Goose has increased to 25,000 birds (Wetlands International 2006). The valid Ramsar 6 criterion level of 1% is 250 individuals, so 17 areas are international importance for this species in Hungary: Lake Fertő, Old Lake at Tata, Lake Velence and Dinnyési Fertő, fishponds at Soponya, fishponds at Rétszilas, Lake Balaton Keszthelyi bay, Eastern-Balaton, Kisbalaton, fishponds at Sumony, Danube at Gemenc, Danube at Karapancsa, natron lakes at Kiskunság, Hortobágy, Lake Tisza, fishponds at Biharugra, fishponds at Begécs, Lake Csaj at Tömörkény, Lake Fehér at Szeged and Szegedi Fertő.

The increase of the Greater White-fronted Goose and Greylag Goose populations did not compensate for the decrease of the Tundra Bean Goose and Lesser White-fronted Goose populations, so the total number of geese in the Pannonic region decreased (Figure 18). This led to both national and regional shifts of species predominance (Figure 19). In the 1980s the Tundra Bean Goose was the predominant species in western and the Greater White-fronted Goose in eastern Hungary. The number of the Bean Goose decreased everywhere and the Greater White-fronted Goose and Graylag Goose steadily increased.

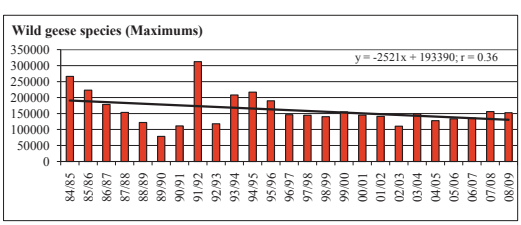

Figure 18. Sesonal maximal numbers and trend of wild geese in Hungary.
Säsongsmaxima för alla gåsarterna och trend).

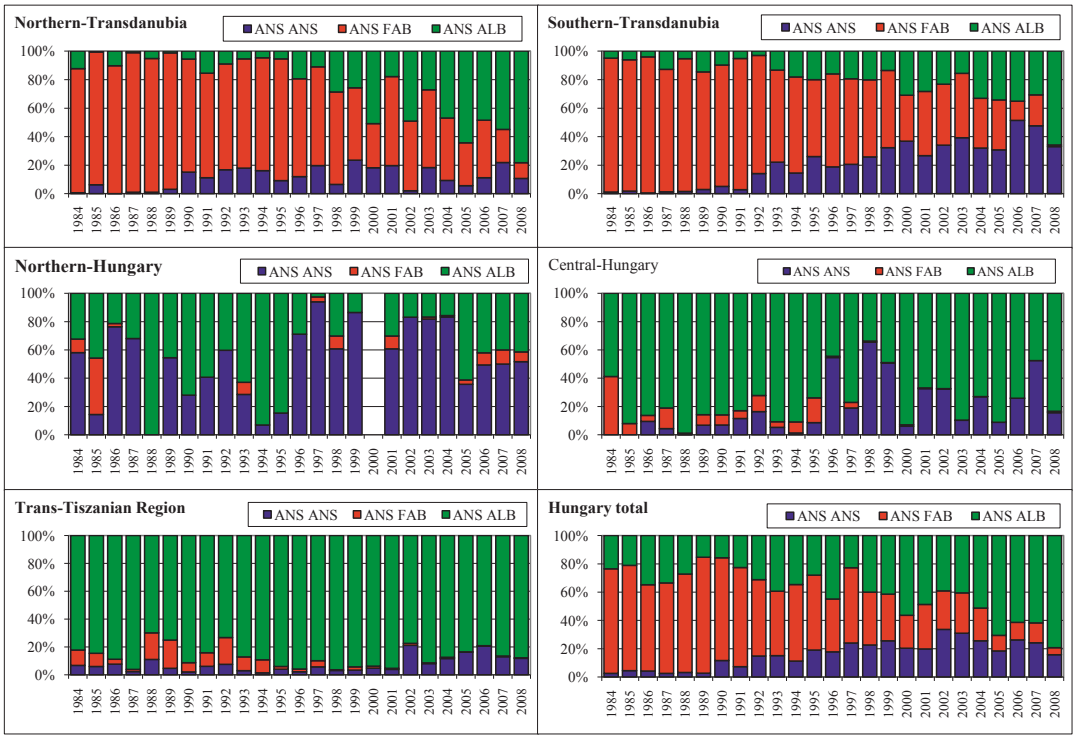

Figure 19. Percentage of various goose species as compared to overall numbers of geese in the different eco-geographical regions and in the total territory of Hungary.
Procentuella andelen av olika gåsarter i olika ekogeografiska regioner och i hela Ungern.

Despite these changes, many wetlands in Hungary are internationally significant for one or more goose species, which makes the Pannonic region one of the most important European target areas for migration and wintering geese (Figure 20).

All four goose species have similar ecologies and are exposed to similar conditions when they winter in Hungary (Faragó, 1995, 1997, 1998a). In spite of this, two species (Anser fabalis and Anser erythropus) have declining and two have increasing (Anser albifrons and Anser anser) wintering populations. From this I conclude that the reasons of the declines are not to be found in the Pannonic region but in the nesting places.

We have formed the Hungarian Waterfowl Management Plan (Faragó 1997), and this includes a system of 43 areas where hunting of waterfowl is banned (Figure 21). Altogether 177,224 ha of the Ramsar areas have effective protection of waterfowl, including these above mentioned areas of international importance. In the last two decades about 23,000 ha of wetland habitat have been restored to create a better situation for waterfowl.

At the same time as we improve the conditions, the process of drying as part of global and regional climate change is a real threat (Faragó 2005b). Especially the sensitivity of the goose species attached to shallow and astatic waters should be taken seriously in the future. We should more effectively use the directives of the Hungarian Waterfowl Management Plan. In the future we must better combine research, wise management and the conservation of goose species in Hungary and in the neighboring countries as well.

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The necessary sources of Hungarian Goose Monitoring were supplied by Ministry of Country Development (former Ministry of Agriculture and Country Development, and Ministry of Environment and Water). I am thankful for the observers, and all the co-workers who took part in data processing:

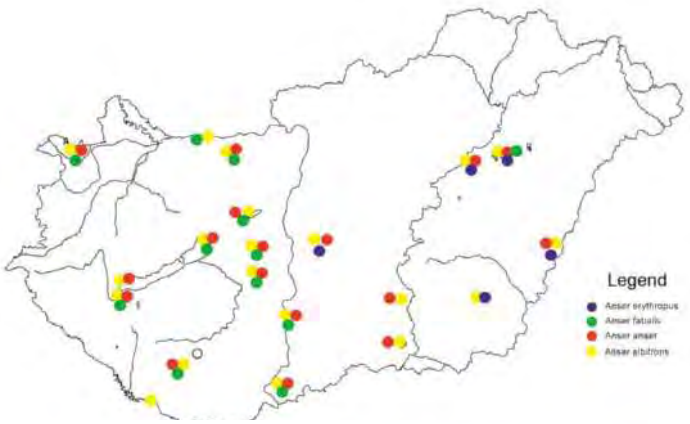

Figure 20. Sites with international importance on the basis of peak number of geese species (after Ramsar 6 Criterion) in Hungary.
Lokaler av internationell betydelse enligt Ramsarkriteriet 6, baserat på högsta antal individer.

Figure 21. Distribution of waterfowl annual closed season areas in Hungary.
Områden där jakt på sjöfåglar är förbjuden i Ungern.

Pellinger, Attila (Lake Fertő), Mogyorósi, Sándor (Lake Fertő), Molnár, Balázs (Lake Fertő), Dr. Jánoska, Ferenc (River Danube between Gyönyű and Szob), Musicz, László (Old Lake at Tata, River Danube at Nyergesújfalu), Fenyvesi, László (Lake Velence and Dinnyési Fertő), Staudinger, István (fishponds at Soponya and fishponds at Rétszilas), Szépe, Attila (fishponds at Rétszilas), Lelkes, András (Lake Balaton Keszthelyi-bay and Kisbalaton), Dr. Nagy, Lajos (Lake Balaton, Keszthelyi-bay and Kisbalaton), Fenyősi, László (River Dráva between Barcs and Szentborbás), Mezei, Ervin (Gravel pits at Gyékényes), †Molnár, István (fishponds at Sumony, fishponds at Pellérd), Ónodi, Miklós (fishponds at Sumony), Madas, Katalin (fishponds at Pellérd), Kókay, Szabolcs (Danube bend), Selmeczi Kovács, Ádám (Danube bend), Kalocsa, Béla (River Danube between Baja and state border), Boros, Emil (Natron lake Kelemen-szék at Fülöpszállás and Natron lake Zab-szék at Szabadszállás), Pigniczki, Csaba (Natron lake Kelemen-szék at Fülöpszállás and Natron lake Zab-szék at Szabadszállás), Nyúl, Mihály (Natron lake Kelemen-szék at Fülöpszállás and Natron lake Zab-szék at Szabadszállás), Gőri, Szilvia (Hortobágy), Tar, János (Hortobágy), Gyüre, Péter (Hortobágy), Dr. Kovács, Gábor (Hortobágy), Végvári, Zsolt (Hortobágy), Barabás, Lilla (Hortobágy), Szilágyi, Attila (Hortobágy), Spakovszky Péter (Hortobágy), Faludi, Csaba (Hortobágy, Lake Tisza), Gál, Lajos (Hortobágy, Lake Tisza), Konyhás, Sándor (Hortobágy), Széll, Antal (Lake Fehér at Kardoskút), Vasas, András (fishponds at Biharugra and Begécs), Tőgye, János (fishponds at Biharugra and Begécs), Dr. Bod, Péter (Lake Csaj at Tömörkény), Domján, András (Lake Csaj at Tömörkény), Nagy, Tamás (Lake Fehér at Szeged and Fertő), Dr. Tokody, Béla (Lake Fehér at Szeged and Fertő),

Jakus, László (Balaton East), Fodermayer, Vilmos (River Danube at Gemenc and River Danube at Karapancsa), Sipos, Sándor (River Danube at Karapancsa), Janács, Gergely (River Danube at Karapancsa), Dr. László, Richárd (NymE Sopron), Vörös, Ákos (NymE, Sopron).

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Sammanfattning

I Ungern började övervakningen av de övervintrande gåspopulationerna med räkningar i november 1984 och 1985. Från vintern 1986/1987 har månatliga räkningar genomförts från oktober till mars. Dessa utvidgades 1989 till att omfatta även september och från 1996 till att omfatta även augusti ochl april. Räkningarna sker med sådan noggrannhet vid alla viktiga lokaler att de gäss som missas inte spelar någon roll vare sig för de nationella eller regionala summorna. Figur 1 visar de observationsområden och lokaler där räkningarna utförs samt indelningen av landet i biogeografiska regioner.

Det är fyra gåsarter som förekommer mer än tillfälligt: sädgås (tundrarasen), blässgås, fjällgås och grågås. Arternas förekomst under det kvartssekel som räkningarna pågått presenteras för hela Ungern i form av maxvärden för varje vintersäsong och trenden för dessa i Figurerna 4, 8, 12 och 16. Lokala trender för de fyra arterna presenteras med hjälp av pilar av olika riktning och tjocklek i Figurerna 5, 9, 13 och 17. Den genomsnittliga geografiska fördelningen av respektive art presenteras i kartform i Figurerna 3, 7, 11 och 15. Gässens antal under olika månader återges i Figurerna 2, 6, 10 och 14 i form av högsta antal, genomsnittligt antal och minsta antal som räknats respektive månad under alla 25 säsongerna.

Tundrasädgåsen har minskat kraftigt i antal. Det högsta antal som räknats var nästan 200.000 individer i november 1984 medan högsta antal de senaste vintrarna legat under 15.000. Nedgången gäller främst antal gäss som anländer på hösten, medan antalet som ses senare under vintern inte visat samma negativa trend.

Blässgåsens trend har varit positiv, men det högsta antal som någonsin räknats var 165.771 fåglar i februari 1992 och även tre andra år under 1990-talets första hälft uppvisade höga värden.

Fjällgåsen förekommer numera i blygsamma antal (högst ett femtiotal) från att ha räknats med 1183 individer i februari 1994.

Grågåsen har ökat kraftigt i antal från högst 5000 i slutet av 1980-talet till över 40.000 i november 2003.

Ökningen av blässgäss och grågäss har inte kompenserat minskningen av sädgäss och fjällgäss, varför det totala antalet övervintrande gäss i Ungern minskat (Figur 18). Detta har lett till förskjutningar i arternas procentuella andelar av det totala beståndet (Figur 19). Flera lokaler uppfyller Ramsarkriteriet 6 och anses därmed vara av internationell betydelse (Figur 20). Nyligen har en skötselplan för sjöfågel antagits och den innefattar bland annat jaktförbud på sjöfågel i 43 områden om tillsammans 177.224 ha (Figur 21). Under de senaste två decennierna har också 23.000 ha våtmarker restaurerats.

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Naturalised geese in Europe

Naturaliserade gäss i Europa

HAKON KAMPE-PERSSON

Abstract

Besides elucidating which populations that ought to be counted as naturalised basic data of 69 national populations of naturalised *Anser and Branta* geese in Europe, and some local populations as well, were given. These populations, representing 15 different taxa, varied widely in size, from one pair to 35,000 pairs. Taking into account that recent population estimates are lacking for about one third of the national populations, at the same time as several populations have been in a phase of rapid growth since the late 1990s, it is no exaggeration to state that the total European post-breeding population of naturalised geese in 2009 numbered more than 800,000 individuals. More than 99% of these were made up of the three species Greater Canada Goose, Greylag Goose and Barnacle Goose.

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Introduction

All but a few of the native goose populations wintering in Europe have increased markedly during the last half a century. During the same period geese that are found in the nature only thanks to Man, introduced deliberately or by mistake, have multiplied many times over, in number of species, in number of populations and in number of individuals. These birds, interchangeably referred to as feral, aliens, foreign, exotics, introduced, non-indigenous, non-native, sedentary, neozoans or naturalised, have gained attention by conservationists, managers and researchers during the last two decades. The increasing interest in these geese is due to their impact on biodiversity and humans (Hughes et al. 1999, Sol et al. 2005, Banks et al. 2008, Fox 2009). The biodiversity might be affected by introduction of alien genes, hybridisation, competition, disease transmission and habitat destruction, while the impact on humans might be economic (agriculture, aircraft, recreation areas and public health) or aesthetic. The impacts most often occupying managers of today are crop damage, fouling of park lawns, golf courses and public baths, and aggression by geese in recreation areas. Another concern is that negative experiences of naturalised geese among the public can spill over to their wild counterparts, resulting in a lower acceptance of geese in general.

A general interest in naturalisation has generated a large number of reports about alien, invasive, non-native and naturalised species during the last decade (e.g. Blair et al. 2000, Lever 2005). Several of these publications are available on internet, but many of them are, at least concerning geese, ambiguous. Already to the simple question whether or not a certain species breeds in a specific country, different reports often give contrary answers.

Summer surveys of naturalised geese were carried out in Britain in 1991 and 2000 (Delany 1993, Rowell et al. 2004), in the Republic of Ireland in 2000 (unpubl. data) and in the Netherlands in 2005 and 2009 (van der Jeugd et al. 2006, de Boer & Voslamber 2010), while a similar survey in Britain in 2009, owing to lack of funding, only covered the two most numerous species (Carl Mitchell pers. comm.). Available knowledge of naturalised geese in Germany up to 2005 was published by Bauer & Woog (2008), and of invasive goose species in France up to 2006 by Dubois (2007). In other countries, several populations have been monitored on a local or regional level, often annually. In some countries, breeding data about at least some of the

less numerous species have been collected by a national body, such as the Rare Breeding Birds Panel in the UK (www.rbbp.org.uk). However, which these monitors are and where they publish their results are often unknown to those searching the data.

Besides elucidating which populations that ought to be counted as naturalised, this report aims at giving basic data about all populations of naturalised *Anser* and *Branta* geese in Europe. The occurrence of Egyptian Goose *Alopochen aegyptiaca* in Europe up to 2009 was reported by Kampe-Persson (2010).

Material and methods

In 1995, a one-day conference on the introduction and naturalisation of birds was organised by the JNNC and the BOU. This led to a review of the process of establishment of such species and the terms that best describe their status (Holmes & Stroud 1995). That article was summarised by Holmes & Simons (1996) in the following way: "Terms such as 'exotic', 'alien' and 'non-native' describe the *origins* of the species concerned, whereas 'feral', 'introduced' and 're-established' describe the *process* by which establishment in the wild has occurred. The consensus at the conference was that 'naturalised' was a more appropriate all-encompassing term for wild self-sustaining populations of such species, describing the *outcome* of the process. The term 'naturalised' can be accompanied by a qualifier explaining the origin of the species concerned to produce the following categories: (1) Naturalised feral: a domesticated species established in the wild. Note that mere keeping in captivity does not necessarily constitute domestication. The species must undergo some change in genotype, phenotype or behaviour in captivity. (2) Naturalised introduction: established species which would not occur without introduction by man. (3) Naturalised re-establishment: a successful re-establishment of a species in areas of former occurrence. Note that 're-established' is favoured over 'reintroduced'. The latter is often used to describe species which have been re-established in an area of former natural occurrence, following extinction. This usage is incorrect, however, since reintroduction implies that the species was *introduced* in the first place. (4) Naturalised establishment: establishment of a species which occurs but does not breed naturally in a given area e.g. a vagrant, passage migrant or winter visitor. Note that these terms are meaningless without some geographical reference."

Another three definitions of importance in this context were given by IUCN (1998): (1) Re-introduction: an attempt to establish a species in an area which was once part of its historical range, but from which it has been extirpated or become extinct. (Re-establishment is a synonym, but implies that the re-introduction has been successful). (2) Translocation: deliberate and mediated movement of wild individuals or populations from one part of their range to another. (3) Re-inforcement/Supplementation: addition of individuals to an existing population of conspecifics.

In a recent AEWA publication, Owen et al. (2006) defined a non-native taxon as "a species, sub-species or discrete geographical population that would not occur in an area without interference by man. This includes: (1) A taxon introduced as a breeding bird to a region where it normally only occurred in the non-breeding season; (2) A taxon introduced entirely outside of its previous known range; (3) A taxon imported and taken into captivity at a location outside of its normal range; (4) Domesticated taxa that have established in the wild, including domestic-type strains that have arisen by hybridisation between wild and domesticated individuals."

In spite of these definitions, it is far from always evident if a specific population should be counted as natural or naturalised. The problem can be to determine if a population was re-established or re-inforced, if a population was established by wild birds or by birds of captive ancestry, or how much contamination with genes from another taxa or discrete geographical population that is acceptable, if any at all. Currently, there is a tendency to treat more and more of the re-established and established populations as natural. Opinions about contamination with foreign genes are strongly divided, ranging from insistence on getting such birds eliminated to a want to do nothing at all. In this report, the question whether or not a specific population should be counted as naturalised is outlined under the different species headings. Note that occurrence of non-native genes did not qualify a population to be counted as naturalised.

A prerequisite of a naturalised population is that it is self-sustaining (Sol et al. 2005). In this report, all populations described as not being self-sustaining were mentioned in the text, while all others were included in Appendix. To prevent uncertainty whether any naturalised population had been overlooked, the aim was to include all breeding populations independent of size, also including one population that has ceased to exist. Populations

are shown by nation, reflecting the normal way of monitoring. In some cases, local or regional populations are shown as well, partly when a country houses both natural and naturalised populations of a species, and partly when regional monitoring schemes motivate such a presentation. Information about which monitoring schemes that covers each of the populations is given. Up to three references to publications, giving essential information about establishment, population development, distribution, counts and/or estimates of number of breeding pairs and/or number of individuals, are listed for each population.

Results and discussion

The knowledge about naturalised goose populations varies greatly among countries and species, often also among local populations within a country (Appendix). This applies not only to the quality of the different population estimates, but also to how often populations are surveyed, if surveyed at all. Of national populations, 64% (n = 69) have at least one estimate from either 2008 or 2009. Taking into account that some countries, for instance UK and Germany, publish population estimates with several years delay, that proportion might increase to 77%. On the other hand, one or two populations might be missing in Table 1, as the picture is incomplete for some of the countries.

In the Askania Nova Biosphere Reserve in southern Ukraine, founded by Friedrich von Falz-Fein in the 1880s, all Eurasian goose species are kept in semi-captivity (Alexander Mezinov in litt.). Each one of Greylag Goose, Snow Goose, Bar-headed Goose, Barnacle Goose and Greater Canada Goose produces more than 200 fledglings annually. Some of these fledglings are ringed and released. These releases have produced quite a number of recoveries (Zubko & Havrilenko 2002); for instance, of Snow Geese from Norway (Lund 1966), Finland and France, while Greylag Geese have dispersed and restocked populations not only in Ukraine but also in Smolensk region, Vologodskaya region, Tverskaya region, Tyumenskaya region, Poland, Germany, Romania and Turkey. Geese breeding in Askania Nova were not included in Appendix.

The role of Askania Nova in the restoration of the Ukrainian Greylag Goose population is outlined based on data provided by Mikhail Banik. This exemplifies the importance of geographical scale, because while the Ukrainian population as a whole is re-inforced, some of the local populations might be naturalised. The Ukrainian population passed through a rather narrow bottleneck in the late 19th century and the first half of the 20th, when numbers were reduced to virtually single pairs at some sites, or dropped to zero in others. An opinion, manifested by Lysenko (1991), exists among Ukrainian ornithologists about the important role the Askania Nova population played in the restoration of the Ukrainian population. Though there are very few evidences, based on recoveries of ringed birds at breeding sites, that Askanian birds were founders of newly established sub-populations in different parts of Ukraine, Lysenko (1991) assumed that it was so. In particular, he argued that the re-inforcement process was responsible for the recovery of the Samarian-Orelian sub-population, the largest in Ukraine, and also, based on the behaviour of the birds in these groups, for those smaller sub-populations which breed in Eastern Syvash region, at Molochniy liman in Zaporozhye region and on ponds in the Zgar river flood-plain in the Vinnitsa region. During breeding season birds ringed in Askania Nova were recovered in Kherson region and Odessa region within the range of the Danubian-Dniester sub-population, in Kyiv region within the range of the north-western sub-population, and in Poltava region, Cherkassy region and Dnieperpetrovsk region within the range of the Samarian-Orelian sub-population. The size of the Danubian-Dniester sub-population is fairly stable at 10,000–16,000 individuals, the north-western population comprises about 1,000 breeding pairs, while the Samarian-Orelian sub-population has declined from 48,000 individuals in 1994 to only 12,000–18,000 since 2000 (Lysenko 2001, 2004). In the Kharkiv region, the breeding population declined from 610–635 pairs in the mid-1990s to 310–330 pairs in 2005–2006 (Banik et al. 2008).

Countries not mentioned in Appendix probably lack populations of naturalised geese, but confirmation was only obtained from Andorra (Associació per a la Defensa de la Natura 2002), Belarus (Viktar Fenchuk in litt.), Bulgaria (Bulgarian National Rarities Committee 2009), Cyprus (www.birdlifecyprus.org), Estonia (Elts et al. 2009), Gibraltar (Garcia 2009), Hungary (Hadarics & Zalai 2008, Sándor Faragó in litt.), Latvia (Ķerus 2009), Liechtenstein (Georg Willi in litt.), Lithuania (Saulius Švažas in litt.), Macedonia (Metodija Velevski in litt.), Malta (www.birdlifemalta.org), Portugal (Matias et al. 2007), Slovakia (www.vtaky.sk) and Ukraine (Grishchenko 2004, Mikhail Banik in litt.).

Species accounts

Swan Goose *Anser cygnoides*
All breeding records in Europe are of introduced birds. Seemingly, the Swan Goose often has difficulties in establishing itself. And in the Netherlands, the population is declining (Berend Voslamber in litt.). One reason can be the prevalence to hybridise with the Greylag Goose. In UK in 2000, a total of nine adult Swan Geese were found, but no less than 47 hybrids between Swan Goose and Greylag Goose (Rowell et al. 2004). In the Republic of Ireland, four hybrids between Swan Goose and Greylag Goose and 50 domestic geese were counted in the summer of 2000 (unpubl. data). Locally in South Sweden, introgression has taken place in the Greylag Goose (Kampe-Persson & Lerner 2007).

Taiga Bean Goose *Anser fabalis*
In parts of the Swedish provinces Dalarna, Hälsingland and Härjedalen, where the Taiga Bean Goose was no longer breeding, a total of 376 colour-ring marked goslings, with Greater Canada Geese as foster parents, were released during the years 1974–1991 (von Essen 1982, Svensson et al. 1999). Main wintering area of the released birds was situated at Foteviken (own obs.), less than three kilometres from the venue of the GSG12. A total of 4–5 hybrids between Taiga Bean Goose and Greater Canada Goose have been reported from Sweden (Kampe-Persson & Lerner 2007). It is not known, however, if these hybrids were a side effect of the release project, or the outcome of the Greater Canada Goose spreading into the breeding range of the Taiga Bean Goose. When the marked birds died, and the species ceased to winter at Foteviken, it became impossible to follow the birds. Whether the breeding of the species in the release areas (Svensson et al. 1999) is an outcome of the project or if these breeders are wild birds from adjacent areas is unknown. Most likely, this project was a successful re-inforcement.

Tundra Bean Goose *Anser serrirostris*
Introduction attempts in Hamburg in the 1950s and 1960s failed (Kreutzkamp 2003).

Pink-footed Goose *Anser brachyrhynchus*
Singly pairs bred in UK in 1980, 1991 and 1998 (Sharrock & the Rare Breeding Birds Panel 1982, Delany 1993, Ogilvie & the Rare Breeding Birds Panel 2000). Breeding records in northern Fennoscandia and northern Russia were of wild birds (Van Impe 2000, 2008, Irgens 2004), while at least one of the mates in each mixed pair (Sørensen & Jensen 1991, Husby 1994, Birina 2005) most likely had captive ancestry. Small numbers of Pink-footed Geese of unknown captive or semi-captive origin have been reported from South Sweden (Elleström et al. 1996, Green et al. 1997). A free-flying population in Germany numbered 30 individuals but less than five breeding pairs during the period 2000–2005, but it is doubtful if these birds should be counted as breeding out of captivity (Bauer & Woog 2008).

White-fronted Goose *Anser albifrons*
Introduction attempts of both *albifrons* and *flavirostris* in south-eastern Sweden in the 1930s (Berg 1937) resulted in at least some cases of breeding in the wild (Karlsson 1974). In UK, one pair of *albifrons* bred in 1991 and two pairs in 1998 (Delany 1993, Ogilvie & the Rare Breeding Birds Panel 2000).

Lesser White-fronted Goose *Anser erythropus*
In an area in Swedish Lapland, where the species still was breeding in low numbers (Andersson & Holmqvist 2009), a total of 348 Lesser White-fronted Geese were released during 1981–1999, with Barnacle Geese as foster parents (Andersson & Larsson 2006). In all probability, the population breeding in Sweden today, the last remnant of a formerly abundant Scandinavian population, is a mixture of the original population and birds from the Swedish Lesser White-fronted Goose Project (Andersson & Holmqvist 2007). These birds follow one of the traditional migration routes of the Scandinavian population, routes that were well separated from that of the North Fennoscandian population (Kampe-Persson 2009). Some of the released birds had very likely a hybrid ancestry (Ruokonen et al. 2007), but if any of these birds ever recruited into the breeding population is unknown. A way to catch and screen if any individual in the Scandinavian population has a hybrid ancestry was outlined by Ottvall (2008). As an unwanted side effect of the project some of the released males have paired up with Barnacle Goose females, and quite a number of hybrids have been produced (Kampe-Persson & Lerner 2007). There is no known link, however, between the Swedish project and a pair of Lesser White-fronted Geese that bred in the Swedish province of Medelpad in 2006 (Allberg & Marklund 2006), or of the pairs breeding in the Netherlands (Voslamber et al. 2010). The Scandinavian population of today has been treated as naturalised (Clavell et al. 2005, Jones et al. 2008), but rightly it should be counted as re-inforced.

Greylag Goose *Anser anser*

After a population low in the first half of the 20th century translocations, introductions and re-introductions assisted in restoring the Greylag Goose in Europe (Kampe-Persson 2002). As several of the re-established populations nowadays are indiscernible from the wild ones, these projects turned out to be successful re-inforcements. In the Faroe Islands, for instance, two injured wild birds released in Tórshavn in the 1960s gave rise to a feral population, while breeding by Icelandic migrants did not become regular until the 1970s (Kampe-Persson 2002). The population increased to 2–10 pairs in 1981 (Jensen 2006), 75 pairs in the mid-1990s (Asbirk et al. 1997), 80–100 pairs in the late 1990s, of which about one third was feral (Pennington 2000), 250 pairs in 2004 (Jensen et al. 2004) and 250–300 pairs in 2009, of which all were regarded as wild (Jens-Kjeld Jensen in litt.).

In South-east Iceland, a naturalised population was established in the mid-1950s, which increased to 50 individuals in 1962/1963, 100 in 1968/1969, 500 in 1990/1991, 860 in 2005/2006, 784 in 2008/2009 and 992 in 2009/2010 (Jóhann Óli Hilmarsson in litt.).

In Inner Oslofjord, both Norwegian and Swedish birds were released, establishing a mixed population of the two subspecies *sylvestris* and *anser* (Bergan 2000). If Greylag Geese breeding in the surroundings of Inner Oslofjord are wild birds, descendants of the released birds or a mix of these two is unknown (Arne Follestad in litt.). The counties situated closest to Inner Oslofjord are Østfold to the south-east and Vestfold, Telemark and Aust-Agder to the south-west. The species is breeding in Østfold, but nothing is known about in which numbers. There might be as many as 600–700 pairs in Vestfold, while there are about 55 pairs breeding in the seabird reserves of Telemark. At least some of the geese breeding in Telemark ought to be wild, as the first breeding in this county was recorded in 1974, before the species started to breed in Inner Oslofjord. In Aust-Agder, where the first breeding was recorded in 1992, the breeding population is estimated to number 40–50 pairs (Bengtson et al. 2009). Some of the pairs in Aust-Agder breed at fresh water, indicating occurrence of nominate birds in this county. However, if these birds originate from the naturalised population or from the Swedish is unknown (Arne Follestad in litt.).

Non-native birds were used also in other projects. In 1929, six Eastern Greylag Geese *Anser anser rubrirostris* were brought from India to south-eastern Sweden (Berg 1930, 1937). Nothing was heard about these birds thereafter, but translocations of eggs and birds from that part of Sweden to other Swedish sites took place more than once. All Greylag Geese in Scandinavia were reported as having orange bills in the middle of the 19th century (Nilsson 1858). In a recent study in South Sweden, all examined adults turned out to have either orange/pink or pink bills (Kampe-Persson 2003). Thus, *rubrirostris* genes are apparently well spread in the South Swedish Greylag Goose population of today. Another six *rubrirostris* geese were brought to the Zwin Reserve in Belgium in 1955 (Robyns De Schneidauer 1968). From Zwin the species spread over Belgium and the SW Netherlands. Taking ringing recoveries into account, birds from the Zwin population might have dispersed also to Denmark, Sweden and Germany. Other introductions of *rubrirostris*, using birds from Zwin, took place in England, the Netherlands and France (Sharrock 1976, Teixeira 1979, van den Bergh 1991, Riols 1994). The Zwin *rubrirostris* later hybridised with *anser* and gradually the *rubrirostris* characteristics disappeared from this population (Nilsson et al. 1999). However, do these disappearing characteristics refer to all traits, or only plumage? The bill colour in Dutch Greylag Geese is, for instance, similar to that in South Sweden (Berend Voslamber in litt). Genetic studies in the mid-1990s showed marked differences between breeders in the Netherlands and South Sweden (Blaakmer 1995).

In Lithuania, an unsuccessful re-introduction plan was implemented in the 1950s–1960s, with several geese of Russian origin kept in captivity, but none released (Saulius Švažas in litt.). Despite the fact that these geese were unable to fly and never left captivity, some of them entered the EURING database. By that, they have caused uncertainty whether the Lithuanian population of today is naturalised or wild. The Greylag Goose bred in the whole East Baltic region in the 19th century and the beginning of the 20th, but there were no records of breeding in Lithuania in the 1940s–1970s. Breeding was recorded in Lithuania again since 1980. That was the result of the overall range expansion of the species in the East Baltic region, with breeding recorded also in adjacent North-west Poland and in Latvia. At present the Lithuanian breeding population is estimated at about 150 pairs (Švažas et al. 1997, 1999, Kurlavičius 2006, Saulius Švažas in litt.). In Latvia, 2–3 released pairs bred in Lake Kaņieris in 1972 and 1973, but no evidences of breeding were found thereafter (Mednis 1983).

Introduced birds in Italy are, in contrast to winter visitors, orange billed (Nicola Baccetti in litt.).

Recently, pairs of the pink-billed wild population have colonized two wetlands in S and C Italy (Nicola Baccetti in litt.). In Spain, wild birds have been breeding since 2001, with at least four pairs in 2007 (Molina & Lorenzo 2007, Molina et al. 2008, 2009). Occasional breeding at lower latitudes has been reported earlier however; in Algeria in the 19th century (Zedlitz 1914, Heim de Balzac & Mayaud 1962), in Spain in 1993 (Moreno Gaztambide 1993) and in France in the 19th century and in the beginning of the 20th (Jourd 1935, Riols 1994).

The wintering population at Lac du Der-Chantecoq, east of Paris, is a special case of naturalisation, as those birds are impossible to count during the breeding season. Neck-collaring of 405 Greylag Geese in the Swedish province of Södermanland during 1984–1992 revealed that very likely all Greylag Geese wintering at Lac du Der-Chantecoq originated from Öster-Malma (Andersson et al. 2001). At Öster-Malma a population was re-established during 1970–75, mainly by taking eggs from south-eastern Sweden and using Greater Canada Geese as foster parents (Fabricius 1983). During the first strong winter with a thick snow cover, most probably 1978/1979 (Neubauer 1983), Greylag Geese of this newly re-established population were forced southwards from their former wintering quarters, situated somewhere around the SW Baltic Sea (Fabricius 1983), and by chance they found Lac du Der Chantecoq. If all Greylag Geese wintering at this site nowadays originate from Öster-Malma is unknown however.

As Camargue is situated well outside the traditional migration routes of the species (Kampe-Persson 2002), also that wintering population is very likely mainly made up of naturalised birds. The number wintering at Camargue has increased from less than 50 birds in the 1980s to 2,389 in 2008 (Desnouhes et al. 2003, Deceuninck et al. 2009).

That Greylag Geese are unafraid of humans and breed in an urban setting do not by necessity mean that they are naturalised. The well-studied population at Utterslev Mose in Copenhagen, sometimes referred to as naturalised (Rutschke 1997), is fully wild (Kampp & Preuss 2005). The Greylag Goose has bred at Utterslev Mose at least since 1914, long before the surroundings were urbanised (Jensen 1975).

Soepgans is in the Netherlands used as a generic term for free-flying individuals of domesticated forms of the Greylag Goose, hybrids between such geese and both the Greylag Goose and all other goose species, and all individuals of the domesticated forms of the Swan Goose as well (van der Jeugd et al. 2006). In Appendix, they are all reported as *Anser anser domesticus*. To make figures comparable the same definition was used for data from UK, Ireland and Belgium. The Soepgans is widely distributed in Belgium, found in 42% of the squares of the Flemish Breeding Atlas (Vermeersch et al. 2004), but no good population estimate exists (Anselin & Devos 2005, van der Jeugd et al. 2006).

Bar-headed Goose *Anser indicus*

All breeding records in Europe are of introduced birds. In Norway, the species has bred since the 1950s without becoming established (Gederaas et al. 2007). A small flock in Stavanger produced young every year from the 1950s until the birds disappeared from the area in 1972. One pair bred at Tau during 6–8 years in the 1970s. One female disappeared from Oslo in the early 1970s and returned in late summer with three fledglings. Singly pairs bred in Sør-Trøndelag in 1992 and in Møre og Romsdal in 1994. Several individuals have been observed during the last decade, especially in Mid-Norway and southwards, and the population was in 2007 estimated at 10–49 individuals. Introduction attempts in south-eastern Sweden in the 1930s (Berg 1937) resulted in at least some cases of breeding in the wild (Curry-Lindahl 1963). In Finland, up to two breeding pairs from a population of about 25 birds succeeded in raising young in a good year (Lever 2005, by referring to Blair et al. 2000). The species is still breeding in Finland (www.lintuatlas.fi). Lack of confirmation from Finland indicates, however, that these birds probably do not form a self-sustaining population. Lever (2005, by referring to Blair et al. 2000) stated that ten sub-populations have occurred in ten provinces in Italy, in three of which successful breeding has been recorded. This must be a confusion of species or countries, however, because there are no breeding records in Italy and only a few records of 1–4 individuals in the northern part of the country (Nicola Baccetti in litt., Camilla Gotti in litt.).

Snow Goose *Anser caerulescens*

Occasionally, wild birds cross the Atlantic (Blankert 1980, Sadura & Cooke 1982), but all breeding records in Europe are regarded as being of introduced birds. Statements that the species was fairly common in the East Atlantic flyway in the Middle Ages (Magnus Gothus 1555) were caused by confusion with the Northern Gannet *Morus bassanus*. In Norway, the species ceased to breed in Inner Oslofjord after having bred there 1981–2006 (Ber-

gan 2010). Introduction attempts in south-eastern Sweden in the 1930s (Berg 1937) resulted in at least some cases of breeding in the wild (Curry-Lindahl 1963). Later, breeding was reported from Västerås 1976–1977 and 1980, Strömsholm 1977 and 1980, Hallstahammar 1980, Lake Mälaren 1985, province of Blekinge 1989, province of Östergötland 1993 and 1996–1997, and probably in the province of Södermanland 1987 (SOF 1990, 2002). The species has also bred a few times in Finland (Alström et al. 1992).

Ross' Goose *Anser rossii*
All breeding records in Europe are of introduced birds.

Emperor Goose *Anser canagica*
All breeding records in Europe are of introduced birds.

Barnacle Goose *Branta leucopsis*
Without releases and escapes from captivity, there had, in all probability, been no breeding colonies of the Barnacle Goose in temperate areas today. Nine local populations and one regional, each linked to a nearby source of free-flying captive birds, were included in Appendix. The largest of these ten, on the Danish island Saltholm, is situated only 12 kilometres from Malmö. It has not been proven that the population on Saltholm was founded by escapes however. In contrary, they are normally treated as a wild population resulting of an expansion of the populations on Gotland and Öland (Timme Nyegaard in litt.). Considering the long distances of dispersal documented among free-flying captive Barnacle Geese (Bengtsson 2007), other local populations than the afore-mentioned nine could have been included in Appendix as well, together with populations that were deliberately established. The first Swedish breeding record, for instance, in the province of Härjedalen in 1952 (Burman 1957), was of birds that had escaped from captivity in Scotland (Berry 1951). An ever increasing number of free-flying captive birds from the 1960s onwards correlates fairly well with the establishment of local breeding populations in the Baltic Sea region (Bengtsson 2007).

Barnacle Geese breeding in Iceland, on the Swedish islands of Gotland and Öland, in Estonia and along the German coast are often counted as wild. As these colonies have no known linkage to any source of free-flying captive birds, they were not included in Appendix, but well in Table 1. In Iceland, the species has bred in very small numbers since 1964, and in 1999, the total population was estimated at 80–90 birds, including eight breeding pairs (Náttúrfræðistofnun Íslands 2000). In Öland, the breeding population increased from one pair in 1982 (Fritz 1983) to about 780 in 2005 (Feige et al. 2008), while in Gotland, the numbers increased from one pair in 1971 (Beinert 1982) to 4713 in 2002 followed by a decrease to 3285 in 2008 (Lerner 2009). The Estonian population increased from one pair in 1981 to 189 in 1999 followed by a decrease to 80 in 2006 (Leito & Truu 2008). After the first breeding in 1988 the German "wild" population increased to 160 pairs in 2005 (Bauer & Woog 2008).

Lesser Canada Goose *Branta hutchinsii*
Occasionally, wild birds cross the Atlantic (Vinicombe 2007), but all breeding records in Europe are regarded as being of introduced birds. Due to mixing and hybridisation with Barnacle Geese the species is hard to count in the Netherlands (Berend Voslamber in litt.).

Greater Canada Goose *Branta canadensis*
All breeding records in Europe are regarded as being of introduced birds, but there are some indications of transatlantic dispersal (Kampe-Persson MS).

The size of the Swedish post-breeding population was estimated by combining hunting statistics (www.jagareforbundet.se) and mid-winter counts (Nilsson 2009), taking into account that parts of the Swedish population winter south of the Baltic Sea, some flocks are overlooked during the counts and parts of the Norwegian and Finnish populations most likely winter in Sweden. The latest Finnish estimate concerns the years 2006–2009. Coastal data came from the Finnish Archipelago Bird Census, while the main sources of inland data were waterfowl monitoring and the third Bird Atlas survey of Finland (Markku Mikkola-Roos in litt.).

Breeding of singly pairs, without giving rise to a population, has been reported at Lake Ladoga (Medvedev 1992) and in Latvia in 1991 (Ādamsons & Roze 1995). The small flock in Italy is believed not to be self-sustaining (Nicola Baccetti in litt.).

Hawaian Goose *Branta sandvicensis*
There are no breeding records, but 13 individuals were counted in the Republic of Ireland in 2000 (unpubl. data) and 11 in the Netherlands in July 2009 (de Boer & Voslamber 2010).

Table 1. Total number of naturalised *Anser* and *Branta* geese in Europe. When only a figure for either number of pairs or number of birds was available for a population, the other figure was calculated using the same ratio between number of pairs and number of birds as in similar populations. Before doing such calculations, some of the populations were updated with data not included in Appendix. When only number of adults at onset of breeding was given for a population, a figure for the size of the post-breeding population was calculated.
Totala antalet naturaliserade Anser- *och* Branta-*gäss i Europa. I de fall då endast en av uppgifterna för antalet par och antalet individer fanns tillgänglig för en population beräknades den andra uppgiften genom att tillämpa samma förhållande mellan antalet par och antalet individer som i liknande populationer. Innan dylika beräkningar gjordes uppdaterades en del av populationerna med uppgifter som inte inkluderats i Appendix. I de fall när endast antalet adulter vid häcksäsongens början angetts gjordes en beräkning av populatioens storlek vid häcksäsongens slut.*

Taxon	Number of pairs *Antal par*	Number of individuals *Antal individer*
Anser cygnoides	175–180	600
Anser serrirostris	2	5
Anser brachyrhynchus		14
Anser albifrons albifrons	752–755	3000
Anser albifrons flavirostris	1	5
Anser erythropus	3	7
Anser anser	55,000	315,000
Anser anser domesticus	5000–6000	24,000
Anser indicus	168–193	750
Anser caerulescens	19	161
Anser rossii	1	2
Anser canagica	7	170
Branta leucopsis	20,000	100,000
Branta hutchinsii	200	500
Branta canadensis	56,000–63,000	346,000–356,000
Total	137,000–145,000	790,000–800,000

Brent Goose *Branta bernicla*
There are no breeding records, but in UK, nine birds were counted in the summer of 1991 (Delany 1993) and four in the summer of 2000 (Rowell et al. 2004), while 28 were found in the Netherlands in July 2009 (de Boer & Voslamber 2010).

Red-breasted *Goose Branta ruficollis*

Singly pairs bred in Ukraine in 1998 (Domashevsky 2001), Germany in 2002 (Brandt & Hadasch 2002) and UK in 2003 (Holling & the Rare Breeding Birds Panel 2007).

Monitoring

The quality of the different population estimates was not given in Appendix. In most cases, such information can be found among the references listed under Sources, or it was expressed in mails to the author. An examination of that information makes it possible to draw some general conclusions about monitoring of naturalised geese on a national level.

As long as the populations are quite small or breed in a limited number of well defined colonies, they can be monitored by gathering breeding data centrally. For that to work efficiently, especially when relying on volunteers, a strong incentive to collect and report such data must prevail. One way of attaining that is by regular feedbacks to those collecting the field data, for instance by publishing annual reports within six months of the field season. When the populations grow too large or become too scattered for that kind of monitoring, it is time to organise large-scale summer surveys. Experiences of such surveys from UK and the Netherlands can be used when deciding how frequently such surveys ought to be carried out. Some of the most numerous populations can also be monitored by counts during the non-breeding season, even though such count data normally only give minimum numbers. Often, however, count data can be used for the calculation of population indices, which in turn can be used for the calculation of population estimates. Another option, sometimes practised, is to base a Breeding Atlas on both qualitative and quantitative data.

Total numbers in Europe

Taking into account that recent population estimates are lacking for about one third of the national populations (Appendix), at the same time as several populations have been in a phase of rapid growth since the late 1990s, it is no exaggeration to state that the total European post-breeding population of naturalised geese in 2009 numbered more than 800,000 individuals (Table 1). More than 99% of these were made up of the three species Greater Canada Goose, Greylag Goose and Barnacle Goose. To the numbers given in Table 1 should be added an unknown number of hybrids. Hybrid reports are available from four countries; 318 hybrids in Great Britain in 1991 (Delany 1993) and 210 in 2000 (Rowell et al. 2004), 229 in Germany in 1998 (Randler 2000), 310–327 in Sweden in 2005 (Kampe-Persson & Lerner 2007) and three breeding pairs (Greylag Goose x Greater Canada Goose x Barnacle Goose) in Faroe Islands in 2009 (Jens-Kjeld Jensen in litt.).

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Sammanfattning

Under de senaste femtio åren har gäss som i Europa återfinns i naturen endast tack vare människan, introducerade avsiktligt eller av misstag, ökat flera gånger om, i antal arter, i antal populationer och i antal individer. På grund av det inflytande dessa gäss kan ha på dels biologisk mångfald och dels mänsklig aktivitet har de tilldragit sig ett växande intresse under de senaste två decennierna. Den biologiska mångfalden kan påverkas genom introduktion av främmande gener, hybridisering, konkurrens, sjukdomsspridning eller habitatförändringar, medan påverkan på mänsklig aktivitet till sin karaktär kan vara antingen ekonomisk eller estetisk. Det som oftast sysselsätter tjänstemän idag är skördeskador inom jordbruket, nedsmutsning av parker, badplatser och golfbanor samt attacker av gäss i rekreationsområden. Dessutom finns det en oro för att en negativ inställning bland allmänheten till dessa gäss skall spilla över på deras vilda släktingar, resulterande i en lägre acceptans för gäss i allmänhet.

En hel del har under åren gjorts för att samla in kunskap om de naturaliserade gässen, men för den som söker kunskap på detta område är det ofta svårt att finna rapporterna, och ännu svårare att bedöma deras tillförlitlighet. Avsikten med denna rapport var att dels utreda vilka gäss som bör räknas som naturaliserade och dels göra en sammanställning av grundläggande data om samtliga populationer av naturaliserade gäss i Europa.

I Appendix redovisas samtliga populationer nationsvis, eftersom det vanligtvis är på den nivån som inventeringar och räkningar sker. För Belgium gjordes dock en uppdelning på tre regioner. För grågås och vitkindad gås redovisas även ett antal lokala populationer.

Textdelen ägnas nästan uteslutande åt att artvis reda ut vilka populationer som bör räknas som naturaliserade. Definitioner till trots är detta långt ifrån alltid självklart. Dessutom råder för närvarande en tendens att räkna in allt fler naturaliserade populationer bland de vilda. Problemen beror på vilken geografisk referensram som används, ursprunget för de individer som etablerar en ny population samt förekomsten av främmande gener. De introducerade arterna svangås, stripgås, snögås, dvärgsnögås, kejsargås, dvärgkanadagås och kanadagås är i detta avseende inget problem, varför texten för dessa arter framförallt redovisar sporadiska häckningar samt hur antalet individer i vissa populationer beräknats.

Inom delar av Dalarna, Hälsingland och Härjedalen där arten inte längre häckade släpptes totalt 376 färgringmärkta sädgåsgässlingar med kanadagäss som fosterföräldrar ut under åren 1974–1991. De utsläppta gässen övervintrade vid Foteviken, mindre än tre kilometer från var GSG12 hölls. Efter det att de märkta fåglarna dött och arten slutat att övervintra vid Foteviken, gick det inte längre att följa upp projektet. Om sädgäss som därefter konstaterats häcka i utsättningsområdena varit ättlingar till de utsatta fåglarna, vilda fåglar från närliggande områden eller en blandning av dessa båda kategorier är okänt. Sannolikt var detta projekt en

framgångsrik beståndsförstärkning. Samma resonemang kan föras beträffande det svenska fjällgåsprojektet. Dagens fjällgäss består med största sannolikhet av en blandning av utsläppta och vilda fåglar och utgör därmed den sista spillran av den en gång så talrika skandinaviska fjällgåspopulationen.

Grågåsen uppvisar flest exempel på svårigheten att skilja mellan naturaliserade och vilda populationer. Efter att under första halvan av 1900-talet varit nere på sin lägsta nivå, sett till utbredning och antalet individer i Europa, hjälpte bl.a. omflyttningar och utsättningar till att arten återhämtade sig. Efterhand som gränsen mellan vilda och naturaliserade populationer alltmer suddats ut, har tendensen gått mot att betrakta alltfler naturaliserade populationer som vilda. I texten används Färöarna som exempel på detta, medan Ukraina exemplifierar betydelsen av geografisk referensram – den ukrainska populationen som helhet är beståndsförstärkt medan ett flertal lokala populationer kan vara naturaliserade. I Inre Oslofjorden sattes såväl norska som svenska grågäss ut, dvs. en blandning av raserna *sylvestris* och *anser*. Till följd därav är det idag nästintill omöjligt att avgöra om gässen i fjordens närmaste omgivningar utgörs av vilda fåglar eller ättlingar till de utsatta samt till vilken ras eller rasblandning dessa hör. Till Kalmarsund infördes 1929 sex grågäss av den ostliga rasen *rubrirostris* och till Zwin i Belgien 1955 likaså sex individer. Från Kalmarsund omflyttades under årens lopp ett antal ägg och ungar till olika delar av Sverige och från Zwin flyttades fåglar till bland annat England, Nederländerna och Frankrike. Denna spridning av *rubrirostris* är sannolikt förklaringen till att vi idag i Sverige och Nederländerna finner grågäss med orangeröda eller röda näbbar, vilket inte var fallet i mitten av 1800-talet, då alla grågäss hade orange näbbar. Det oklara begreppsläget beträffande hur man ska se på förekomsten av främmande gener gjorde dock att ingen population togs med i Appendix av den anledningen. Grågässen som häckar i Öster-Malma-området utgör ett specialfall av naturalisering, eftersom de endast kan urskiljas tack vare att de övervintrar på en lokal som ligger utanför artens traditionella flyttningsvägar. En logisk förklaring till hur detta har uppstått kan ges tack vare den halsringmärkning som skedde vid Öster-Malma åren 1984–1992. Grågåsen återetablerades vid Öster-Malma under åren 1970–1975 framförallt genom att ägg togs från sydöstra Sverige och placerades under kanadagäss, vilka därefter fungerade som fosterföräldrar. Under den första stränga vintern efter återetableringen, sannolikt 1978/1979, tvingades grågässen söderut från sitt dittillsvarande vinterkvarter någonstans vid södra Östersjön, och de fann då av en tillfällighet Lac du Der Chantecoq, ett vattenmagasin 15 mil öster om Paris, en lokal som de därefter förblivit trogna. Även övervintrarna vid Camargue utgörs sannolikt av naturaliserade gäss, ty även den lokalen ligger utanför de traditionella flyttningsvägarna.

Soepgans används i Nederländerna som samlande begrepp för friflygande individer av alla former av domesticerade grågäss, hybrider mellan sådana gäss och såväl grågäss som andra arter samt alla individer av domesticerade former av svangås. I Appendix rapporteras dessa gäss som *Anser anser domesticus*. För att göra resultaten jämförbara användes denna definition även för uppgifter från Storbritannien, Irland och Belgien.

Utsättningar och rymningar förutan hade det med största sannolikhet inte funnits några kolonier av vitkindad gås i tempererade områden idag. Nio lokala populationer och en regional, var och en kopplad till en lokal med friflygande tamfåglar, finns med i Appendix. Den största av dessa, på den danska ön Saltholm, ligger endast 12 kilometer från Malmö. Det har inte bevisats att kolonin på Saltholm grundades av förrymda fåglar. Tvärtom betraktas den vanligtvis som ett resultat av en expansion av populationerna på Gotland och Öland. Med hänsyn till de långa spridningsavstånd som dokumenterats bland friflygande vitkindade gäss skulle även andra lokala populationer än de nio kunnat tas med i Appendix, tillsammans med populationer som avsiktligt introducerats. Det första svenska häckningsfyndet till exempel, i Härjedalen 1952, gjordes av fåglar som rymt från fångenskap i Skottland. Ett ständigt ökande antal friflygande vitkindade gäss från 1960-talet och framåt sammanfaller ganska väl med etablerandet av kolonier i östersjöområdet. Vitkindade gäss som häckar på Island, Gotland, Öland, i Estland och längs med den tyska kusten räknas ofta som vilda. Eftersom dessa kolonier inte har någon känd koppling till någon lokal med friflygande fångna fåglar togs de ej med i Appendix men väl i Tabell 1.

Eftersom uppgift om antalet individer saknas från åtminstone de senaste två åren för en tredjedel av de nationella populationerna, samtidigt som flera av dessa varit inne i en fas av snabb tillväxt sedan sent 1990-tal, är det ingen överdrift att påstå att totala antalet naturaliserade gäss i Europa vid häckningsperiodens slut år 2009 uppgick till drygt 800.000 (Tabell 1). Drygt 99% av det totala antalet kom från endast tre arter: kanadagås, grågås och vitkindad gås. Till dessa skall läggas ett okänt antal hybrider.

Appendix. Naturalised populations of *Anser and Branta* geese in Europe. Year of first breeding (or year of introduction, if year of first breeding was unknown), monitoring scheme (M), latest count/estimate of number of pairs (year within brackets), latest count/estimate of number of individuals (year within brackets; two digits given for years within the 2000s), and 1–3 data sources are given for each population. A horizontal bar indicates lack of data. Monitoring schemes and data sources are listed below the table.
Naturaliserade populationer av Anser- *och* Branta-*gäss i Europa. År för första häckning (eller introduktionsår om år för första häckning är okänt), övervakningsprogram (M), senaste uppgift om antalet häckande par (årtal inom parentes;endast två siffror anges för år på 2000-talet), senaste uppgift of antalet individer (årtal inom parentes), och 1–3 datakällor anges för varje population. Minustecken anger att uppgift saknas. Övervakningsprogram och datakällor listas under tabellen.*

Taxon *Taxon*	**Population** *Population*	**First** *Första*	**M** *M*	**No. of pairs** *Antal par*	**No. of birds** *Antal individer*	**Sources** *Källor*
A cygnoides	**Germany**	1967	a	15–20 (05)	-	5
A cygnoides	**Netherlands**	-	b	150 (08)	500 (05)	34,42,68
A cygnoides	**Belgium**	-	-	10 (02)	-	63
A serrirostris	**Netherlands**	1993	b	2 (08)	5 (09)	34,67,68
A brachyrhynchus	**France**	2001	-	-	14 (03)	19
A a albifrons	**Germany**	2001	a	4 (05)	-	5,73
A a albifrons	**Netherlands**	1980	b	745 (08)	1999 (09)	34,66,68
A a albifrons	**Belgium**	-	-	3–6 (02)	-	63
A a flavirostris	**United Kingdom**	-	cd	1 (03)	-	29
A erythropus	**Netherlands**	2002	b	3 (08)	7 (09)	13,34,69
A anser	**Iceland**	1957	-	-	992 (09)	52
A anser	**United Kingdom**	1930s	de	-	50,000 (08)	16,46,48
A anser	**Ireland**	1967	f	-	1555 (08)	14,15,45
A anser	Inner Oslofjord, NO	1979	g	87 (09)	-	11
A anser	**Norway**	1960s	-	>87 (09)	-	
A anser	Öster-Malma, SE	1965	h	-	3230 (08)	17
A anser	Malmö, SE	-	i	<100 (09)	>500 (09)	9
A anser	**Sweden**	1930	-	-	>4000 (08)	60
A anser	Hamburg, DE	1960s	s	143 (09)	≥700 (09)	28,37
A anser	C. Neckar valley, DE	1984	r	11 (08)	234 (08)	75
A anser	**Germany**	-	a	5000–5500 (05)	-	4,5
A anser	**Netherlands**	1961	b	35,000 (08)	189,903 (09)	34,68,69
A anser	Flanders, BE	1956	-	1200–1300 (02)	-	18,57,63
A anser	Wallonia, BE	1987	-	25–31 (01–07)	-	31
A anser	**Belgium**	1956	-	1225–1331 (02)	-	
A anser	**France**	1970	t	146–166 (08)	-	61
A anser	**Switzerland**	1983	j	36 (08)	-	59,65,74
A anser	**Austria**	1970s	-	-	200–500 (09)	
A anser	**Italy**	1984	-	>100 (09)	-	49,62
A anser	**Slovenia**	2007	-	2 (08)	-	
A anser	Náměšť n Oslavou, CZ	1977	-	18 (08)	-	22
A anser	Chomutov, CZ	1988	-	21–24 (08)	-	53,55
A anser	Česká Lípa, CZ	2007	-	1 (09)	-	54,56
A anser	**Czech Republic**	1977	-	40–43 (08)	-	
A a domesticus	**United Kingdom**	-	cd	-	841 (08)	16,58
A a domesticus	**Ireland**	-	f	-	236 (05)	15
A a domesticus	**Netherlands**	-	b	3700–5000 (08)	15,000–18,000 (05)	34,39,40
A a domesticus	**Belgium**	-	-	-	-	63
A a domesticus	**France**	-	-	-	-	
A indicus	**United Kingdom**	-	cd	2 (05)	52 (00)	29,30,58
A indicus	**Germany**	1956	a	15–18 (05)	-	5
A indicus	**Netherlands**	1972	b	100 (08)	350 (05)	34,43,68
A indicus	Flanders, BE	1989	-	25–35 (05)	>70 (02)	2,6,63

Appendix. forts

A indicus	Wallonia, BE	2001	-	2 (01–02)	-	31
A indicus	**Belgium**	1989	-	25–35 (05)	>80 (02)	
A indicus	**France**	1999	-	3 (06)	-	19
A caerulescens	**United Kingdom**	-	cd	8 (05)	86 (00)	29,30,58
A caerulescens	**Norway**	1981	g	0 (09)	0 (09)	10,11
A caerulescens	**Germany**	1990	a	-	69 (09)	5
A caerulescens	**Netherlands**	-	b	3 (08)	6 (09)	34,68,69
A rossii	**Netherlands**	2004	b	1 (08)	2 (05)	34,68,69
A canagica	**United Kingdom**	2001	cd	2 (05)	16 (08)	16,29,58
A canagica	**Netherlands**	-	b	5 (08)	150 (05)	34,68,69
B leucopsis	**Faroe Islands**	1991	-	10–12 (09)	-	32,33
B leucopsis	**United Kingdom**	-	cd	≥120 (05)	1516 (09)	16,29,58
B leucopsis	**Ireland**	-	f	3 (00)	15 (00)	
B leucopsis	Saltholm, DK	1992	k	1317 (08)	-	20
B leucopsis	**Denmark**	1989	k	1320 (08)	-	20,25
B leucopsis	Inner Oslofjord, NO	1979	g	251 (09)	-	11,12
B leucopsis	**Norway**	1979	-	300–325 (09)	-	7,8
B leucopsis	Fjäderholmarna, SE	1978	-	256 (09)	-	23
B leucopsis	Vållholmen, SE	2002	-	92 (10)	-	
B leucopsis	NE Scania, SE	1987	l	>150 (09)	-	50,71
B leucopsis	Lake Yddinge, SE	1995	-	50 (09)	400 (09)	50
B leucopsis	Malmö, SE	1987	i	150–200 (09)	1967 (09)	8,9,51
B leucopsis	**Sweden**	1952	-	>1800 (09)	-	
B leucopsis	Turku, FI	1984	m	269 (09)	2600 (09)	
B leucopsis	Helsinki area, FI	1989	m	1300 (09)	8600 (09)	
B leucopsis	**Finland**	1978	m	>2000 (08)	14,200 (09)	
B leucopsis	**Germany**	1995	a	30 (05)	-	5
B leucopsis	**Netherlands**	1982	b	8300 (08)	33,842 (09)	34,44,68
B leucopsis	Flanders, BE	1992	-	200 (05)	-	2,6,63
B leucopsis	Wallonia, BE	1994	-	<10	-	31
B leucopsis	**Belgium**	-1992	-	200 (05)	-	
B leucopsis	**France**	2001	-	-	30 (06)	19
B leucopsis	**Austria**	1996	-	-	5–10 (09)	
B hutchinsii	**Netherlands**	-	b	200 (08)	500 (05)	34,68,69
B canadensis	**Faroe Islands**	1985	-	1 (09)	-	1,33
B canadensis	**United Kingdom**	1665	de	-	88,866 (00)*	3,30,35
B canadensis	**Ireland**	-	f	-	>400 (00)	15
B canadensis	**Denmark**	1930s	-	1 (09)	-	1,21,25
B canadensis	**Norway**	1936	-	>2000 (00)	>15,000 (09)	1,27
B canadensis	**Sweden**	1933	n	15,000–20,000 (09)	100,000 (08)	1,47,60
B canadensis	**Finland**	1966	o	7000–8000 (09)	-	26,64,70
B canadensis	**Poland**	2005	p	3 (09)	≥19 (09)	
B canadensis	**Germany**	1920s	a	1400–1600 (05)	>6000 (05)	5,24
B canadensis	**Netherlands**	1973	b	4000 (08)	23,798 (09)	34,38,41
B canadensis	Flanders, BE	1973	-	2000 (05)	-	2,6,63
B canadensis	Wallonia, BE	1986	-	670–1000 (07)	-	31
B canadensis	Brussels, BE	2002	-	>12 (04)	-	72
B canadensis	**Belgium**	1973	-	2682–3012 (05)	-	
B canadensis	**Luxembourg**	2002	q	5 (09)	50–80 (09)	36
B canadensis	**France**	1970	-	1125 (08)	≥4250 (08)	19
B canadensis	**Austria**	1989	-	5–10 (09)	30–100 (09)	
B canadensis	**Russia**	1987	-	-	300 (1991)	1

* = Number of full-grown individuals at the beginning of the breeding season. *Antal fullvuxna individer vid början av häckningssäsongen.*

Monitoring schemes Övervakningsprogram (M)

a. Projektgruppe Neozoen der Deutschen Ornitologen-Gesellschaft; collects population data continuously.
b. SOVON Vogelonderzoek Nederland; summer surveys in 2005 and 2009.
c. Rare Breeding Birds Panel (RBBP); collates annual breeding records since 1996.
d. Wildfowl & Wetlands Trust (WWT); naturalised goose surveys in 1991 and 2000.
e. Wetland Bird Survey (WeBS); monthly counts of non-breeding birds.
f. Irish Wetland Bird Survey (I-WeBS); monthly counts of non-breeding birds.
g. Norsk Ornitologisk Forening, avdeling Oslo og Akershus (NOF OA); summer surveys annually 1978–1991 and every second year thereafter.
h. Ligue pour la Protection des Oiseaux (LPO); annual mid-winter counts.
i. Skånes Ornitologiska Förening (SkOF); summer surveys annually since 2002.
j. Schweizerische Vogelwarte, Sempach: number of breeding pairs reported annually.
k. Dansk Ornitologisk Forening (DOF); as part of the DATSY programme, number of breeding pairs reported annually up to 2008.
l. Nordöstra Skånes Fågelklubb; number of breeding pairs reported annually.
m. Finnish Environmental Institute (SYKE); summer surveys + total count in September.
n. Leif Nilsson; national counts in September, October, November and December.
o. Finnish Archipelago Bird Census; summer surveys of 36 census areas comprising 1,700 islands.
p. Alien Species in Poland; data taken from the website of the Polish Rarity Commission.
q. Lëtzebuerger Natur- a Vulleschutzliga (LNVL); population monitored annually.
r. Friederike Woog; number of adults, goslings and non-breeders recorded annually since 2003.
s. Arbeitskreis an der Staatlichen Vogelschutzwarte Hamburg (AKVSW); intensive monitoring of the breeders.
t. Ligue pour la Protection des Oiseaux (LPO); number of breeding pairs reported annually since 1990.

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Tundra Bean Goose *Anser fabalis rossicus* during spring migration in northern Sweden – rare visitor or regular passage migrant?

Tundrasädgåsen Anser fabalis rossicus *under vårflyttningen i norra Sverige – en sällsynt gäst eller regelbunden flyttfågel?*

THOMAS HEINICKE

Abstract

In spring 2007–2009, I studied the races of staging Bean Geese *Anser fabalis* in northern Sweden, both in the hand and in the field. In all study periods, the Tundra race *rossicus* was found quite regularly with greatest numbers near Alvik in the Luleå region. Simultaneous counts revealed a maximum of 2722 individuals in spring 2009. The predominance of rossicus at Alvik was confirmed by catching in 2009. As large numbers of Bean Geese in early May have been reported from the Alvik area for many years, *rossicus* should be considered a regular and numerous spring migrant through northern Sweden. The occurrence of *rossicus* in northern Sweden is linked by ring recoveries to a breeding population in Finnmark, Norway. Birds, ringed during spring staging in mid May at Valdak marshes, and probably breeding in their wider surroundings, are reported yearly from Luleå region in late April/early May. There is also a link to a moulting site of rossicus at Varanger peninsula, Norway. New recoveries of birds, ringed in northern Sweden, at various sites in Finnmark confirm this connection.

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Introduction

The Bean Goose *Anser fabalis* is a rare breeding bird in northern parts of Scandinavia (e.g. Nilsson et al. 1999, Svensson et al. 1999, Follestad 1994), using special staging areas along the western coast of the Gulf of Bothnia during spring migration (Skyllberg et al. 2003, 2008, 2009). A planned new railway, crossing the major spring staging area in the Ume River Delta, caused concerns because of possible negative impact on the future development of the Swedish Taiga Bean Goose *Anser fabalis fabalis* breeding population that migrates in a large extent through that area.

These concerns necessitated new scientific interest in the Bean Goose issues in Sweden. Since the mid 2000s, several studies are being conducted on spring staging Taiga Bean Geese at sites along the Gulf of Bothnia (Nilsson et al. 2008). These studies include catching and neck-banding, organised by Leif Nilsson (Lund University) and Adriaan de Jong (University of Agricultural Sciences, Umeå). Since spring 2007, I have joined these catching events. This has given me the opportunity to study the races of staging Bean Geese, both in the hand and in the field.

Material and methods

Goose catching

Goose catching was started in the Ume River Delta (63°45'N, 20°17'E; Skäret field complex) in April 2005. After a break in spring 2006, catching activities were resumed 17–26 April 2007 in the Ume River Delta (63°44'N, 20°16'E; fields near Stöcke) and at fields near lake Brånsjön (63°54'N, 19°51'E). The activities were repeated in both areas 15–30 April 2008. In 2009, catching started in mid April in the Ume River Delta (fields near Stöcke) and continued from 26 April to 3 May in the Alvik area/Luleå region (65°34'N, 21°45'E; fields near Klubben and Alviksgården). The geese were caught on cereal stubble fields, using cannon net equipment. Every Bean Goose was individually marked with a blue neckband and separated into *fabalis or rossicus*. Additionally, 10 birds (8 *fabalis*, 2 *rossicus*) were tagged with satellite transmitters between 2007 and 2009.

For correct race identification, a combination of the following criteria was used: (1) age and sex, (2) measurements of wing, tarsus, bill-head length, culmen and bill structure (see Dzubin & Cooch 1992), (3) form of the nail (round in *fabalis*, oval in *rossicus*), and number of teeth in the upper mandible (20–23 in *rossicus*, 24–27 in *fabalis*). Every marked bird was also photographed, and for each goose the bill-colour type after Burgers et al. (1991) was determined from these pictures. For later genetic tests, also feather samples from every goose were collected.

Goose counts

During the spring season of 2007, 2008 and 2009, I made repeated goose counts in the Ume River Delta and around Lake Brånsjön. In 2008, goose flocks near Djäkneböle (SW of Umeå) were also counted regularly. On 29–30 April 2008, I made my first goose counting trip to staging sites near Skellefteå, Piteå and Luleå. Improved site coverage was achieved in 2009, with regular counts on the same sites as in 2008, and additional counts on Västerslätten/Umeå, on three additional sites near Skellefteå and around Persöfjärden N of Luleå (Table 1). For a detailed description of the main counting sites see Skyllberg et al. (2008).

Goose counts, with identification of subspecies, were carried out during daytime at feeding sites (cereal fields and grasslands) or during daytime-resting at nearby roosts. I used a 20–60× magnification telescope and followed the identification schemes of Barthel & Frede (1989), Heinicke (2004) and Heinicke et al. (2005) (Table 2). Because some individuals are difficult to identify, I used group identity and separation of groups of the same subspecies within larger mixed flocks (Huyskens 1986, 1999) as an additional identification criteria.

Table 1. Goose counts during spring 2007 to 2009 at staging areas in Västerbotten (Vb) and Norrbotten (Nb) counties in northern Sweden.
Gåsräkningar på rastplatser i Västerbottens (Vb) och Norrbottens (Nb) län vårarna 2007–2009.

Counting sites *Räkningsplatser*	County *Län*	Coord-inates	2007	2008	2009
Ume River Delta Umeå	Vb	63°45'N 20°16'E	17–20, 22–26 Apr	15–18, 21–23, 25–28 Apr	17–24, 28–30 Apr, 3 May
Lake Bransjön Umeå	Vb	63°54'N 19°51'E	20–22, 24 Apr	18, 20–23, 25–28, 30 Apr	19, 22–24, 29 Apr
Djäkneböle Umeå	Vb	63°47'N 20°04'E	-	19, 21–28, 30 Apr	17, 19–23 Apr
Västerslätten Umeå	Vb	63°51'E 20°12'E	-	-	23–24 Apr
Gärdefjärden Skellefteå	Vb	64°23'N 21°18'E	-	-	25, 28, 30 Apr, 3 May
Innervik Skellefteå	Vb	64°42'N 21°04'E	-	-	25, 28, 30 Apr, 3 May
Kågegården Skellefteå	Vb	64°51'N 20°56'E	-	29–30 Apr	25, 28, 30 Apr, 3 May
Drängsmark Skellefteå	Vb	64°54'N 20°58'E	-	-	25, 28, 30 Apr, 3 May
Ostträsket Skellefteå	Vb	64°55'N 21°01'E	-	29–30 Apr	25, 28, 30 Apr, 3 May
Öjebyn Piteå	Nb	65°22'N 21°26'E	-	29 Apr	25, 28, 30 Apr, 3 May
Alvik+Ersnäs Luleå	Nb	65°34'N 21°45'E	-	29–30 Apr	25–28, 30 Apr, 1–3 May
Persöfjärden Luleå	Nb	65°47'N 22°05'E	-	-	27 Apr, 1 May

Table 2. Features used for the field identification of Taiga and Tundra Bean Geese.
Karaktärer som användes i fält för att skilja taiga- och tundrasädgäss.

	Anser fabalis fabalis	*Anser fabalis rossicus*
Size *Storlek*	Large and stoutly built goose, +/- size of a Greylag. *Stor och kraftigt byggd gås, ungefär så stor som grågås.*	Smaller than fabalis, size between Greater Whitefront and Greylag, very similar to Pinkfoot. *Mindre än* fabalis, *storlek mellan bläsgås och grågås, nästan samma som spetsbergsgås.*
Neck *Hals*	Relatively long, comparatively thin. *Relativt lång, jämförelsevis tunn.*	Relatively short, comparatively thick. *Relativt kort, jämförelsevis tjock.*
Head *Huvud*	Head and upper neck relatively dark collared, lower neck and body paler, flattened and mostly straight bill–head–profile. *Huvud och övre hals relativt mörkkragad, nedre hals och kropp blekare och vanligen rak näbb–huvud–profil.*	Head mostly darker brownish-grey, but neck and body paler, body colour often more grey-brownish, roundish head profile. *Huvud oftast mörkare brungrått, men hals och kropp blekare, kroppsfärg ofta mera gråbrun, rundad huvudprofil.*
Bill *Näbb*	Long and elongated, mostly with dominant orange colour, straight or slightly curved lower mandible. *Lång och utdragen, oftast med dominerande orange färg, rak eller något krökt nedre näbbhalva.*	Mostly short, robust and very compact, mostly dominantly dark with orange bill ring (dominantly orange bill rare), clearly to slightly curved lower mandible, large males sometimes show quite long bills. *Oftast kort, robust och mycket kompakt, oftast dominerande mörk med orange näbbring (dominerande orange näbb sällsynt), tydligt till något krökt nedre näbbhalva, stora hanar ibland med tämligen lång näbb.*
Sex *Kön*	Males larger than females, females similar in size like larger rossicus males. *Hanar större än honor, honor stora som stora rossicus.*	Males larger than females, larger males in size like *fabalis* females. *Hanar större än honor, stora hanar som* fabalis-*honor*
Voice *Läte*	Calls with very low frequency, deeper than Greylag. *Läten lågfrekventa, djupare än hos grågås.*	Calls with much higher frequency than fabalis, higher than Greylag. *Läten med mycket högre frekvens än hos* fabalis, *högre än hos grågås.*
Flight *Flykt*	Large-winged, long- and thin-necked goose, often also long bill obvious. *Långvingad, lång- och smalhalsad, ofta påtaglist lång näbb.*	Shorter and broader wings, short and thick-necked, dark and roundish head quite obvious. *Kortare och bredare vingar, kort- och tjockhalsad, mörkt och rundat huvud tydligt.*

Results

Goose catching and measurements

In 2005–2009, 74 Bean geese were caught and neckbanded. Thirty (41%) of the birds belonged to the subspecies *A. f. rossicus*. Of the birds caught in the Ume River Delta 97% were *A. f. fabalis*, but in the Alvik area only 22% belonged to this subspecies (Table 3).

To demonstrate correct identification of the ringed rossicus birds, statistics for some important measurements are shown in Table 4 (for detailed measurements see Appendix 1). As many second-year birds are still not fully grown in spring, only measurements for adult birds were used. The measurements of the Tundra Bean Geese caught in 2009 fit well within the range of measurements given for *A. f. rossicus* in Cramp (1977; Table 5). The grinning patch was even more prominent than the data in this source. Also, the percentages of bill-colour

Table 3. Number of Bean geese caught at different spring staging areas in northern Sweden.
Antal gäss som fångades på olika vårrastplatser för sädgås i norra Sverige.

Subpecies	2005 Ume Delta	2007 Bråsjön	2008 Ume Delta	2009 Ume Delta	2009 Alvik/Luleå	Total
Anser fabalis fabalis	4	1	27	4	8	44
Anser fabalis rossicus	0	0	0	1	29	30

Table 4. Measurements of adult Tundra Bean Geese *A. f. rossicus* caught in spring 2009 in northern Sweden. Measurements in millimetres.
Mätningar av adulta tundrasädgäss A. f. rossicus *fångade våren 2009 i norra Sverige. Mått i millimeter.*

Measurements *Mått*	Min	Max	Mean	SD	N
wing length adult males *vinglängd adulta hanar*	404	456	437.9	13.97	15
wing length adult females *vinglängd adulta honor*	393	436	416.0	14.06	13
culmen length adult males *kulmen adulta hanar*	57.2	62.0	59.5	1.57	15
culmen length adult females *kulmen adulta honor*	51.1	57.9	54.2	2.22	13
bill-head length adult males *näbblängd adulta hanar*	116	123	120.5	1.67	15
bill-head length adult females *näbblängd adulta honor*	105	114	111.0	3.28	13
bill depth adult males *näbbhöjd adulta hanar*	30.9	33.4	32.0	0.65	12
bill depth adult females *näbbhöjd adulta honor*	28.7	31.4	29.8	0.79	12
tarsus adult males *tars adulta hanar*	74.8	81.3	78.6	1.84	12
tarsus adult female *tars adulta honor*	71.0	77.5	73.7	2.15	12
grinning patch adult males *näbbglipa adulta hanar*	8.9	10.2	9.4	0.38	12
grinning patch adult females *näbbglipa adulta honor*	8.5	9.5	8.9	0.30	12

Table 5. Comparison of measurements of Tundra Bean Geese from northern Sweden with literature data from *rossicus* and *fabalis*: min–max span, means in brackets.
Jämförelse av mått för tundrasädgås från norra Sverige och mått från litteraturen för rossicus och fabalis: min–max-intervall, medelvärde i parentes.

	rossicus (this study)		*rossicus* (Cramp 1977)		*fabalis* (Cramp 1977)	
	adult male	adult female	adult male	adult female	adult male	adult female
Wing *Vinge*	404–456 (438)	393–436 (416)	430–478 (454)	405–458 (433)	452–520 (481)	434–488 (460)
Culmen *Kulmen*	57–62 (59.5)	51–58 (54.2)	52–63 (57.7)	49–60 (54.6)	57–70 (63.6)	55–66 (60.0)
Tarsus *Tars*	75–81 (78.6)	71–78 (73.7)	70–81 (75.2)	69–79 (73.9)	76–90 (82.2)	73–80 (76.6)
Grinning patch *Näbbglipa*	8.9–10.2 (9.4)	8.5–8.5 (8.9)	7.0–10.0 (7.9)	6.9–8.6 (7.5)	5.5–7.3 (6.4)	5.3–7.0 (6.2)

types of the *rossicus* birds in our sample were very similar to those of birds ringed in the Netherlands (type 2b=3,3%, 2c=40,0%, 2d=56,7%; n=30; Burgers et al. 1991).

Goose counts

During the goose counts, staging Tundra Bean Geese were found at all visited sites (Table 6). By far the largest numbers were found in the Alvik-Ersnäs area SW of Luleå. This area appears to be the key staging area for *A. f. rossicus* in Northern Sweden. In most sites, maximum numbers occurred in late April or early May, when most Taiga Bean Geese have departed already. A flock of 211 *rossicus* Bean Geese observed near Lake Bråsjön on 20 April 2007 was probably exceptional (early occurrence and high number for this site). They may have been forced to stop over by heavy snowfall and stayed only for one day.

Table 6. Maximum counts (with counting dates in brackets) of Tundra Bean Geese at different sites during spring migration 2007–2009 in northern Sweden.
Högsta antal (med räkningsdatum i parentes) tundrasädgäss på olika platser vårarna 2007–2009 i norra Sverige.

Site	2007	2008	2009
Ume River Delta	32 (19 Apr)	57 (22 Apr)	291 (29 Apr)
Bråsjön	211 (20 Apr)	30 (26 Apr)	60 (29 Apr)
Djäkneböle	-	42 (25 Apr)	0
Västerslätten	-	-	65 (24 Apr)
Gärdefjärden	-	-	116 (03 May)
Innervik	-	-	38 (28 Apr)
Kågegården	-	79 (29 Apr)	128 (28 Apr)
Dränsmark	-	-	20 (28 Apr)
Osträsket	-	191 (29 Apr)	356 (30 Apr)
Piteå	-	39 (29 Apr)	118 (28 Apr)
Alvik+Ersnäs	-	1360 (29 Apr)	2457 (02 May)
Persöfjärden	-	-	8 (01 May)

Table 7. Simultaneous counts of staging Tundra Bean Geese at different sites during spring migration 2009 in northern Sweden.
Samtidiga räkningar av rastande tundrasädgäss på olika platser under vårflyttningen 2009 i norra Sverige.

Site	24+25 April		27+28 April		29+30 April		2+3 May	
	rossicus	*fabalis*	*rossicus*	*fabalis*	*rossicus*	*fabalis*	*rossicus*	*fabalis*
Ume River Delta	82	1024	150	>450	291	397	1	0
Bråsjön	27	1024	?	?	60	451	?	?
Västerslätten	65	112	?	?	0	0	0	0
Gärdefjärden	0	111	0	39	0	154	116	3
Innervik	0	69	38	0	6	0	0	0
Kågegården	3	17	128	68	0	12	0	0
Dränsmark	8	190	20	50	0	0	0	0
Osträsket	0	114	219	97	356	176	30	0
Piteå	75	41	118	0	94	0	5	0
Alvik+Ersnäs	754	500	1480	379	1907	258	2457	44
Persöfjärden	?	?	3	47	8	155	?	?
Total	1014	3202	2156	(>788)	2722	1603	2609	>47

In 2009, numbers of staging Tundra Bean Geese increased quickly during the last days of April (Table 7). Numbers culminated by the end of April and early May, with the highest concentration in a single site on 2 May (Alvik). Numbers of Tundra Bean Geese were fluctuating strongly in the Alvik/Ersnäs area (27 Apr: 1540, 28 Apr: 1440, 30 Apr: 1907, 1 May: 1300, 2 May: 2457, 3 May: 1650). This indicates high migration activity and a high turnover rate during this period. Taiga Bean Goose numbers, on the other hand, dropped markedly during the last days of April, and, by early May, most birds had departed. Therefore, the vast majority of Bean Geese at the coastal staging areas in early May were of the subspecies *rossicus*.

Recoveries of marked birds

Two neckbanded Tundra Bean Geese were observed in the Alvik area in 2008. One of them was also observed there in 2009. The birds had been marked at the spring staging area "Valdak marshes"

(70° 10' N, 24° 50' E) along the Porsangen Fjord, Northern Norway (one in May 2003 and the other in May 2005). Subspecies identification of these birds as *rossicus* was verified by measurements and genetics (Aarvak & Øien 2005, T. Aarvak pers. comm.). After their visits in Northern Sweden in 2008 and 2009, the birds were also observed at the Valdak marshes in mid May the same year (Aarvak & Øien 2009, T. Aarvak pers. comm.).

A Swedish marked *rossicus* bird, ringed on 19 April 2009 at Ume River Delta, was observed there until 29 April. Afterwards it went to the Alvik/Ersnäs area SW of Luleå, where it was seen on 1–3 May and finally on 5 May 2009 at Persöfjärden north of Luleå.

Additionally, one of the Swedish *rossicus* neckbands was found near a coastal spring staging area of Tundra Bean Geese on Varanger peninsula in the second half of May, whereas two other birds, one with a transmitter, were observed in late May at the Tana river basin north-east of Utsjoki along the Norwegian-Finnish border. This transmitter birds was located in late May in a nearby tundra-like habitat in Finland. The second transmitter bird was located during the breeding season also in a tundra-like habitat in the central part of the Norwegian Finnmark (L. Nilsson in litt.).

In late July 2009, five different Swedish *rossicus* with neckbands were observed at a moulting site of Tundra Bean Geese in central Varanger peninsula (I. Øien, T. Aarvak in litt.).

Discussion

Status of the Tundra Bean Goose in northern Sweden

The occurrence of large numbers of Tundra Bean Geese in northern Sweden was completely unknown before the study reported here. SOF (2002) characterizes *rossicus* only as a migrant through central and southern Sweden, and with insufficient knowledge of numbers of birds involved. Persson (1997) reported up to 500 birds during autumn migration in Skåne, the highest number of *rossicus* ever in Sweden so far.

For Västerbotten, Olsson & Wiklund (1999) listed only two observations of single birds: 3 May 1995 at lake Brånsjön and 9 November 1996 at Röbäcksslätten near Umeå. Also Skyllberg et al. (2003, 2008 & 2009) routinely assumed almost all spring staging Bean Geese in northern Sweden to belong to the ssp. *fabalis*. Skyllberg et al. (2008) mentioned spring observations of four Norwegian marked *rossicus* neckbands from the Luleå region, but they didn't take into account that a certain part of spring staging Bean Geese in northern Sweden could be of the *rossicus* subspecies.

Only quite recently, Skyllberg et al. (2009) reported, that up to 50 Tundra Bean Geese may use staging areas in southern Västerbotten, but explain this as a result of deviation from their normal flyway to Kola peninsula. They also considered the possibility, due to 500–1000 Tundra Bean Geese moulting in Finnmark (Aarvak & Øien 2009), and regular occurrence of neckbanded birds from Finnmark in the Luleå region, that a substantial number of Bean Geese counted in Alvik/Ersnäs and Persöfjärden could be of the *rossicus* subspecies.

Unfortunately, Skyllberg et al. (2009) do not give any exact figures for the numbers of *rossicus* involved, but suggested that the higher numbers of Bean Geese they counted in Northern Sweden in 2007–2008 versus the period 2002–2006 could be a result of a "contribution" from *rossicus* birds. However, using their numbers of maximum counts for Västerbotten and Norrbotten (see Skyllberg et al. 2009), this would give a contribution of about 500 birds only. Compared to a minimum of 1669 and 2722 Tundra Bean Geese counted in Northern Sweden in 2008 and 2009 respectively (Tables 6 & 7), their estimate of up to 500 *rossicus* birds is by far too low.

Looking at the phenology of spring-staging Tundra Bean Geese in 2009 (Table 7), their numbers peak during the last days of April and in early May. This means that the migration peak is 1–2 weeks later than for Taiga Bean Geese. This also means, that a final wave of Bean Geese staging in the Ume River Delta late in the migration period (early May), assumed to be Taiga Bean Geese by Skyll-

Table 8. Maximum counts of Bean Geese in Alvik/Ersnäs area during spring 2002–2008.
Högsta antal räknade sädgäss i Alvik/Ersnäs-området vårarna 2001–2008.

Year *År*	Maximum count *Högsta räknat*	Source *Källa*
2002	823 (28 Apr)	Skyllberg et al. (2008)
2003	817 (27 Apr)	Skyllberg et al. (2008)
2004	1230 (1 May)	Sjöberg & de Jong (2005)
2005	2127 (4 May)	Sjöberg & de Jong (2005)
2006	1230 (3 May)	Skyllberg et al. (2008)
2007	1160 (26 Apr)	Sjöberg & de Jong (2007)
2008	2022 (30 Apr)	Sjöberg & de Jong (2008)

Table 9. Reports of larger flocks of resting Bean Geese in southern Sweden in early May 2008 and 2009 (source: SVALAN Rapportsystemet för fåglar).
Rapporter om större flockar av rastande sädgäss i södra Sverige i början av maj 2008 och 2009 (källa: SVALAN Rapportsystemet för fåglar).

2008	Place *Plats*	Numbers *Antal*	2009	Place *Plats*	Numbers *Antal*
1 May	Tåkern	400	1–2 May	Östen	600
2 May	Kvismaren	550	1 May	Kvismaren	200
3 May	Kvismaren	400	3 May	Kvismaren	200
4 May	Tåkern	200	3 May	Tåkern	130
4 May	Kvismaren	100			

berg et al. (2008, 2009), consists in fact mostly of Tundra Bean Geese.

These differences in timing of spring migration between Tundra and Taiga Bean Geese in Northern Sweden can be used, when interpreting count data from the Alvik-Ersnäs area from previous years. As maximum numbers in the Luleå region between years 2002 and 2008 were always counted in the last days of April or in early May (Table 8), this time frame strongly indicates that at least since 2002 a high proportion of *rossicus* birds is involved in spring-staging Bean Goose numbers there.

In this context, substantial numbers of staging Bean Geese in Central Sweden in early May in 2008 and 2009 are of special interest (Table 9 and SVALAN). Although no information on subspecies was given for most of these observations, the late timing makes these birds good candidates for Tundra Bean Geese, which, thus, should be added to the numbers of *rossicus* observed in Northern Sweden at the same time. Taiga Bean Geese at spring staging areas in southern Ostrobothnia (Kristinestad and Kauhajoki/Finland), which mainly use staging areas in Central Sweden before, have their migration peak even 1–2 weeks earlier than in southern Västerbotten (Skyllberg et al. 2009). This fact and also the recoveries of two Norwegian *rossicus* neckbands, observed in Kvismaren on 19 April 2006 and 17 March 2007 respectively (Aarvak & Øien 2009) support the opinion of more *rossicus* birds staging in Central Sweden in late April/early May.

Breeding range of Tundra Bean Geese migrating through northern Sweden

A number of neckband recoveries from Norwegian and Swedish Tundra Bean Geese and data from

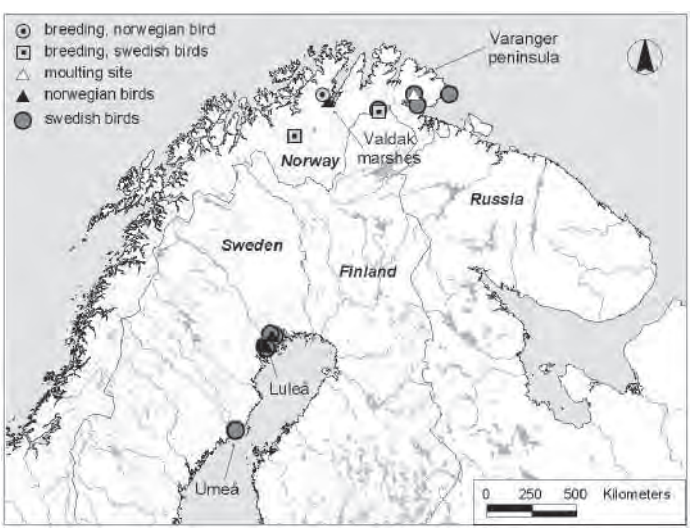

Figure 1. Connectivity between spring staging areas of Tundra Bean Geese in northern Sweden (grey circles = Swedish neckbands, black triangle = Norwegian neckbands) and staging, moulting and breeding areas in northern Scandinavia revealed by ring recoveries and satellite telemetry (for details see text).
Samhörigheten mellan vårrastplatser för tundrasädgås i norra Sverige (grå cirklar = svenska halsringar, svarta trianglar = norska halsringar) och rast-, ruggnings- och häckningsplatser i norra Skandinavien så som de framgår av återfynd och satellittelemetri (se texten för detaljer).

two Swedish transmitter *rossicus* birds are now available to link the staging sites along in Northern Sweden with the breeding area of Tundra Bean Geese (Figure 1). Four out of eight neckbanded *rossicus*, caught in mid May at Valdak marshes in Northern Norway (Aarvak & Øien 2005, 2006 & 2009, Øien & Aarvak 2007), were later observed in the Luleå region between late April and early May. Annual arrival in Valdak was between 10 and 14 May, sometimes only 4 days after they were last seen near Luleå (Aarvak & Øien 2009). One *rossicus* bird, caught in mid May 2006 at Valdak Marshes, and fitted with a satellite transmitter, was located during breeding time in tundra habitat west of the Porsangerfjord, but, due to failed breeding, the bird later on went to central Varanger peninsula for moult, where also two of the birds, seen in Northern Sweden, were observed (Aarvak & Øien 2006, 2009).

As the Valdak marshes only host smaller numbers of staging Tundra Bean Geese in May (maximum: 216 birds in 2008; Aarvak & Øien 2009), there should exist other spring-staging areas in Finnmark or in neighbouring parts of Finland and Russia. At least two such areas have been confirmed by recoveries of Swedish Tundra Bean Geese in Northern Norway: Kariel/Varanger peninsula (70°06' N, 29°23' E) and Tana River near Sirma (70°01' N, 27°25' E).

During the breeding season, two *rossicus* birds, fitted with satellite transmitters near Luleå, were recorded in tundra-like habitats in northernmost Finnish Lapland and Norwegian Finnmark respectively. Aarvak & Øien (2009) reported breeding of *rossicus* birds in tundra-like habitats in central part of the Norwegian Finnmark, and stated, that the breeding range of Taiga Bean Geese in Finnmark County is restricted to its easternmost, forested parts. There is no reason to expect *rossicus* birds, that breed east of the Kola Peninsula, to pass northern Sweden. Thus, the breeding range of the rossicus birds staging in Northern Sweden consists of tundra-like habitats in Norwegian Finnmark, Northern Finnish Lapland and, maybe Kola Peninsula in Russia.

The Norwegian breeding bird atlas (Gjershaug et al. 1994) presents breeding records of Bean Geese in areas, now known to be within the breeding range of Tundra Bean Geese. This atlas is based on observations from 1977–1986, and, unless a major shift in breeding habitat choice of Taiga Bean Geese has occurred, the Bean Geese of tundra-like habitats were Tundra Bean Geese even then. These birds were likely to use the same migration route as they do today, and, consequently, were almost entirely overlooked by birdwatchers in Northern Sweden.

Consequences for the size estimate of the northern Scandinavian Bean Goose population

Based on the assumption that all Bean Geese migrating through Northern Sweden belonged to the *fabalis* ssp., Skyllberg et al. (2008 & 2009) estimated the current breeding population of Taiga Bean Geese in Northern Scandinavia at 5000–6000 birds. This study shows that this estimate is poorly founded, because a substantial proportion of these birds are Tundra Bean Geese. This is particularly true for the Bean Geese staging near Luleå, which contributed with about one-third of their estimate.

Skyllberg et al. (2008, 2009) also assumed that all Scandinavian Taiga Bean Geese migrate along the coast of Northern Sweden, and that all these migrants breed in Scandinavia. There is no support for these assumptions. Instead, data from satellite transmitters fitted on Taiga Bean Geese in the Ume River Delta falsify the latter assumption. Some birds were heading for breeding areas in Finland and northern Karelia in Russia (L. Nilsson, pers. comm.).

The conclusion is that the estimates of the Scandinavian Taiga Bean Goose population made by Skyllberg et al. are based on faulty assumptions. Given the proportion of Tundra Bean Geese and a number of outside-Scandinavia-breeders among spring-staging Bean Geese along the coast of Northern Sweden, the Scandinavian population of Taiga Bean Geese is probably much smaller than 5000–6000 individuals. The number of Taiga Bean Geese that use other, more westerly migration routes is probably not large enough to compensate for the other effects. A devaluation of the Scandinavian breeding population calls for further investigations and stronger conservation measures for this species, which already is categorized as Near-Threatened in Sweden (Gärdenfors 2005) and Vulnerable in Norway (Gjershaug et al. 2006).

Finally, it must be stressed, that Bean Geese in Sweden no longer can be assumed, routinely(!) to be Taiga Bean Geese. Neckband sightings and (unpublished) counts have shown that fair numbers of Tundra Bean Geese occur in Sweden also during autumn migration and in winter. Improved classification of Bean Geese to subspecies is badly needed, because first when a large proportion of Bean Geese is classified at the subspecies level, can the true population size of both subspecies in Sweden

and its neighbouring countries be measured satisfactory.

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Appendix 1. Features and measurements (in mm) of Tundra Bean Geese *A. f. rossicus* caught in northern Sweden.
Karaktärer och mått (i mm) för tundrasädgäss A. f. rossicus *fångade i norra Sverige.*

No	Age Sex *Ålder Kön*	Wing length *Ving-längd*	Culmen length *Kulmen-längd*	Bill-head length *Näbb-huvud längd*	Bill depth *Näbb-höjd*	Tarsus *Tars*	Nail form *Näbb-nagel*	No. of teeth *Antal tänder*	Bill colour-type *Näbb färgtyp*	Grinning patch *Näbb-glipa*
1	ad F	425	52.1	110	30.0	72.0	oval	24	2c	8.7
2	2y F	408	52.3	112	30.1	76.6	oval	23	2d	9.4
3	ad M	445	58.3	120	32.0	80.3	oval	23	2d	9.5
4	ad F	430	54.4	114	30.3	73.2	oval	23	2d	9.1
5	ad M	424	57.4	121	31.9	78.1	oval	22	2d	9.7
6	ad F	407	52.2	111	30.3	72.6	oval	21	2c	8.9
7	ad F	404	54.0	108	29.1	71.7	oval	21	2d	8.5
8	ad M	443	61.1	122	31.5	79.0	oval	23	2b	9.5
9	ad M	420	59.7	120	32.5	74.8	oval	22	2d	9.9
10	ad M	450	58.4	122	31.7	78.8	oval	24	2c	9.0
11	ad F	421	56.6	111	29.6	73.3	oval	23	2c	8.9
12	ad M	444	58.5	119	32.0	78.0	oval	23	2d	9.0
13	ad M	430	61.1	122	31.4	80.9	oval	23	2c	9.5
14	ad F	396	52.3	113	28.9	71.0	oval	23	2c	8.6
15	ad F	428	57.1	112	31.4	76.2	slightly oval	23	2d	9.3
16	ad F	417	54.8	113	30.9	73.7	oval	22	2c	8.5
17	ad F	393	51.1	105	29.6	71.1	oval	24	2c	9.1
18	ad F	398	53.6	111	30.2	77.5	oval	23	2c	9.5
19	ad M	455	57.5	121	33.0	80.1	oval	23	2d	10.2
20	ad M	452	61.0	122	32.1	76.1	oval	24	2d	9.0
21	ad M	404	57.2	116	30.9	77.5	oval	22	2d	8.9
22	ad M	429	62.0	119	33.4	81.3	oval	22	2d	9.3
23	ad M	435	59.2	120	31.9	78.7	oval	22	2d	9.3
24	2y M	390	55.1	111	31.8	72.6	oval	23	2d	9.4
25	ad F	430	56.5	117	29.1	77.1	oval	23	2d	8.7
26	ad F	436	51.3	105	28.7	74.6	oval	23	2c	8.8
27	ad M	444	61.4	123	-	-	oval	-	2c	-
28	ad F	423	57.9	113	-	-	oval	-	2d	-
29	ad M	438	58.7	120	-	-	oval	-	2c	-
30	ad M	456	60.7	121	-	-	oval	-	2d	-

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Satellite tracking of Bean Geese *Anser fabalis fabalis* and *A. f. rossicus* from spring staging areas in northern Sweden to breeding and moulting areas

*Satellitspårning av sädgäss (*Anser fabalis fabalis *och* A. f. rossicus*) från rastplatser i norra Sverige till häckningsområden och ruggningsplatser*

LEIF NILSSON, ADRIAAN DE JONG, THOMAS HEINICKE & KJELL SJÖBERG

Abstract

In order to determine their breeding and moulting sites we fitted eight Taiga Bean Geese *Anser fabalis fabalis* and two Tundra Bean Geese *A. f. rossicus* with satellite transmitters in 2007–2009 at their spring roosting sites at Umeå and Luleå, Sweden. Nine of these transmitters transferred GPS positions for 1–4 months. All positions were N–ENE of the catching sites. The Tundra Bean Geese migrated to Finnmark in Norway and neighbouring parts of Finland. The Taiga Bean Geese migrated to sites near Övre Soppero (Sweden) and Kautokeino (Norway) in the west, through northern Finland, to Russian Karelia. Three of five Taiga Bean Geese with active transmitters flew to Novaya Zemlya to moult. Our results indicate that a significant proportion of the Taiga Bean Geese that migrate along the coast of northern Sweden in spring do not breed west of 20° E, and that many of them moult on Novaya Zemlya. The Tundra Bean Geese that pass through northern Sweden in spring belong to the Finnmark population that breeds slightly north of the Taiga Bean Geese.

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Introduction

The Bean Goose *Anser fabalis* is distributed over the northern Palearctic from Scandinavia to the far east of Russia. Within this large distribution, it is represented by four subspecies or 2–3 species, depending on the taxonomy used. Of these taxa, Taiga Bean Goose *A. f. fabalis* and Middendorff's Bean Goose *A. f. middendorffi* are mainly found in taiga (i.e. northern boreal) habitats, while Western Tundra Bean Goose *A. f. rossicus* and Eastern Tundra Bean Goose *A. f. serrirostris* inhabit tundra habitats. *A. f. fabalis* and *A. f. rossicus* are the only taxa regularly observed in Europe (Nilsson et al 1999, Van den Bergh et al. 1999). In this article, *A. f. fabalis* will be referred to as Taiga Bean Goose and *A. f. rossicus* as Tundra Bean Goose.

In Sweden, the Bean Goose is represented by the Taiga Bean Goose *Anser fabalis fabalis*, breeding in the northernmost parts of the country. The national population has been estimated to be 650–1250 pairs (Nilsson 2007), and is considered as Near Threatened (Gärdenfors 2005). Outside the breeding season, large numbers of Bean Geese occur in Sweden, and the majority of the world population of Taiga Bean Geese *A. f. fabalis* is thought to pass through Sweden during autumn migration. There is some uncertainty about the taxonomy of many Bean Goose reports, however, and the proportion of Tundra Bean Goose *A. f. rossicus* reports has increased remarkably since the *fabalis/rossicus* issue was brought up (Heinicke 2010). Due to annual goose counts since 1977/1978, the staging areas, numbers and trends of Bean Geese outside the breeding season are well known (Nilsson & Persson 1984, Nilsson 2008). Thanks to earlier neckbanding programs in Finland and Sweden, even the movements in south and central Sweden are well documented (Nilsson 1984, Nilsson & Pirkola 1991). On the other hand, where the Bean Geese go and what they do between their departure from the spring-staging sites along the coast of northern Sweden and their return in autumn, is virtually unknown.

In the late 1990s, plans were presented for a railway passing an area south of Umeå, close to the

Table 1. Summary data for the Bean Geese (*Anser fabalis fabalis* and *A. f. rossicus*) marked with satellite transmitters in northern Sweden in 2008 and 2009.
*Sammanfattande uppgifter för de sädgäss (*Anser fabalis fabalis *och* A. f. roisscus*) som märktes med satellitsändare i norra Sverige under 2008 och 2009.*

PTT	Neck-band *Hals-band*	Taxon	Marking date *Märk-datum*	Marking site *Märkplats*	Start of migration *Flytt-start*	Last signal *Sista signal*	Breeding area, country *Häcknings-område*	Moulting area *Ruggnings-område*	Seen in autumn/ winte- *Sedd vinter/höst*
			2008		2008	2008			
34294	YME	Taiga	April 20	Umedeltat	May 4	May 20	Soppero, SE		
34295	OXG	Taiga	April 19	Umedeltat	April 29	Aug 17	Karelia, RU	Novaja Zemlja	
34297	OXN	Taiga	April 20	Umedeltat	May 7	Aug 17	Soppero, SE		X
			2009		2009	2009			
90822	ECP	Taiga	April 19	Umedeltat	May 10	June 30	Finnmark, N		
90823	ECV	Taiga	April 19	Umedeltat	April 30	Aug 5	Lapland, SF	Novaja Zemlja	X
90820	EER	Taiga	April 26	Alvik	May 4	June 14	Soppero, SE		X
90821	E00	Taiga	April 26	Alvik	May 6	Aug 27	Soppero, SE	Novaja Zemlja	X
90824	EZX	Tundra	April 28	Alvik	May 10	Aug 29	Finnmark, N		X
90825	EZA	Tundra	April 28	Alvik	May 11	June 16	Lapland, SF		X

mouth of the Ume River. This are is one of the main spring staging areas of Bean Geese in northern Sweden (Nilsson & Persson 1984). A Control Program was launched to evaluate the possible effects of the railway construction on staging Bean Geese and other waterfowl. This program included regular spring counts, a study of habitat utilization, a neck-banding program for Bean Geese, and several other studies. The railway project also generated a number of compensatory measures, e.g. the construction of permanent and temporal ponds, food provisioning, removal of woodlots, and restoration of coastal meadows near roosting sites.

Unfortunately, the chances of neck-band sightings are futile when the Bean Geese are in their remote breeding and moulting areas. To overcome this problem, we used satellite transmitters to study the migration from the spring-staging sites to the breeding and moulting areas.

Methods

Bean Geese were caught with cannon nets at three locations: the Ume River Delta, Brattby near Vännäsby, and Alvik SW of Luleå in 2005, 2007, 2008 and 2009. A total of 75 Bean Geese were neck-banded during these years, both Taiga and Tundra Bean Geese. Ten adult males (1 in 2007, 3 in 2008 and 6 in 2009) were supplied with satellite transmitters (Table 1). In 2007 and 2008 (one goose) we used 45 g Argos/GPS Solar PTTs, whereas we used 40g Battery Powered LC4s for the eight other birds. All transmitters were produced by Microwave Telemetry Inc. The transmitters were programmed to send one GPS position per day, and they had an estimated lifespan of one year. GPS positions were downloaded from the Argos website and plotted on adequate maps.

Only adult males were chosen, because (A) males are larger, (B) transmitters on the back of females may interfere in the act of mating, and (C) the ground tracking function of the transmitters can be triggered during long incubation periods of females and the bird might be assumed to be dead. We used harnesses (Teflon ribbon in 2007, leather in 2008 and 2009) to attach the transmitters on the back of the geese. Each transmitter goose was also neck-banded to ensure the bird could be identified even when it lost its transmitter.

Results and discussion

The 2007 goose lost its transmitter after a few days and will not be discussed any further. The other transmitters were transferring positions regularly, but ceased to do so after one to four months (Table 1). The very last signals were received on 29 August, before the start of southward migration of most Bean Geese. Six of the transmitter birds were later identified in southern Scandinavia, and were found to carry neither transmitter nor harness. How the birds lost the transmitters is unclear. It may be

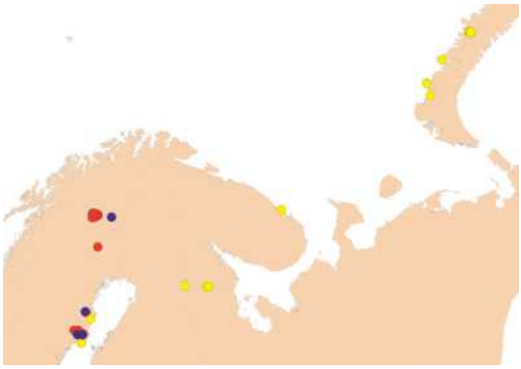

Figure 1. Satellite positions of three Taiga Bean Geese *Anser fabalis fabalis* marked in the Ume River delta in 2008.
Satellitpositioner för tre taigasädgäss Anser fabalis fabalis *från Umedeltat märkta 2008*.

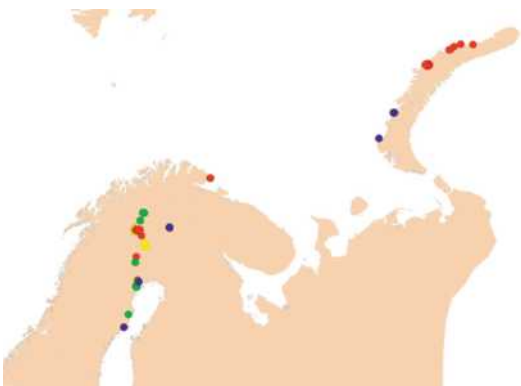

Figure 2. Satellite positions of four Taiga Bean Geese *Anser fabalis fabalis* marked in the Ume River delta and the Alvik area, Luleå in 2009.
Satellitpositioner för fyra taigasädgäss Anser fabalis fabalis *från Umedeltat och Alviksområdet, Luleå märkta 2009*.

that the geese got so slim during moult that they could slide out of the harness or they managed to destroy the harness with their strong beaks. For long-term transmitter studies of Bean Geese, the harnesses we used are clearly unsuitable.

Breeding areas

As all transmitter birds were adults, we assume that the birds were within their breeding area when the positions "settled" after spring migration. The breeding areas of the Taiga Bean Geese (n=7) were N–ENE of the catching sites (Figure 1 and 2). Five (71%) of them headed for the region between Övre Soppero in northernmost Sweden and Kautokeino in Norway, almost due north of the Alvik catching site near Luleå (Table 1). The wetland region around Övre Soppero (Figure 3) was the same area as where relatively high densities of Bean Geese were found during aerial surveys of breeding waterfowl in 1972–1975 (Nilsson unpubl.).

The other two Taiga Bean Geese had more easterly goals for their spring migration: the 2009 Alvik bird went to central Finnish Lapland and the 2008 Ume River Delta bird to Russian Karelia N of Kalevala (Figure 1 and 2). The latter bird may have flown across the Gulf of Bothnia between a staging site near Skellefteå and its final destination, but the intervals between the GPS positions were too large to confirm this (Figure 1).

The Tundra Bean Geese (n=2) migrated slightly further north than the Taiga Bean Geese into tundra habitats in Norwegian Finnmark and adjacent parts of Finnish Lapland (Figure 4). These areas and their habitats do differ from the breeding areas of the Taiga Bean Geese in this study, but it is still unclear whether the populations of these two taxa are geographically and/or ecologically isolated or overlapping.

Spring migration strategy

The pattern of migration between the catching site and the breeding areas differed between Taiga and Tundra Bean Geese. Whereas the Tundra Bean Geese flew virtually non-stop to their breeding grounds (Figure 4), the Taiga Bean Geese stopped at one or several staging sites along the way (Figure 1 and 2). Also, our data confirm that Taiga Bean Geese use multiple staging sites along the coast of the Gulf of Bothnia during a single season (Nilsson, de Jong & Heinicke 2009).

Moult migration of Taiga Bean Geese

Moulting of Taiga Bean Geese on Novaya Zemlya has been reported already in the early 20th century (Alpheraky 1905), and a Taiga Bean Goose marked in Finnish Lapland in August 1985 was shot during moult on Novaya Zemlya in the summer of 1996 (Ström et al. 1997). Despite this, we did not expect spring-staging Taiga Bean Geese in northern Sweden to use this eastern moulting site at a regular basis. Instead, we thought of the 2008 Karelian bird that migrated to Novaya Zemlya as of an odd bird with odd behaviour. The fact that two of the 2009

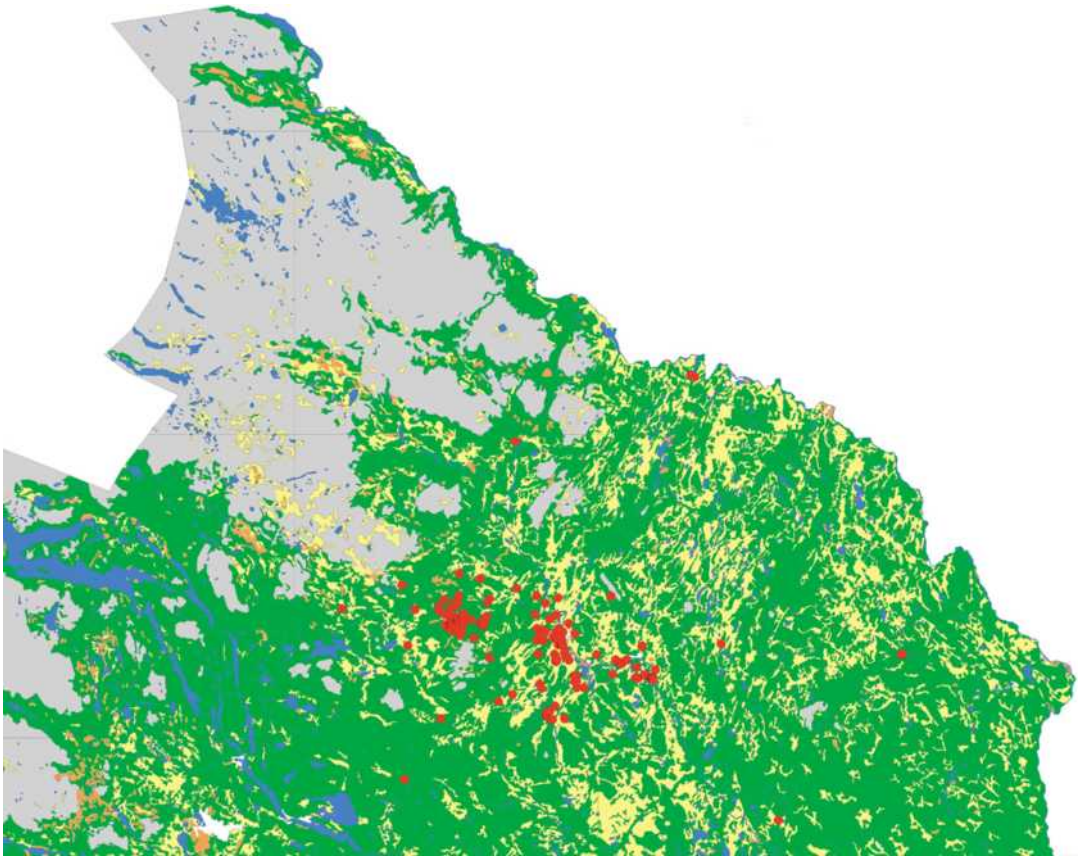

Figure 3. All satellite positions obtained from the breeding areas in northernmost Sweden from four Taiga Bean Geese *Anser fabalis fabalis* marked in the Ume River delta and in Alvik 2008 and 2009.
C Lantmäteriet Gävle 2010. Medgivande I 2010/1578.
Samtliga satellitpostioner för fyra taigasädgäss Anser fabalis fabalis *från Umedeltat och Alviksområdet, Luleå, märkta 2008 och 2009.*

Taiga Bean Geese also chose to moult on Novaya Zemlya forced us to change opinion. With three (60%) out of five birds with active transmitters (Table 1) choosing Novaya Zemlya, this behaviour appears to be normal rather than exceptional. The positions for the three tagged Bean Geese on Novaya Zemlya were well spread along the west coast of the island, all three birds visiting different sites before settling at the moulting sites (Figure 5).

The reason why these birds prefer this remote site over other moulting sites, e.g. on Varanger Peninsula (Norway) and in southern Swedish Lapland, is not obvious (Nilsson, de Jong & Sjöberg 2008, de Jong 2010). In this context, the GPS position of the 2009 Övre Soppero bird on the NE coast of Varanger Peninsula is noteworthy. For migrating geese, this position should be within "scanning distance" from one of the Varanger moulting sites. This position and the position on the coast of the Kola Peninsula for the 2008 bird, show that the geese make a short stop before crossing the Barents Sea (Figure 1 and 2).

Local movements within the breeding area

Within their breeding area, the birds show considerable local movements. It should be remembered, though, that our data are 100% male biased. Not

Figure 4. Satellite positions of two Tundra Bean Geese *Anser fabalis rossicus* marked in the Alvik area in 2009.
Satellitpositioner för två tundrasädgäss Anser fabalis rossicus *från Alviksområdet, Luleå, märkta 2009.*

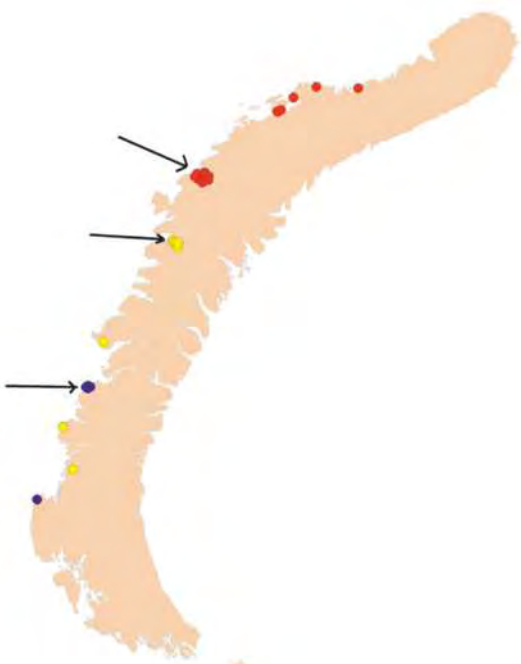

Figure 5. Satellite positions of three Taiga Bean Geese *Anser fabalis fabalis* on Novaya Zemlya the summers 2008 and 2009.
Satellitpositioner för två taigasädgäss Anser fabalis fabalis *på Novaya Zemlya somrarna 2008 och 2009.*

surprisingly, the birds were more mobile early in the season, but even in the middle of the breeding season considerable movements occurred. The full temporal pattern of these movements and the habitat preferences they express are planned to be presented elsewhere.

Obviously, our data stem from a limited number of Bean Geese and limited time-frames; goose-catching and transmitters are highly resource consuming. Despite this, our findings result from two catching sites, two years and two Bean Goose taxa, and show consistency over these factors.

Conclusion

Our study shows that (1) Taiga Bean Geese commonly use multiple spring-staging sites in northern Sweden before reaching their breeding area, (2) a significant proportion, maybe the majority, of the Taiga Bean Geese staging along the coast of the Gulf of Bothnia during spring migration breed east of longitude 20°E in Sweden, Norway, Finland, and probably even Russia, (2) Tundra Bean Geese of the Finnmark population in (predominantly) Norway use staging sites in northern Sweden during spring migration, and (4) Taiga Bean Geese that use the spring-staging areas near Umeå and Luleå, commonly fly to Novaya Zemlya, Russia, to moult.

Acknowledgements

Grants for this study were obtained from Carl Tryggers Foundation for Scientific Research, the Swedish Environmental Protection Agency, and the Swedish Ornithological Society (Alvin's foundation). Goose catching was financed with support from the Swedish Transport Administration (formerly Swedish Rail Administration) in 2005–2007, and by Stiftelsen Naturvård vid Nedre Umeälven in 2008–2009. We want to thank the landowners and the field staff for making the catching of Bean Geese possible. Also, we would like to thank bird-watchers around the country for sending us their observations of neckbanded Bean Geese.

Permission for canon-netting was given by the Swedish Environmental Protection Agency (412-1004-07) and the Västerbotten County Board (521-4697-2007. 521-4916-2008 and 521-4636-2009), and for using neckbands and transmitters by the Umeå Ethical Committee on Animal Experiments (A19-07). The map in Figure 3 is based on "Översiktskartan" (Permit I2010/1578, Lantmäteriet i Gävle 210).

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Sammanfattning.

I samband med diskussionerna kring Botniabanans dragning i anslutning till Umedeltat, en av de viktigaste vårrastplatserna för sädgås i norra Sverige, uppkom ett behov av ökad kunskap rörande sädgässen häcknings- och ruggningsplatser. Då chansen är liten att sädgäss med halsringar blir sedda i dessa glest befolkade trakter försågs 10 sädgäss (8 taigasädgäss och 2 tundrasädgäss) med satellitsändare under 2007–2009. Nio av dessa sändare producerade användbara data (Tabell 1). Resultaten av satellitspårningarna illustreras i kartor i Figur 1–5. Tyvärr hade samtliga sändare slutat fungera innan gässen började sin höstflyttning.

Fyra av sju taigasädgäss flyttade till myrområdena runt Övre Soppero i nordligaste Norrbotten. En av dessa taigasädgäss flyttade senare till Novaja Zemlja i Ishavet norr om Sibirien för att rugga. De övriga tre taigasädgässen fördelade sig på södra Finnmark i Norge, finska Lappland och ryska Karelen. De sistnämnda ruggade båda på Novaja Zemlja. De båda tundrasädgässen flyttade till norska Finnmark och angränsande delar av Finska Lappland. Tundrasädgässens flyttningsstrategi tycks skilja sig från taigasädgässens, då de flög nästan non-stop till sina häckningsområden medan taigasädgässen rastade på ett eller flera ställen under flyttningen genom nordligaste Sverige.

ORNIS SVECICA 20: 190–201, 2010

Review of the historical distribution of the Lesser White-fronted Goose *Anser erythropus* in Europe

Översikt av den historiska utbredningen av fjällgås Anser erythropus *i Europa*

JOHAN H. MOOIJ

Abstract

The Lesser White-fronted Goose *Anser erythropus* showed a dramatic decline since the first population estimates of the 1950s. At most wintering sites the species was overlooked until the middle of the 20th century and the migratory routes, staging areas and wintering sites were poorly known. Population modelling under consideration of the official estimates of the size of the total Lesser White-fronted Goose population since the 1950s indicates the possibility that the species population may have reached a level of 250,000–300,000 individuals in the second half of the 19th century, which means that the decline probably started already at the middle of the 19th century. Records from hunting, catching and observations in wintering and staging areas indicate that Lesser White-fronted Geese not only migrated over western Siberia and eastern Europe but also over western Europe. Because hunting is still one of the major threats, the species can only be saved from extinction if the key sites are protected and hunting of all goose species is banned in all staging areas of the species.

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Introduction

The Lesser White-fronted Goose *Anser erythropus* is a monotypic and exclusively Palaearctic species that apparently separated from the Greater White-fronted Goose *Anser albifrons* about 175,000 years ago (Pedall et al. 2008). Both species are morphologically and genetically still very similar. Alphéraky (1904) stated that the species most probably was breeding throughout the tundra zone of northern Eurasia from Kamchatka to Lapland and was wintering in Western Europe, Greece, Turkey, northern Egypt, Persia, India, South-China and Japan. Nowadays the breeding area is disjunct and the main wintering areas seem to be in Iraq and South China, with small numbers still wintering in the border region of Greece and Turkey (Aarvak & Timonen 2004).

The Lesser White-fronted Goose is included in Appendix 1 of the African-Eurasian Waterbird Agreement (AEWA) under the Bonn Convention, in Appendix II of the Bern Convention, and in Appendix I of the EU-Birdsdirective. In 2008 AEWA adopted and published an International Single Species Action Plan for the Western Palaearctic population of the species (AEWA 2008).

In this study, historical records of Lesser White-fronted Geese are presented and analysed in an effort to delineate historical migratory routes as well as population development since the middle of the 19th century.

Methods

Records were collected from literature (Alphéraky 1904, Bauer & Glutz von Blotzheim 1968, Davies 1949, Davis & Scott 1946, De Smet 2005, Drobovtsev 1972, Dubois et al. 2000, Dzieciolowski & Frankiewicz 1970, Eykman et al. 1941, Faragó 1995, Fransson & Pettersson 2001, Handrinos & Goutner 1990, Kampe-Persson 2004, 2008, Klemm & Kohl 1988, Koffijberg et al. 2005, Kumari & Jögi 1972, Leibak et al. 1994, LOB 2007, Mooij & Heinicke 2007, 2008, Mooij et al. 2008, Norderhaug & Norderhaug 1982, 1984, Noskov 2002, Pachenko & Priklonski 1972, Persson 2000, 2004, Prokosch & Hötker 1995, Raudonikis & Shvazhas 1991, Rogacheva 1992, Salmen 1980,

Sterbetz 1968, 1982, Smith 1974, Švažas 1996, Švažas et al. 1997 & 1998, Tischler 1914, Thienemann 1907, 1908, Tkachenko & Litvinova 1990, Tomiałojc 1990, Van Impe 1982, Van Oort 1909, Vinogradov 1990, Vlaamse Avifaunacommissie 1989, Von Transehe 1965, Watson 1955, Witherby et al. 1939, Yeatman-Berthelot 1991, Žalakevičius 1998), and from data banks of BTO, DOF, SOVON, SVALAN, and ZMA. I also used data from birds with transmitters (http://www.piskulka.net, http://gis-lab.info/projects/piskulka-eng.html) and personal communication with a number of colleagues.

Releases of Lesser White-fronted geese started in Sweden in 1981 (von Essen 1982, 1991, 1996). To exclude records of these birds, only data from the period up to 1982 were used. All observations were supplied with geographical coordinates and fed into "ArcView" GIS. Double entries were deleted so that a record was considered only once.

Results

Records of Lesser White-fronted Geese

A total of 986 records was accepted for analysis, of which about three quarters dated from after 1960. The average number of birds observed per record increased until the 1920s and was then more or less stable, with exception of the 1970s (Table 1). The higher average of that decade was a result of a special monitoring programme in Hungary (Sterbetz 1976, 1982). Most records concerned single or few birds. Higher numbers (>100 individuals) were recorded in the Swedish breeding sites (1910s–1940s) and the Evros delta in Greece (1960s–1970s).

Table 1. Records of Lesser White-fronted Geese in Europe 1850–1982.
Fynd av fjällgäss i Europa 1850–1982

Period	Number of records *Antal rapporter*	%	Number of birds/record *Antal fåglar per rapport*
before 1900	28	2.8	1.17
1900–1909	22	2.2	5.75
1910–1919	17	1.7	12.27
1920–1929	22	2.2	34.45
1930–1939	42	4.3	21.84
1940–1949	27	2.7	49.20
1950–1959	66	6.7	12.85
1960–1969	254	25.8	32.27
1970–1979	371	37.7	107.33
1980–1982	137	13.9	44.88
	986	100.0	32.20

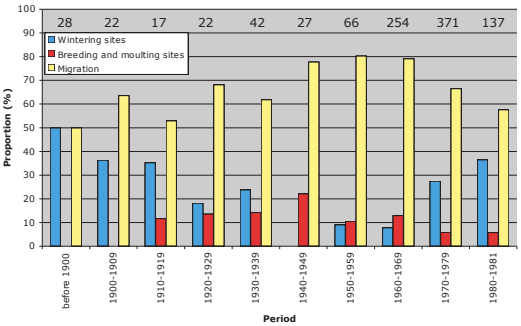

Figure 1. Records of Lesser White-fronted Geese in Europe until 1982 divided according to their origin.
Fynden av fjällgäss i Europa fram till 1982 uppdelade på deras ursprung: övervintringsplatser (blått), häck- och ruggplatser (rött) och fynd under flyttningen (gult).

The number of records (Table 1) increased in the 1930s, dropped during the 1940s but increased again after the war in spite of the dramatic decline of the population, which illustrates the growing interest in the species. The proportion of records from breeding and moulting areas, wintering areas and staging areas per decade is given in Figure 1. Up to the 1910s there were no records from the breeding and moulting areas. In all periods the majority of the records originated from the staging areas along the migratory routes. The proportion of records from the wintering areas declined in the 1920s but increased again in the 1970s.

Geographical distribution of the records over the study period

The records from before 1900 represent birds that were shot or caught by professional goose catchers. A considerable number of these birds are now in scientific collections in western Europe: Belgium (2 records), Germany (12), the Netherlands (5), the United Kingdom (4), Lithuania (1), Poland (1), Sweden (1), Spain (1) and Greece (1 record).

The records from the period 1900–1949 (Figure 2) mainly concerned birds collected during hunting or catching through the 1930s. Then interest in the species increased and the number of birds observed in the field grew considerably. Besides observations from the Fennoscandian breeding areas there is a considerable number of observations from the Baltic States, Denmark, Northern Germany and the

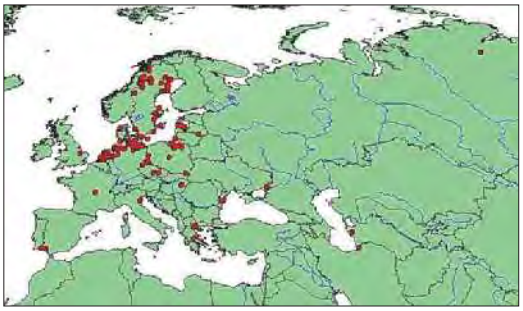

Figure 2. Distribution of Lesser White-fronted Goose records in the period 1900–1949.
Utbredningen av fjällgåsfynden under perioden 1900–1949.

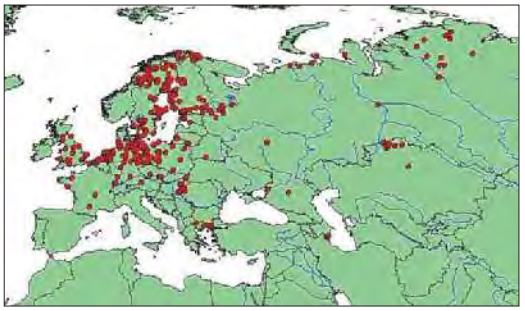

Figure 3. Distribution of Lesser White-fronted Goose records in the period 1950–1982.
Utbredningen av fjällgåsfynden under perioden 1950–1982.

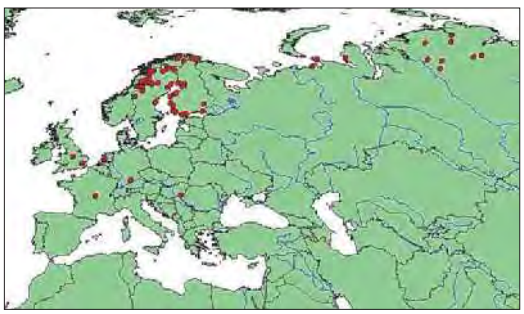

Figure 4. Distribution of Lesser White-fronted Goose records in summer (June–August).
Utbredningen av fjällgåsfynden under sommaren (juni–augusti).

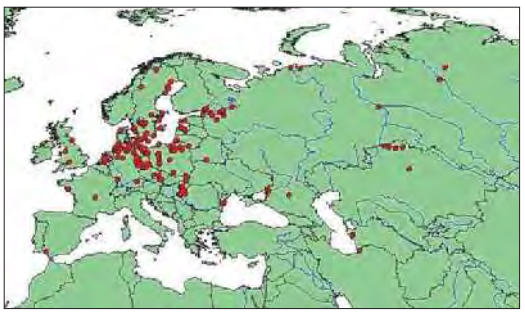

Figure 5. Distribution of Lesser White-fronted Goose records in autumn (September–November).
Utbredningen av fjällgåsfynden under hösten (september–november).

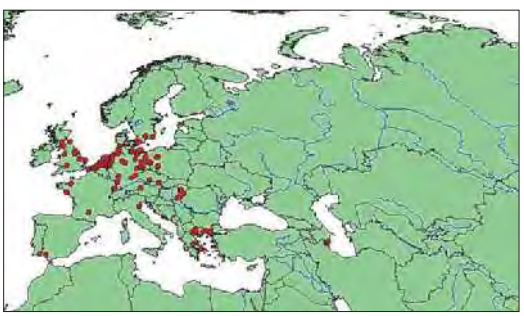

Figure 6. Distribution of Lesser White-fronted Goose records in winter (December–Febrary).
Utbredningen av fjällgåsfynden under vintern (december–februari).

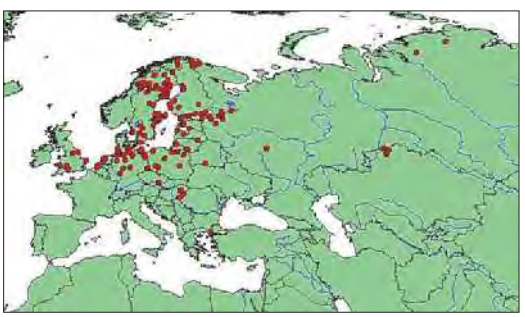

Figure 7. Distribution of Lesser White-fronted Goose records in spring (March–May).
Utbredningen av fjällgåsfynden under våren (mars–maj).

Netherlands, Poland and southern Sweden, but also single observations in other countries.

In the period 1950–1982 not only the number of records showed a considerable increase, but the records were also much more spread over Europe than in the earlier periods. The highest concentrations were reported from the Baltic States, Finland, Germany, Hungary, the Netherlands, Poland, Sweden and the United Kingdom (Figure 3).

Seasonal distribution of the records

Summer (June, July, August) records concerned birds staying in the traditional breeding and moulting areas (Figure 4). The records outside these areas in France, Germany, Hungary, the Netherlands and the United Kingdom most certainly are birds escaped from captivity or injured by hunting. The records along the Bothnian coast of Sweden and Finland most likely refer to non-breeders.

Autumn (September, October, November) records are spread over most of Europe as well as along a flyway through western Siberia via northern Kazakhstan to the Black and the Caspian Sea (Figure 5). Focal areas are the coast of the Baltic States, the Leningrad Oblast in northern Russia, southern Sweden, Poland, the northern part of Germany, the former Czechoslovakia, Hungary and northern Kazakhstan.

Winter (December, January, February) records came from Belgium, France, Germany, the Netherlands, the United Kingdom and western Poland as well as Italy and the Iberian peninsula, furthermore from Greece, Azerbaijan, and northern Iran (Figure 6).

Spring (March, April, May) records concentrate again in northern Europe and northern Kazakhstan. In Europe most records came from the Baltic States, northern Germany, Poland, Sweden, Finland and northern Russia. Further records came from Greece, Hungary, the Netherlands and the United Kingdom (Figure 7).

Historical population level and development

There are no estimates of the actual size of the population until the middle of the 20th century. But Scott (1939) reports concentrations of at least 30,000–60,000 Lesser White-fronted Geese at the southern coasts of the Caspian Sea, and Sterbetz (1968, 1976, 1982) estimated the peak number of Lesser White-fronted Geese in the Hortobágy Puszta at 80,000–120,000 individuals in the first half of the 20th century and after the dramatic decrease at less than 5000 individuals in the 1960s. Vinogradov (1990) estimated that c. 100,000 Lesser White-fronted geese annually passed through northern Kazakhstan in the middle of the 20th century, c. 60,000 birds the Kuma-Manych depression and c. 15,000 the coasts of the Sea of Azov. In the Kizil Agach area in Azerbaijan the former winter population size was said to be 35,000–40,000, but in 1996 only about 1000 Lesser White-fronted Geese could be found (Paynter 1996). At the end of the 19th century high numbers passed annually over the Aral Sea, but around the 1950s only single birds flew along this route (Alphéraky 1904, Vinogradov 1990). Considering these data a population estimate of at least 200,000 Lesser White-fronted Geese in the Western Palearctic in the first half of the 20th century does not seem unrealistic.

For the late 1970s, Yu. N. Mineev estimated for the Bolshezemelskaya Tundra a population of 3600–5400, V.N. Kalyakin & V.G. Vinogradov for the southern Yamal Peninsula c. 10,000 and A.S. Martynov for the southern Taimyr Peninsula c. 110,000 individuals (Rogacheva 1992, Vinogradov 1990). Although Rogacheva (1992) considered the estimate of Martynov "tentative and highly overestimated" a population estimate for the Russian arctic for the late 1970s of at least c. 100,000 Lesser Whitefronted Geese seems realistic. Since then the population decreased to a level of less than 15,000 birds until the 1990s (Lorentsen et al. 1999) and to c. 10,000 birds in 2000 (Morozov 2006, Morozov & Syroechkovski Jr. 2005).

Hunting

Since the 1980s on most regularly monitored sites the population numbers decreased with about 5% annually (Tolvanen et al. 2004). In spite of the fact that the Lesser White-fronted Goose has been a non-quarry species for a number of decades in most of its living range, hunting pressure did not substantially change during the past century (Table 2). The current total bag is estimated at 2400 birds (Mooij 2005).

Discussion

Historical migration pattern

The distribution of records (Figure 3–7) indicates that Lesser White-fronted Geese not only migrated over western Siberia and eastern Europe as described in Madsen et al. 1999 and AEWA 2008. At least during the study period there was also a

Table 2. Regional hunting pressure on the Lesser White-fronted Goose according to literature data (e.g. Flint pers.comm., Kellomäki pers.comm., Sterbetz 1968, Tolvanen & Pynnönen 1998, Vinogradov 1990, Yerokhov pers.comm, Yerokhov et al. 2008).
Regionalt jakttryck på fjällgåsen enligt litteraturdata (referenser ovan).

Country	Year	LWfG *Fjällgås*	Bag *Alla gäss*	%
Hungary (Hortobágy)	1920–1925	62	956	6.5
Hungary (Hortobágy)	1934	90	783	11.5
Hungary (Hortobágy)	1936	4	16	25.0
Kazakhstan (Kostanay Region)	1963	5	60	8.3
Hungary (Hortobágy)	1966	34	86	39.5
Russian Federation (Purynsky Lake, Taimyr)	1967	-	-	27.0
Russian Federation (Pura river, Taimyr)	1972	8	33	24.2
Russian Federation (Chelyabinsk Region)	1987–1996	-	-	10–40
Kazakhstan (Steppe area)	1980s			c. 10
Kazakhstan (Kostanay Region)	1996	6	111	5.4
Kazakhstan (Kostanay Region)	1997	1	24	4.2
Kazakhstan (Kostanay Region)	1997	1	13	7.7
Kazakhstan (Kostanay Region)	1998	2	14	14.3
Kazakhstan (Kostanay Region)	1999	1	66	1.5
Kazakhstan (Kostanay Region)	2000	0	4	0.0
Kazakhstan (Kostanay Region)	2001	2	33	6.1
Bulgaria	2002	3	123	2.4
Kazakhstan (Kostanay Region)	2002	4	51	7.8
Russian Federation (St.Petersburg)	2003	1	4	25.0
Russian Federation (Karelia)	2003	7	31	22.6
Kazakhstan (Kostanay Region)	2003	0	3	0.0
Kazakhstan (Lake Biyesoigan)	2004	6	17	35.3
Kazakhstan (Lake Kostanay)	2006	10	195	5.1

regular migratory route to a number of Western European countries.

Pooling all records in one map (Figure 8A) indicates the existence of a number of migration routes in the Western Palearctic (Figure 8B). The available data do not give information about the historical importance of each of these different flyways, but high numbers of Lesser White-fronted Geese were recorded in the Kuma-Manych Valley and the coast of the Sea of Azov in Russia (Alphéraky 1904, Vinogradov 1990), south of the Caspian Sea (Scott 1939), the Hortobágy Puszta in Hungary (Sterbetz 1968, 1982), Swedish Lapland (Norderhaug & Norderhaug 1982, 1984), the Evros Delta in Greece (Handrinos & Goutner 1990) and the steppe areas around the Aral Sea and in northern Kazakhstan (Alphéraky 1904, Vinogradov 1990). The numbers recorded in western Europe were rather small most of the time.

In the 19th century and also in the early decades of the 20th century most geese were staging in more or less remote areas. Besides, until the 1980s in most of Europe there were hardly any ornithologists with good equipment and most of them had limited mobility. As a result most goose haunts were seldom or irregularly visited by ornithologists and even if regional goose concentrations were checked, Lesser White-fronted Geese were easily overlooked. Therefore all Lesser White-fronted Goose data from the period before the 1980s were more or less collected by chance and are rather poor. For that reason it is not possible to make any statements about the importance of each of the delineated migratory routes and staging areas during the study period.

There are hardly any historical records from the Baltic States, where a considerable number of Lesser White-fronted Geese must have crossed in the past (Kumari & Jögi 1972, Leibak et al. 1994, LOB 2007, Raudonikis & Shvazhas 1991, Švažas 1996, Švažas et al. 1997 & 1998, Von Transehe 1965). From Greece there are only two records of Lesser White-fronted Geese from the 19th and only four from the first half of the 20th century, although

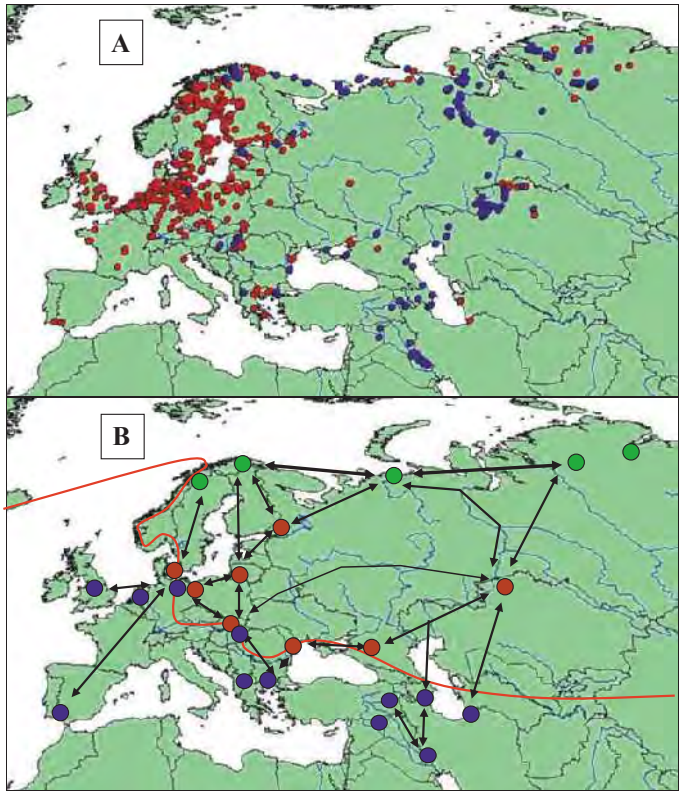

Figure 8. (A) Distribution of all Lesser White-fronted Goose records of this study (red) combined with records of birds with satellite transmitters (blue). (B) Possible migratory network based on breeding and moulting sites (green dots), staging areas during migration (brown dots) and wintering sites (blue dots). The red line is the 0° winter isotherm.
(A) Utbredningen av alla fjällgåsfynd från denna studie (röda punkter) kombinerade med registreringar från satellitförsedda gäss (blå punkter). (B) Möjligt nätverk för flyttvägarna mellan häck- och ruggplatser (gröna cirklar), rastplatser under flyttningen (bruna cirklar) och övervintringsplatser (blå cirklar). Den röda linjen visar isotermen för noll grader under vintern.

almost certainly the species must have wintered in the country in considerable numbers in that period (Handrinos & Goutner 1990). In Hungary the situation was not much different (Sterbetz 1968).

In Naumann (1842) and Stresemann (1961), the Lesser White-fronted Goose was described as a rare and in Frieling (1936) and Niethammer (1938) as a "not rare" and regular migrant and winter guest in Germany, while Bauer & Glutz von Blotzheim (1968) stated that it was a regular migrant in the eastern part of the north European lowlands, in some years in large flocks. In spite of the fact that the species seemed to be a rare migrant in most of Germany, the species was recorded in most parts of the country.

From 1945, as Peter Scott started Lesser White-fronted Goose monitoring in Great Britain, until 1980 the species was annually recorded with one to three birds, associated with Greater White-fronted Geese at Slimbridge in Gloucestershire as well as in Bean Goose flocks in Norfolk and Scotland (Davies 1949, Davis & Scott 1946, Smith 1974, Watson 1955). These were "undoubtedly wild birds" (Ogilvie & Wallace 1975).

Although there are hardly any records of larger Lesser White-fronted Goose flocks along the West European/Atlantic migratory route from the 19th and the first half of the 20th century this is no proof that such a route never existed. Also from most East European staging areas such historical information is lacking. On the contrary, the data of this study show that there are a comparably high number of records from western Europe from this period, which indicate that in former times a migratory route to western Europe very well could have existed. That small numbers still follow this route is indicated by more recent data published by De Smet 2005, Heinicke & Mooij 2005, Kampe-Persson 2004, 2008, Koffijberg et al. 2005, Mooij & Heinicke 2007, 2008, and Mooij et al. 2008.

Lesser White-fronted Goose as a species

The Lesser White-fronted Goose was described as

a species in the 18th century (Linnæus 1758), but at most wintering sites the species was overlooked until the middle of the 20th century and the migratory routes, staging areas and wintering sites were poorly known. That's why there are hardly any data about the occurrence of the Lesser White-fronted Goose before the 20th century.

Middendorff (1853, 1867) classified the Lesser White-fronted Goose as a "circumboreal tundra bird species" that was more common than the Greater White-fronted Goose along the Taimyr and Boganida rivers. In the middle of the 19th century, Nilsson (1858) reported that two white-fronted goose species occurred in Scandinavia and Schlegel (1877) described the Lesser White-fronted Goose as a subspecies of the Greater White-fronted Goose, but noted that it also could be described as a separate species. Hudson (1895) did not recognise the Lesser White-fronted Goose as a species. Alphéraky (1904) stated that there cannot be any doubt about the fact that the Lesser White-fronted Goose is a separate species, but that the delineation of the species' flyways is difficult, because it is not separated from the Greater White-fronted geese at most sites by hunters and ornithologists. But Witherby et al. (1939) states "Further research may show that the breeding-ranges of this bird and the White-fronted Goose do not overlap, in which case they may perhaps be treated as forms of one species." This statement was still included in the 5th edition of the "Handbook of British Birds" of 1948.

Historical distribution of the Lesser White-fronted Goose in literature

Apart from Alphéraky (1904), the distribution of the Lesser White-fronted Goose has been described by Witherby et al. (1939), Dementiev & Gladkov (1952) and Uspenski (1965). There are only minor differences in their accounts, and they support the findings of this study that Lesser White-fronted Geese migrated to western Europe in those days. More recent studies estimated the number of Lesser White-fronted Geese currently migrating through and/or wintering in Germany to be at least 50 birds annually (Mooij 1995, Mooij & Heinicke 2008), which indicates that this flyway is not irrelevant.

Largely based on observations from Finland and northern Sweden from the period between 1900 and 1980 and Finnish literature data (Hortling 1929a, b, Merikallio 1915, 1920, Munsterhjelm 1911, 1913, Sandman 1892), Norderhaug & Norderhaug (1982, 1984) suggested a migratory route over Finland, which has been quoted in more recent literature (Lorentsen et al. 1999). It was based on poor information and suffered from a large gap of records from staging sites along the Central European flyway. Besides, they did not take into consideration the possibility of a small proportion of Lesser White-fronted Geese migrating along a westerly route as indicated in older literature, e.g. Alphéraky (1904), Niethammer (1938), Rosenius (1937), Schlegel (1877), Witherby et al. (1939).

Migratory network in Europe

The wintering sites of the western Palaearctic Lesser White-fronted Geese are situated at the positive side of the 0°C isotherm for January (Figure 8). According to Nankinov (1992 & 1994) there are six main migratory routes in Europe and Western Siberia. Two of them lead the geese to western Europe, one from northern Siberia along the arctic coast and the southern coast of the Baltic Sea and the other from northern Fennoscandia along the east coast of Sweden. Five of these routes were also found in this study, whereas the sixth route of Nankinov, which followed the Volga, Kama and Pechora valleys in north-south direction, was not found. But the records instead indicated a new migratory route over the Pripyat and Oka Valleys in a west-east direction (Figure 8B). The existence of a West European migratory route is also indicated by the record of a Lesser White-fronted Goose ringed in Swedish Lapland in June 1956 and shot in southwestern France in November 1959 (Dubois et al. 2000, Fransson & Petterson 2001).

In the past decade a number of Lesser White-fronted Geese were marked with satellite transmitters in northernmost Fennoscandia, the Polar Ural and the Puturana Mountains (Aarvak & Øien 2003, Lorentsen et al. 1998, Morozov & Aarvak 2004, www.piskulka.net). The records of these birds showed migratory routes through western Siberia as well as along the Russian and Baltic coast and through East Europe to Greece and Iraq. These data were combined with the records of this study (Figure 8A).

In most West European countries Lesser White-fronted geese were found associated with Taiga Bean Geese *Anser fabalis fabalis* and Russian Greater White-fronted Geese (Davies 1949, Davis & Scott 1946, Kampe-Persson 2007, Mooij & Heinicke 2007, 2008, Mooij et al. 2008, Watson 1955, Smith 1974), which indicate that these birds originated from Fennoscandia as well as from Russia.

Data from the western migratory route gathered by Kampe-Persson (2008), combined with the results of this study, indicate that Lesser White-fronted Geese of Jämtland and southern Lapland seem to have migrated over Sweden to western Europe, whereas the breeding birds of northern Lapland and Finmark most likely mainly migrated over Finland and Hungary to eastern Europe (Kampe-Persson 2008, Mooij et al. 2008). Most of the breeding birds of the western part of arctic Russia seem to migrate to Europe along the coast of the White and Baltic Seas (Aarvak & Øien 2003, Lorentzen et al. 1998), whereas most of the eastern Russian and western Siberian breeding birds mainly migrate along the western Siberian plain to northern Kazakhstan and subsequently to the wintering sites in the Black Sea–Caspian Sea region (Morozov & Aarvak 2004).

As a result of this migratory network in most staging and wintering areas there is a mixture of birds from different breeding areas and new pair bonds can be formed between birds from different breeding sites, and males follow their female to her native breeding site. This mechanism, ensuring genetic exchange between different breeding populations and preventing the development of genetic subunits, was genetically confirmed by Ruokonen et al. 2004.

The drastic decline of the Fennoscandian breeding population, starting in the southern part of the breeding area and subsequently spreading to the north resulted in a decline of the number of Lesser White-fronted Geese using the West European/Atlantic migratory route. As a result Lesser White-fronted Geese observed in western Europe in the past decades most likely mainly belonged to the Russian breeding population.

Besides birds of wild origin, birds of the Swedish Lesser White-fronted Goose reinforcement project winter in western Europe, especially in the Netherlands since the beginning of the 1980s. These birds reach their wintering sites by a rather narrow migratory corridor from Sweden crossing the German Wadden Sea coast to the Netherlands (Mooij & Heinicke 2007, 2008). During the past decade the birds of this increasing population started spreading and most likely started to mix up with the birds of wild origin, i.e. both populations will be increasingly integrated in the coming years.

Historical population level and development

The first estimate of the population size of the Lesser White-fronted Goose was made by Uspenski (1965), who estimated the world population to be at least 100,000 birds in the 1950s. This estimate must have been considerably too low because this study indicates a population level only in the Western Palearctic to have decreased from c. 200,000 in the early 20th century to c. 100,000 in the 1970s and currently less than 10,000 birds. But maybe this decline was even bigger. According to Bauer & Glutz von Blotzheim (1968), Buisman & Van Oort (1939), Deutsche Jäger-Zeitung 1916, Flint & Krivenko (1990), Grimpe (1933), Krivenko (1996), Lebret (1952), Niethammer (1938), Ringleben (1957), Schlegel (1877) and Van Oort (1937) waterbird numbers in Europe have declined considerably since the middle of the 19th century, so the decrease of Lesser White-fronted Goose numbers could have started already in the 19th century. In consideration of the estimates of Flint & Krivenko (1990) and Krivenko (1996), who stated that the present waterbird populations on the territory of the former USSR only reach about one third of the level of the 1850s and that the populations of the forest-tundra/tundra even decreased faster and reached one third of the 1850-level already in the 1960s/1970s, it does not seem unrealistic that the Lesser White-fronted Goose population may have reached a level of 250,000–350,000 individuals in the middle of the 19th century.

Hunting

Based on conservative estimates of the annual goose bags of several goose species in the Western Palearctic it seems that in spite of the fact that nowadays the species is a non-quarry species in its complete living range, more than 2400 Lesser White-fronted Geese (i.e. 20–25% of the population) are shot each year (Mooij 2005). Yerokhow et al. 2008 estimated the annual Lesser White-fronted Goose bag for northern Kazakhstan to be about 2500 individuals, which means that the total bag in western Palearctic must be considerably higher than 2400. With a population size of 8000–13,000 individuals, annual loss due to hunting is at least 20–30% of the population. On top of this an annual natural mortality of at least 5% has to be added, which brings annual mortality to at least 25–35%. The most alarming aspect is that these birds are shot by accident during regular goose hunting of other species, especially because they cannot easily be distinguished from the look-alike Greater White-fronted Goose (Yerokhow et al. 2008, Yerokhow, pers.com.).

Small Lesser White-fronted Goose flocks tend

to associate with other goose species. As a result of the declining population this social behaviour will be strengthened in the future. The only effective protection measure would therefore be to ban all goose hunting or at least Greater White-fronted Goose hunting from all Lesser White-fronted Goose sites (Kruckenberg & Mooij 2007, Tolvanen et al. 2009).

Conclusions and consequences for the protection of the species

Based on the results of this study it can be concluded that

1. in the 19th century the Lesser White-fronted Goose bred in the Eurasian shrub tundra from Fennoscandia to Chukotka and migrated in winter to areas south of the zero degree isotherm from Spain and Great Britain in the west to China and Japan in the East.
2. the world population of the Lesser White-fronted Goose was probably considerably higher than 100,000 birds in the 1950s.
3. the decline of the Lesser White-fronted Goose population probably started already at the middle of the 19th century.
4. there is a considerable number of data, which indicate that Lesser White-fronted Geese not only migrated over western Siberia and eastern Europe, but also over western Europe, but it is not possible to decide, which migratory route has been the most important one.
5. in spite of all protection measures hunting is still one of the major threats of the long-term survival of the Lesser White-fronted Goose, which only can be brought to an end if (Greater White-fronted) goose hunting is banned from all staging areas of the species.

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Sammanfattning

Denna uppsats är en översikt av den historiska dokumentationen av fjällgåsens förekomst i Europa. Den baserar sig främst på litteraturuppgifter men delvis även på personlig information. Målet är särskilt att kartlägga artens flyttstråk. Eftersom utsläpp av i fångenskap uppfödda fjällgäss började i Sverige 1981, och dessa inte kan skiljas från individer från det ursprungliga vilda beståndet, har jag begränsat analysen till att omfatta rapporter fram till 1982.

Efter att ha sorterat bort dubbelrapportering av samma individer har jag accepterat 986 rapporter för analysen. Antalet individer per rapport ökade fram till 1920-talet men har därefter vatit i huvudsak stabilt (Tabell 1). Ett undantag är 1970-talet, då antalet var högre på grund av ett specialprojekt i Ungern. De flesta rapporter avser få individer och rapporter om fler än hundra finns bara från det svenska häckningsområdet (1910–1940-talen) och från Evros delta i Grekland (1960–1970-talen).

Antalet rapporter ökade under 1930-talet, minskade under kriget för att därefter åter öka trots den drastiska beståndsnedgången, något som illustrerar det ökande intresset för fjällgåsen (Figur 1). I samma figur visas fördelningen av observationerna från häcknings- och ruggningsområden, rastområden och övervintringsområden. Under alla perioderna dominerar rapporter från rastområden längs flyttstråken.

Rapporternas geografiska fördelning visas i Figurerna 2–3. Från före 1900 var fynden få, främst exemplar i museisamlingar, totalt 28, spridda på många länder men med flest (12 st.) i Tyskland.

Säsongsfördelningen av fynden framgår av kartorna i Figur 4–7. Sommarfynden utanför häcknings- och ruggningsområdet avser troligen fåglar som stannat på grund av skadeskjutning eller yngre fåglar som ännu inte börjat häcka (Bottenkusten). Höstfynden är spridda längs flyttvägarna över en stor del av Europa och västra Sibirien. Vinterfynden ligger klart längre söderut och övervintringsområdet når ända till Medelhavsländerna. Övervintringen sker huvudsakligen på plussidan av vinterns nollgradersisoterm (Figur 8b). Vårfynden visar åter en koncentration norrut.

Den tidiga historiska utvecklingen av fjällgåsbeståndet är svår att klarlägga eftersom rapporterna är få från 1700- och 1800-talen. Dessutom var fjällgåsens status som art förr oklar och man skilde ofta inte på fjällgås och bläsgås. De uppgifter som finns kann dock tolkas så att det inte är orealistiskt att tro att det fanns omkring 200.000 fjällgäss i västra Paläarktis under första halvan av 1900-talet. Detta bestånd hade sannolikt halverats fram till 1970-talet. Därefter har nedgången fortsatt till 15.000 fåglar 1990 och 10.000 år 2000.

Jakten är omfattande. Tabell 2 visar andelen fjällgäss i den totala gåsjakten för olika länder. Trots att fjällgåsen länge varit fridlyst på de flesta håll skjuts i dag årligen ungefär 2400 individer. Detta beror på att man sällan hinner skilja fjällgäss från andra gäss, särskilt bläsgås, i jaktsituationen.

Vad gäller flyttvägarna visar den historiska fyndbilden (alla fynd samlade i Figur 8a) på ett antal olika flyttvägar (Figur 8b). Bland annat torde det stå helt klart att icke obetydliga antal flyttade till Västeuropa. Vad gäller Skandinavien verkar det som om fjällgäss från Jämtland och södra Lappland flyttade till Västeuropa medan de från norra Lappland och Finnmark flyttade via Finland till Sydosteuropa. De flesta av flyttsråken har varit desamma under historiens gång. Bara något enstaka har försvunnit eller tillkommit.

Uppskattningen att det årligen skjuts 2400 fjällgäss innebär att jakten tar 20–25% av beståndet. Detta är dock ett minimum eftersom en omfattande jakt i Kasakstan inte ingår i värdet. Det mest alarmerande är att fridlysning inte fungerar eftersom det i praktiken inte går att skilja ut fjällgässen under jakten. Det enda som skulle fungera är totalförbud för gåsjakt, eller åtminstone totalförbud för bläsgåsjakt, i alla områden där fjällgäss vistas.

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The Swedish population of Lesser White-fronted Goose *Anser erythropus* – supplemented or re-introduced?

Det svenska beståndet av fjällgås Anser erythropus – *förstärkt eller återinplanterat?*

ÅKE ANDERSSON & NIKLAS HOLMQVIST

Abstract

We have investigated historical records of observations of Lesser White-fronted Goose *Anser erythropus* of the original Fennoscandian population in the area in Sweden where captive-reared goslings of the same species were released during 1981–1999. The release project has earlier been regarded as a re-introduction project. The data in this review include reports from many sources and we can present earlier unpublished observations from the area. The large number of observations of birds from the Fennoscandian population proves that the release of goslings in the actual area was a supplementation of a small but extant population and not a re-introduction.

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Introduction

From the 1950s to the 1990s the breeding population of Lesser White-fronted Goose *Anser erythropus* in Sweden decreased from some thousand pairs to about 10 pairs in 1990 (von Essen 1999). During the following decade the decline continued. The trend was similar in Norway, Finland and western Russia (Kear 2005, Jones at al. 2008) with a significant and continuous decrease. The species is probably extinct in Finland today.

In the late 1970s, Lambart von Essen at the Swedish Association for Hunting and Wildlife Management started to prepare a release programme. During the period 1981–1999, 348 geese were released in a traditional breeding area of the species in Swedish Lapland (Andersson & Larsson 2006). No captive-reared geese have been released after 1999.

The release activities have been labelled re-introduction in earlier works (see for example von Essen 1996, 1999) and this opinion and terminology has survived in later reports (Andersson & Larsson 2006). In this review we analyse and evaluate the available information from the period just before and after the start of the release, in order to elucidate whether or not birds from the original population occurred in the area.

Materials and methods

We have compiled historical data including records found in archives as well as results from interviews. The Swedish Ornithological Society has collected avifaunistic information on a national basis since 1975 and published it in a yearly report (e.g. Risberg 1976). The archive emanating from Lambart von Essen includes correspondence and notes from interviews with ornithologists as well as people inhabiting in the mountain area. A special effort was made by Per Hansson (2006) who listed all known observations of the species in Västerbotten county. A similar compilation of published data was done by Rolf Gustafsson for Norrbotten county. The information from these two works is available in the data base of the Species Information Center (www.artportalen.se/birds/), except records in the breeding area, which are excluded because of security reasons.

In this review we focus primarily on findings made within a 50 km radius from the places where the releases took place. From this area we only accepted observations where the status of the birds could be determined (released birds or birds of Fennoscandian origin). All findings before summer 1981, adult birds before spring 1982, breeding birds before 1983 and un-ringed breeding birds

Table 1. Observations of Lesser White-fronted Geese 1975–1984 within or close to the breeding areas in Lycksele and Pite lappmark in Swedish Lapland under circumstances where presence of released birds can be excluded. Under Reference we list the original source. Svalan I (Sv I) is the database where sensitive observations are omitted, while Svalan II (Sv II) includes classified data. Nr refers to the position of the observation on the map (Figure 1).
Observationer av fjällgäss 1975–1984 inom eller nära häckningsområden i Lycksele och Pite lappmarker under omständigheter då förekomst av utsläppta fåglar kan uteslutas. Under Reference listas ursprungskällan. Svalan I (Sv I) är databasen utan och Svalan II (Sv II) med sekretessklassade observationer. Nr anger plats för observationen på kartan i Figur 1.

Nr	Date	Observation	Within *Inom* 0–30 km	Within *Inom* 31–50 km	Reference
1	1975-06-18–21	1 pair	Båssjosjaure, Tjålmejaure		H. Berglund, LvE arch., Sv II
2	1976-05-29	2	Delta in Ammarnäs		V. Olsson, Sv I
3	1976-07-25–31	2 ad + 2 imm	Giertos, Tjålmejaure		H. Berglund, LvE arch., Sv II
4	1976-07-30	2 ad + 4 pull	Giertos, Tjålmejaure		H. Berglund, LvE arch., Sv II
5	1978-06-30	Breeding record	Vaggejukke, Svaipa		L. von Essen, LvE arch., Sv II
6	1978-07-17	Heard	Västra Tjålmejaure		P. Oppentocht, LvE arch., Sv II
7	1978-07-26	2 ad	Västra Tjålmejaure		P. Oppentocht, LvE arch., Sv II
8	1978	A few pairs left	Björkfjället		E. Norén, Sv II
9	1978	A few pairs left		Tjahthsavaggie, Birdejaure	E. Norén, Sv II
10	1978	A few pairs left		Buorguokjávrrie, Biellojaure	E. Norén, Sv II
11	1979 breeding season	1 pair	Suolojaure		P.-H. Lango, LvE notebook 8
12	1979-07-05	1 ad + 4 pull	S Vielparnjarga		P. Oppentocht, LvE arch., Sv II
13	1979-07-12	3 ad	Vielparnjarga		P. Oppentocht, LvE arch., Sv II
14	1980-05/06	2	Delta in Yraft, Laisälven		W. Thorfe, LvE arch., Sv I
15	1980 breeding season	1	Suolojaure		P.-H. Lango, LvE notebook 8
16	1980-06-11	1	Svaipa		LvE arch.
17	1980-06-23	5	Båssjosjaure, Tjålmejaure		R. Nordin, Sv I
18	1980-08-27	13 ad	Luspasjaure		E. Norén, Västerbotten County adm arch.
19	1981-06-23	6 ad	SW Luspasjaure		L. Strömgren, Report to ÅA
20	1981-08-09	1 pair + 5 im	Luspasjaure		P. Klaesson, LvE arch., Sv. II
21	1982-05-29–06-11	Up to 10 ad	Delta in Ammarnäs		L. Gustafsson, Sv I
22	1982-06-26	10 ad	Tjålmejaure		P. Svensson, LvE arch., Sv II
23	1984-07-10	2 ad + 2 pull	W Vielparnjarga		P. Oppentocht, LvE arch., Sv II

before 1985 were categorized as birds of Fennoscandian origin (Table 1, Figure 1). Observations reported from areas situated 50–100 km from the release area are shown in Table 2.

The first release of young Lesser White-fronted Geese took place in July 1981 (11 goslings). Theoretically, these birds could breed already in 1983 and their possible descendents in 1985. Even though it is rare that the species breeds successfully at the age of two years (Owen 1980, del Hoja et al. 1992, Kear 2005), we consider 1983 as the first year for possible breeding of released (colour-ringed) geese, and 1985 in the case of their offspring, in order to prevent any misinterpretation of the data given in the archives. Releases were made almost annually in 1981–1999, all with colour-ring marked birds.

Results

In total, 23 records of birds from the original population at, or close to, breeding habitat within a distance of 50 km from the release localities were found (Figure 1 and Table 1). From a larger area (51–100 km from the release sites, Table 2) there are reports verifying breeding of the species

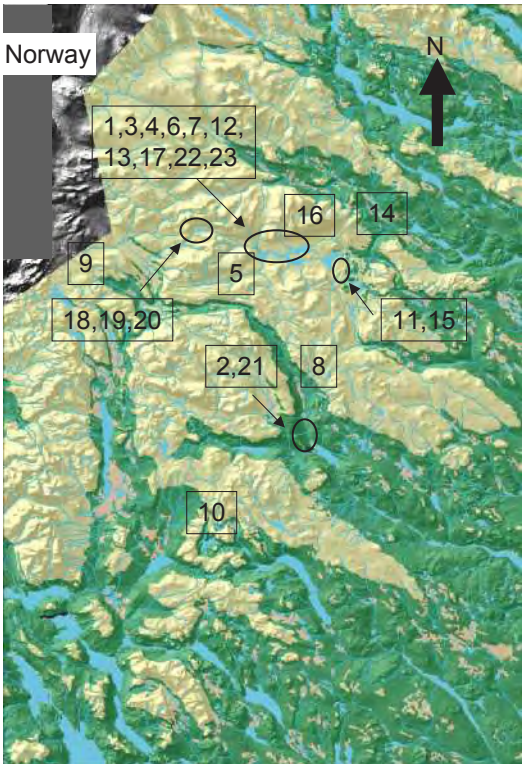

Figure 1. Map showing position of observations of Lesser White-fronted Goose (n=23) in or close to the area where captive-bred geese where released during the years 1981–1999. All observations included were made between the years 1975 and 1984 and only include birds from the original Fennoscandian population. The numbers refers to position number (Nr) in Table 1.
Karta över fjällgåsobservationer (n=23) i eller nära området där fåglar uppfödda i fångenskap släpptes ut åren 1981–1999. Alla medtagna observationer gjordes åren 1975–1984 och omfattar endast fåglar från den ursprungliga fennoskandiska populationen. Siffrorna hänvisar till numreringen i Tabell 1.

at some localities until 1988 or 1991 and observations of adults until 1998. Considering the historical records of occurrence in these areas and the site fidelity of released geese, it is most likely that the main part of these observations consists of geese from the original Fennoscandian population.

Discussion

The presented data show that a small breeding population consisting of birds from the original Fennoscandian population of Lesser White-fronted geese was still present when the release of captive-reared gooslings started in 1981. Individual birds from this indigenous population living in the western part of the release area survived at least until 1984, but probably even longer considering the longevity of Lesser White-fronted Geese. For example, Piet Oppentocht (in litt.) who visited the western part in 1978–1988, recorded the species or its excrements also in 1985 (including observation of one un-ringed adult, three adults and one observation of a downy young without adults). In 1986 and 1987 geese were heard calling and excrements found. In 1988 (the last visit) one single downy young was seen without parents. Therefore, it is likely that Lesser White-fronted Geese continued to breed at this site. However, we do not include these data since we can not exclude that these birds could be descendants of released individuals.

With exception of the western parts of the release area there are few observations recorded in the archives. Hence, we cannot be sure that birds of the original population were still breeding in the whole area when releases commenced in 1981. From the eastern part there are very few known records. A nest was reported in 1983, but we cannot rule out that it was wrongly identified or a result of breeding of released birds and therefore we exclude this record.

As shown in Table 2, at longer distances (51–100 km) from the release area, there are reports that could indicate even longer presence of birds of Fennoscandian origin after the releases started. Table 2 also includes observations of birds in or near suitable breeding grounds from adjacent areas in Norway (Øien & Aarvak 1993, Gjershaug et al 1994). But the origin of these birds cannot be determined due to the possible presence of un-ringed descendants of released birds. However, these findings give further support to the overall picture of a scarce but widespread breeding population in the mountain area used for release of captive-reared goslings.

Besides observations in the breeding areas there are also reports showing that the migration route along the Skellefte River was still used by Lesser White-fronted Geese during the 1970s and the early 1980s (Hansson 2006). Flocks were seen during spring 1976 and 1981 (in both cases with adults as well as 2K subadults) along this migration route leading to the mountain area where the releases started in 1981.

We conclude that the release of captive-reared Lesser White-fronted Geese started at a time when breeding birds of Fennoscandian origin still inhabited the area. Thus, according to the IUCN guide-

Table 2. Observations of Lesser White-fronted Geese during 1985–1998 at a distance of 50-100km from the area used for release of captive bred goslings. Only observations close to or within suitable or known breeding areas are included. All released captive-reared birds were marked with colour rings, but their offspring lack rings.
Observationer av fjällgäss under perioden 1985–1998 som gjorts på ett avstånd av 50-100 km från området som användes för utsättning av unga fjällgäss. Alla observationer är gjorda inom eller nära kända eller lämpliga häckningsplatser. Samtliga fjällgäss som var uppfödda i fångenskap och släpptes ut bar färgringar, men deras avkommor saknar ringar.

Date	Observation	Locality	Distance	Reference
1988-07-01	Un-ringed pair with 3 goslings *Omärkt par med tre ungar*	Södra Storfjället, northern part	85 km	P. Risberg, LvE arch.
1989-06-27	4 adult (≥ 3 without rings) two consecutive days *4 ad två efterföljande dagar*	Södra Storfjället, northern part	85 km	P. Risberg, LvE arch.
1994-06-24	Feathers *Fjädrar*	Södra Storfjället, northern part	85 km	L. von Essen, LvE arch.
1997-07-06	2 ex	Södra Storfjället, northern part	85 km	Molin, LvE arch.
1998-05-16+18	5 ex	Krutvattnet, Ström	100 km	U. Åkesson, Sv I
1998-05-27	3 ex	Krutvattnet, Ström	100 km	U. Åkesson, Sv I
1986-06-20	3 ex	Ältsvattnet	50 km	B. Liehr, LvE arch., Sv II
1986-08-11	> 1 heard hörd	Gingeljaure, W Övre Ältsvattnet	50 km	E. Norén, Västerbotten county adm. arch.
1988-07-16	Suspected brood *Misstänkt kull*	Ältsvattnet	50 km	L. von Essen, LvE arch.
1985–1992	Suspected and proofed breeding until 1991 (1992) *Misstänkt och säkerställd häckning till 1991 (2992)*	Norway: Grane, Hattfjelldal and Rana communities	50–100 km	Øien, I. J. & T. Aarvak 1993 Gjershaug, J. O. et al. 1994

lines and terminology (IUCN 1998) the releases should not be labelled as a re-introduction but instead fulfil the criteria for population "re-inforcement" or "supplementation".

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Sammanfattning

I denna artikel redovisas fynd av fjällgäss, de flesta tidigare opublicerade, från den ursprungliga, fennoskandiska, populationen i Sverige mellan åren 1975 och 1984. Observationerna är gjorda i eller nära det område som användes för utsättningar av uppfödda fjällgåsungar inom Projekt Fjällgås under åren 1981–1999. Vi kan redovisa 21 fynd inom en radie av 30 km från utsättningsområdet och ytterligare två inom 31–50 kms radie, där vi kunnat utesluta att det rör sig om fåglar som härstammar från projektet (Tabell 1 och Figur 1). I Tabell 2 redovisas även 10 fynd av fjällgäss på kända eller lämpliga häckningsplaster mellan åren 1985–1998 dvs. efter det att utsättningar av fjällgäss startat. Men beroende på avståndet till området där utsättningar gjordes och andra faktorer, t.ex. att de vuxna fåglarna var omärkta, så bedöms även flertalet av dessa observationer gälla fåglar från den ursprungliga fennoskandiska populationen. Sammanställningen av dessa fynd visar att det häckade fjällgäss av den ursprungliga fennoskandiska populationen i området som användes för utsättningarna av fjällgäss i Projekt Fjällgås när dessa startade 1981 och att det fortsatte att häcka fåglar från denna population i området efter det att utsättningarna startade. Utsättningen av uppfödda fjällgäss inom Projekt Fjällgås har tidigare setts som ett reintroduktionsprojekt. Fynden som presenteras i denna artikel visar att utsättningarna istället är att betrakta som en förstärkning av ett befintligt bestånd enligt IUCNs kriterier för artbevarandeprojekt.

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Dutch Greylag Geese *Anser anser*: migrants or residents?

Grågåsen Anser anser *i Holland: flytt- eller stannfågel?*

BEREND VOSLAMBER, ELISE KNECHT & DAVID KLEIJN

Abstract

During the last twenty years more than 2500 Greylag Geese have been neck-banded at different moulting places in the Netherlands. Almost all birds have been re-sighted at least once. We used the 45,000 re-sightings that had been reported during the winter months October through February 1994–2010 in order to determine the migratory movements. We assume that the moulting site is about the same as the breeding site. Geese banded in west, central and south Netherlands wintered on average within 10 km from the breeding site. Geese from the northern part showed a much larger average distance, this was mainly due to a large proportion of them wintering in Spain. However, this habit changed during the course of the study, and in recent years only a small proportion wintered in Spain. We estimate that currently over ninety percent of the Dutch Greylag Geese are resident and winter close to their breeding site.

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Introduction

In the first half of the 20th century the Greylag Goose was a migratory species which bred in Scandinavia and wintered in Spain. Since the 1970s the Greylag Goose population is rapidly expanding in size and range due to reduced hunting pressure and improved foraging conditions on heavily fertilized agricultural grasslands (van Eerden et al. 1996, Madsen et al. 1999). In recent decades, climate change resulted in significant increases in winter temperatures (Kleijn et al. in press). At the same time there are indications that the Greylag Goose population is changing its migratory behavior. For example, almost 50,000 Greylag Geese now winter in southern Sweden, a region where wintering was rare until the early 1990s (Nilsson 2009).

In the Netherlands the Greylag goose is a native species that went extinct in the beginning of the twentieth century. After a number of unsuccessful attempts to reintroduce the species it bred for the first time in 1961 (van den Bergh 1991). Between 1961 and 2009 the Dutch population grew with an average of 20% per year and now consists of approximately 190,000 individuals. From 1990 onward the number of ringed and especially neck-banded Greylag Geese has increased in the Netherlands (Buijs & Thomson 2001). Despite the increased ringing and neck-banding efforts, little information is available about the migration patterns of Greylag Geese breeding in the Netherlands (Speek & Speek 1984, Loonen & de Vries 1995). On the contrary a lot of information has been published about birds from populations that use the Netherlands for staging in spring and autumn but not for breeding (Nordic Greylag Goose Working Group 1988, Nilsson 1990, Voslamber et al. 1993, Voslamber 1993, Andersson et al. 2001).

In this paper we briefly describe the Greylag Goose neck-banding programme in the Netherlands. We subsequently use the resightings from this neck-banding scheme between 1990 and 2010 to examine the migratory behaviour of the Dutch Greylag Goose population. We ask whether the migratory behaviour of Greylag Geese has changed over time and whether there are differences between geese from different regions or different sexes.

Table 1. Number of birds colour-ringed per region 1990–2009, total number of observations per region (N) and average number of observations per individual bird (Mean). See Figure 1 for distribution of ringing sites over the Netherlands.
Antal färgmärkta fåglar per region 1990–2009, totalt antal observationer per region (N) och medeltal observationer per individuell gås (Mean). Se Figur 1 för märkplatsernas läge i Nederländerna.

	Numbers colour-ringed *Antal färgmärkta*					N	Mean
	1990–1994	1995–1999	2000–2004	2005–2009	Total		
North	89	25	0	281	395	5221	13,2
Mid	0	109	230	508	847	80858	95,5
West	126	88	0	648	862	10219	11,9
South	0	0	143	266	409	5121	12,5
Total	215	222	373	1703	2513	101419	

Material and methods

Catching and marking

Between 1990 and 2010 over 2500 Greylag Geese have been individually marked with neckbands (Table 1, Figure 1). Greylag Geese were generally caught during their moulting period which, in the Netherlands, is mainly in June (end of May through half July). In most of the areas only adults with young were caught, but in 2008 and 2009 a number of large groups of non-breeding Greylag Geese were caught in some of the areas. The birds were driven to walk or swim in the direction of a funnel-shaped net ending in a corral (e.g. Persson 1994).

The 4.8 cm diameter and 4.5 cm high neck collars used for Greylag Geese in the Netherlands are dark green with white unique inscriptions. Under good light conditions, codes can be read from a distance of up to 500–600 meters. In addition to neck collars, all birds received a metal ring from the Dutch Centre for Avian Migration and Demography on one of their tarsus. From 1999 onwards most birds were also ringed with a coloured leg ring with the same code as the neckband. By ringing the birds in three ways (neckband, colour leg ring, metal ring) we were able to see if there is loss of bands.

Resightings

Until January 2010 over 100,000 observations of neck-banded Greylag Geese have been reported.

Information about the Greylag Geese neck-banding project has been published in several local papers. Observers who reported sightings received a list with the other sightings of 'their' birds. Observations initially came via regular mail or email. Recently, observations can be reported through the website www.geese.org (in Dutch, English and German). After the creation of this website a lot of observations, also from the past were entered by the observers through google-maps. The website is considered to be motivating to volunteers because they can check online where the bird they have observed has been ringed and which other observations of the same bird have been made.

Mis-identification of neck collars does occur due

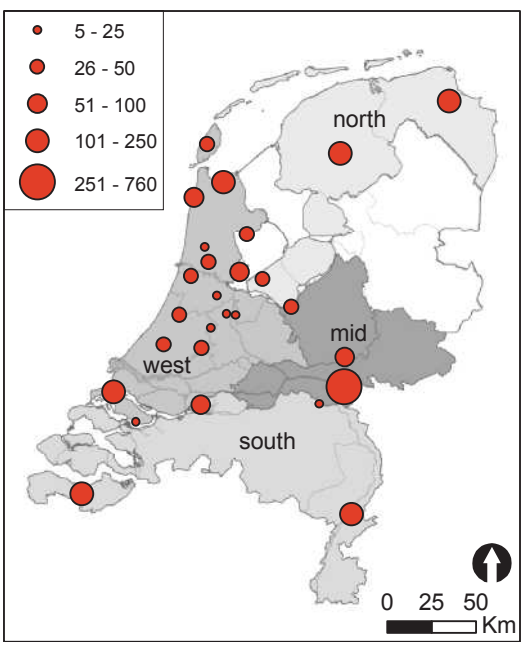

Figure 1. Distribution of ringing sites in different regions of the Netherlands 1990–2010. Point size indicates number of ringed birds.
Märkplatsernas läge inom olika regioner i Nederländerna 1990–2010. Punktens storlek anger antal märkta fåglar.

to distance to the birds or to weather conditions. Mis-readings in the areas with a lot of sightings do not affect the results, but mis-readings outside the main areas do have an effect on results. We deleted all obvious mis-readings and incomplete readings from the data-base. Besides that we tried to check all observations on possible mis-identification and if possible changed them.

Analyses

To analyse the migration patterns and to examine whether they had changed between 1994 and 2010, we selected all observations done during the winter months (October, November, December, January, February) between 1 January 1994 and 1 January 2010. Very few resightings were available from 1990–1993, therefore they were omitted from the analyses. This selection resulted in about 45.000 records for each of which we calculated the Euclidian distance between the ringing site and the observation site. To check whether birds from different parts of the Netherlands displayed different migration patterns we subdivided the Netherlands in four regions (Figure 1).

As geese were generally caught during moulting and geese may moult in areas at considerable distance from their breeding area, we also selected resightings of geese which were known to be older than 4 years and that had been observed in an area during the breeding period (1 March–15 April). We assumed that the areas in which these birds were observed during that period of the year were their actual breeding areas. The results of the analyses in this smaller subset of resightings were similar to the one using the ringing site. In the remainder of the paper we will therefore only present results relating ringing site to resightings in the winter period.

The resighting rate was much higher in the Ooijpolder area, due to higher resighting numbers by the first author, than in any other area in the Netherlands. This could have biased the estimated dispersal distance because in this area observer effort near the ringing site was much larger than far from the ringing site. To account for this, we used a random selection of 10.000 observations from the Ooijpolder area in the statistical analyses.

As resightings of individual geese are not independent we used Generalized Linear Mixed Models with a normal distribution and a logarithmic link function to analyze the data. Distance between ringing site and resighting was the dependent variable and "year of observation", "month of observation", "ringing region" and "sex" were explanatory fixed variables. Goose identity entered the model as a random variable. Wald tests were used to examine the significance of variables. The same was done with selected data after 2000 instead of after 1994, because the number of observations over the years 2000–2010 was more constant. Since 2000 there is also a more constant average distance between ringing and wintering site. We wanted to see if the influence of the factors region, month, year and sex was the same for this period than for the whole period.

Most birds winter close to their breeding site, so we wanted to know whether there are differences between years/sex/region. From the birds with a long distance dispersal pattern, we were interested in what they have in common. The graphs and tables produced to analyse this part of the study were done using Pivot table and extracting the data needed.

All analyses were carried out using the statistical software Genstat (Payne et al. 2002).

Results

Resightings

Almost all marked birds (>99%) were seen at least once after ringing. The frequency of resighting differed strongly between the different study areas (Table 1). In one of the areas (Ooijpolder, Nijmegen) there is an ongoing detailed study to investigate the breeding performances of Greylag Geese. In this area the first author was out in the field at least once a week and most of the birds in this area were observed regularly. In the period 1997 to 2009 over 80.000 observations were collected of the 600 birds that had been ringed in this area (average number of observations per individual: 130, range 0 to 1656).

In the other study areas the frequency of observation was much lower and depended on the number of observers and their enthusiasm to go out in the field as often as possible. Of the approximately 1700 birds ringed in these areas about 20.500 observations have been collected (average 12 per individual, range from 0 to 230). Nevertheless, also in these areas hundreds of observations were collected which allowed us to determine (differences in) dispersal patterns reliably (see below).

Factors explaining migration patterns

Winter dispersal distances did not differ between sexes. On average males flew further (34.1 km)

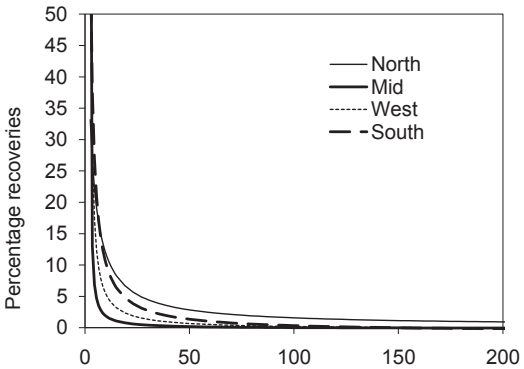

Figure 2. Modelled relation between distances and observations (%) for Dutch Greylag Geese from four regions in winter.
Modell för relationen mellan anvstånd och andel observationer (%) för nederländska grågäss från fyra regioner vintertid.

than females (22.8 km) but the difference was not significant (Wald statistic=2.22, d.f.=2, $p>0.05$).

Birds ringed in different regions in the Netherlands did show significant differences in migration distance (Wald statistic=297.34, d.f.=3, $p<0.001$). Birds from areas in the north travelled a much larger distance (281.9 km) than those from the West (8.9 km), the Centre (2.5 km) or the South (7.9 km). The high average dispersal distance of geese from the northern region is largely caused by 17% of the neck-banded individuals that winter in Spain. All in all 75% of the birds that have been seen in Spain, Italy or France originate from the region North.

Despite the significant regional differences, in all four regions the percentage of birds migrating a certain distance decreased very rapidly with increasing distance to the ringing sites (Figure 2). Even in the northern region only a small proportion of birds

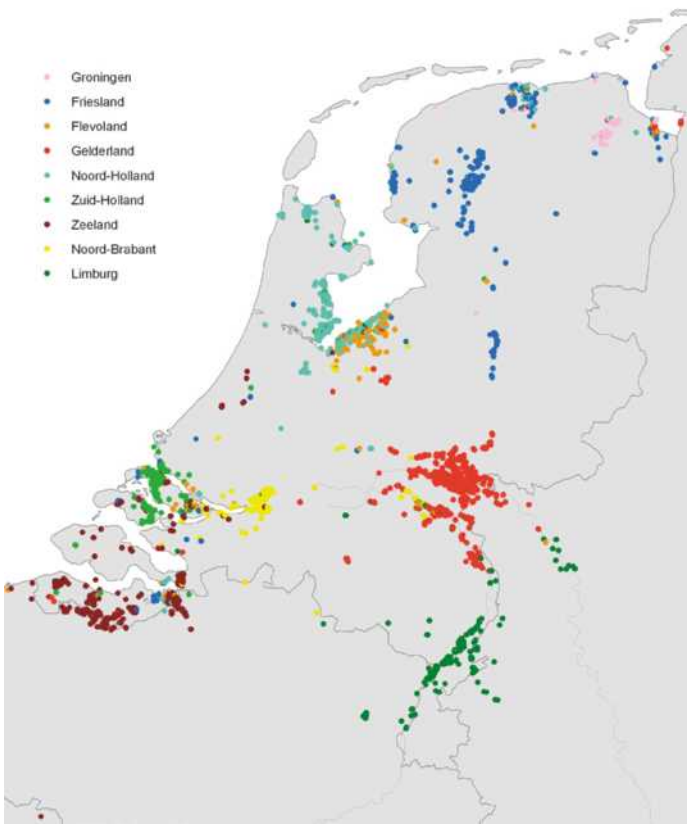

Figure 3. Observations within the country of neck/banded Greylag Geese from different ringing sites in the Netherlands.
Observationer inom landet av halsmärkta grågäss från olika märkplatser i Nederländerna.

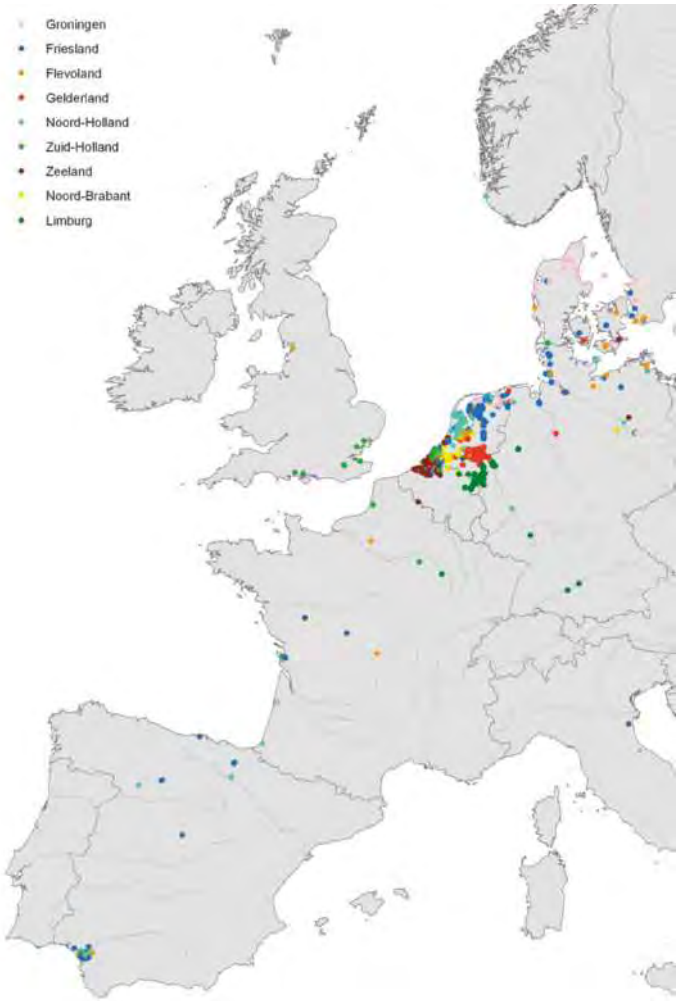

Figure 4. Observations outside the borders of the country of neck/banded Greylag Geese from different ringing sites in the Netherlands.
Observationer utanför landet av halsmärkta grågäss från olika regioner i Nederländerna.

disperse over large distances. Most of the observations of neck-banded geese in the Netherlands (n = 43,692) were done in or close to the different ringing-areas. As a result, all Dutch populations seem to have their own 'home range' (Figure 3). Of course there is some overlap in 'home range area', but this overlap is relatively small. For the birds dispersing outside the Netherlands (n=1376 observations of 89 birds), dispersal distances are very variable. Most of the birds observed outside the Netherlands were from ringing sites close to the border and were spotted in the neighbouring countries Germany and Belgium just on the other side of the border. A small number of birds were reported further away (Figure 4) and only 0.78% of all neck-banded birds had been resighted at distances of over 1000 km from the ringing location. These birds were resighted in Spain, France and Italy and existed of an equal proportion of females (52%) and males (45, sex of 3% of the birds was unknown).

Migration patterns were linked to ringing sites. For example, all but one of the birds migrating to southern Europe came from just three locations that were at least 80 km apart: De Deelen and Oostvaardersplassen in region North and Waterland in region West. In contrast, many birds from the ringing site 'Tetjehorn' in Groningen (which is just 70 km from De Deelen) migrated northward and wintered partly in northern Denmark and southern Sweden.

The average migration distance of neck banded Greylag Geese changed drastically over the course of the last two decades (Figure 5). From 1994 to

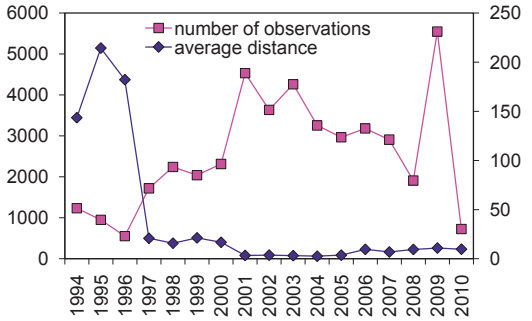

Figure 5. Change in average migration distance of Dutch Greylag Geese in time, 1994–2010. Y-axes: left observations, right kilometers.
Förändring av genomsnittliga flyttdistansen för nederländska grågäss perioden 1994–2010.

1996 a large proportion of birds were wintering in Spain resulting in average dispersal distances of 200–250 km. Nowadays, the data that we have show that most of the birds stay in the surroundings of their breeding area and distances of over 200 km are extremely rare. It must be noted however, that observations from the Oostvaardersplassen, De Deelen and Waterland sites make up a large proportion of the total number of observations before 1996. In Oostvaardersplassen and Waterland no birds were neck-banded after 1998, however, in De Deelen area neck banding was resumed after 2005. Three per cent of the birds that were neck-banded in that area after that year have been observed in Spain.

Discussion

Until recently the Greylag Goose has been seen as a migrating species (Cramp & Simmons 1977), but during the last decades increasing numbers stay all year round on the breeding grounds (Kampe-Persson 2002). Data about the migration of Dutch birds are lacking in the period between the onset of breeding around 1960 and the start of our study in 1990. In Scandinavia however the species dramatically changed its migrating behaviour during the last decades resulting in over 50,000 instead of almost no wintering birds (Nilsson 2009).

We think that nowadays over 90% of the Dutch Greylag Geese are residents. If this also has been the case in the early years after settlement is not clear, but during the first years of our study the number of birds seen in Spain has been much higher than during the last years. The reason for a resident population is not certain, but weather conditions seem a good explanation. Especially during the main period of our study winters were extremely mild according to the IJnsen-index (IJnsen 1991). Recent Dutch winters are much milder than they were in the past (www.knmi.nl). Interesting would be to analyse the influence of severe winter weather such as the one from 2009/2010 with a lot of snow in great parts of Northwest Europe. Where would Greylags go when they obviously cannot find food anymore? Would they go south? Or do they stay in the surrounding of their normal wintering area?

Another explanation could be that the hunting pressure is lower in the Netherlands than in Spain or France, which leads to higher winter survival of adult birds (Nilsson & Persson 1996). Since some years so called foraging areas have been established where hunting is banned. Although hunting pressure outside these areas is still high (80.000 Greylag Geese shot in recent years; Kleijn et al. 2009) birds are save within the foraging areas.

A further explanation for a large proportion of resident birds, often mentioned by people in the field, could be that part of the population has mixed with feral geese, but in which amount this is the case is unclear and thus highly speculative. Future analyses of DNA could maybe give some clarity in this.

Our study shows that both within and between breeding populations there can be large differences in migration patterns. While in the study period most Greylag Geese wintered in the immediate surroundings of the ringing site, some individuals however still fly to southern Europe and others to Scandinavia for wintering. Where do these patterns come from? In theory, in most winters there is no reason to leave the country. In mild and normal winters the food availability seems to be enough to feed all the birds. If there are parts of the country where the birds should leave the breeding areas, these are the northern provinces (Groningen, Friesland) where winter conditions are more severe. It remains strange that part of these birds move northwards to northern Denmark, southern Sweden and southern Norway. Breeding Greylag Geese from these Scandinavian areas are known to migrate southwards to Spain in the past (Andersson et al. 2001).

It is surprising that birds from ringing sites that were in relatively short distance from each other can show completely different migrating strategies. As mentioned birds from ‘Tetjehorn’ migrate north to Scandinavia while birds from ‘De Deelen’ migrate to Spain and the ringing sites are only 70

kilometer apart from each other. Also in other parts of the country we see differences like this. Birds from 'Scheelhoek' and 'Reeuwijk' in the province of Zuid-Holland partly winter in Great Britain while birds from 'De Biesbosch' and 'Zoetermeer' never have been seen so far to the west, although the distance between these ringing sites is only about 50 kilometer. One of the possible reasons for these differences between populations might be a founder effect.

Our results seem to indicate that an increasing proportion of the Dutch Greylag Geese population is overwintering near their breeding locations. However, care should be taken with this conclusion because data of neck-banded geese from breeding populations that disperse over large distances were only available during the first years of the study. Our data show, however, that only populations that were already well-established in the early 1990s had Greylag Geese dispersing over very large distances. If we assume that the breeding populations that were part of this study were selected randomly with respect to their migratory behaviour, our data would indicate that the chance that a random breeding population had geese dispersing over large distances was much higher in the early 1990s than after 2000. This would indirectly support our conclusion that over time the proportion of Greylag Geese that is over wintering in far away places is declining.

In the case of birds flying to Spain there seems to be a recent problem. During the late nineties several birds were reported from Coto Doñana in the southwest of the country. Since 2000 almost no birds are reported from at least that part of Spain anymore. Do our birds not migrate to Spain anymore, are they not reported anymore or is it a ringing effect? The birds flying to Spain almost all came from ringing sites where there is no ringing in recent years. The only exception is De Deelen in the province of Friesland. Maybe not surprisingly: almost all recent sightings of Dutch Greylag Geese in Spain were birds from this ringing area. The idea is that there are still Dutch (and Scandinavian (pers. com. Leif Nilsson)) birds going south, maybe renewed ringing in the areas Oostvaardersplassen en Waterland could give some clarity in this.

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A warm thank you to all volunteers that helped with catching and ringing and resighting the geese. They are too numerous to mention them all, but we do like to mention the die harts notably Hennie van den Brink, Loes van den Bremer, Kell Eradus, Chris van Turnhout and Frank Willems. We also like to mention Maarten J.J.E. Loonen who initiated neckbanding of Greylag Geese in the Netherlands in 1990. The contribution of EK & DK and partly BV was made within the framework of the project "Populatiebeheer overzomerende Grauwe ganzen" (BO-02-013-005).

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http://www.knmi.nl/klimaatscenarios/waarnemingen/monitoring_temperature.php (Figure 3)

Sammanfattning

I början av 1900-talet var grågåsen utrotad i Holland och enbart en genomflyttande art som häckade i Skandinavien och övervintrade i Spanien. Arten etablerade sig sedan åter i landet och under nittonhundratalets senare hälft ökade antalet med i genomsnitt 20% per år och beståndet är i dag ungefär 190.000 individer. Flera studier har publicerats om hur utländska bestånd använder Holland som rastplats utanför häckningstiden. Däremot har det häckande beståndets vintervanor inte studerats närmare. I denna uppsats gör vi detta genom att utnyttja observationerna av halsmärkta grågäss under vintern (oktober–mars) under perioden 1 januari 1994 till 1 januari 2010. Totalt använder vi 45.000 observationer av 2500 halsmärkta gäss (Tabell 1).

Märkningarna skedde på ruggningsplatser (Figur 1) från slutet av maj till början av juli. Även om grågäss kan rugga rätt långt från häckningsplatsen har vi antagit att häckningsplatsen för grågässen i denna studie låg nära ruggningsplatsen. Vi fick stöd för detta antagande genom att separat analysera återfyndsmönstret för individer som vi säkert visste var fyra år eller äldre och som hade observerats under häckningsperioden 1 mars till 15 april. Sådana gäss bör nämligen vara lokala häckfåglar. Vi fann att mönstret för dessa gäss var detsamma som för alla gäss, och vi ansåg därför att vi kunde utnyttja hela materialet för i vår analys.

Över 99% av de märkta fåglarna återsågs minst en gång. I ett särskilt intensivt studerat område (Ooijpolder, Nijmegen; 'mid' in Table 1) var det genomsnittliga antalet observationer av varje gås väsentligt högre än i andra områden, hela 95 mot ungefär 12 i övriga delar av landet. Men även dessa lägre värden innebar att tillräckligt många observationer kunde analyseras.

Könen skilde sig inte i flyttningsavstånd. Däremot var det stor skillnad mellan de fyra regionerna. Gäss från norra regionen flyttade i genomsnitt nästan 300 km medan de från de övriga tre regionerna hade medelvärden på under 10 km. Skillnaden beror på att 17% av gässen från norra regionen flyttade till Spanien, medan motsvarande andel i de övriga tre regionerna var mycket låg. Hela 75% av de fåglar som återsetts i Spanien, Italien eller Frankrike hade sin hemvist i den norra regionen.

Oberoende av vilka avstånd de olika regionala bestånden flyttade så avtog andelen individer snabbt med ökande avstånd. De flesta fåglar övervintrade mycket nära häckningsplatsen. Detta innebär att varje population har sitt eget hemområde hela året och som är skilt från de andra beståndens (Figur 3). Observationerna utanför Holland kom oftast från platser nära gränsen och bara ett mindre antal från platser på större avsstånd (Figur 4).

Det skedde en kraftig förändring av flyttningsavståndet under studieperioden (Figur 5). Åren 1993–1996 var medelavståndet mellan häckningsplatsen och vinterobservationerna mycket högre än senare. Efter 1996 är det sällan som gäss flyttat längre än 20 km. En felkälla kan vara att flertalet långflyttare före 1997 hade märkts på tre platser: Oostervaardersplasen, De Deelen och Waterland. På Oostervaardersplassen och Waterland har inga gäss märkts efter 1998 och gäss därifrån kan därför teoretiskt fortfarande vara långflyttare. Detta motsägs dock av att gäss från De Deelen, där märkningen återupptogs 2005, har upphört med sin långflyttning också. Endast tre procent av fåglarna märkta i detta område efter 2005 flyttade till Spanien. Vi är anser därför att det är säkerställt att de grågäss som häckar i Holland i princip är stannfåglar numera.

En del andra mönster framträder också. Lokala bestånd, som häckar nära varandra, uppvisar delvis rätt olika spridningsbilder. En hel del gäss flyttar numera norrut och övervintrar i Danmark och i de södra delarna av Norge och Sverige. Utan att vi kan komma fram till några säkra slutsatser om orsakerna till skillnader eller förändringar spekulerar vi om förklaringar som klimatförändring, ändringar i jakttryck, förändring av rapporteringsmönster, och genetiska effekter genom inblandning av förvildade tamgäss. Vi utesluter däremot försämrade födobetingelser under vintern i Holland.

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Assessing impacts on geese from mining activities in the Ramsar site Heden, East Greenland

Undersøgelse af påvirkning fra mineaktiviteter i Ramsarområdet Heden i Østgrønland

CHRISTIAN M. GLAHDER, DAVID BOERTMANN & JESPER MADSEN

Abstract

Due to planned mining activities inside a Ramsar site in Jameson Land, East Greenland, studies of Pink-footed *Anser brachyrhynchus* and Barnacle *Branta leucopsis* geese were performed in 2008. An aerial survey in Jameson Land showed a threefold increase in the moulting geese over the last 20 years to c. 19,000 Pink-footed geese and 16,500 Barnacle geese. About 25% of the Pink-footed geese can be affected by the mining activities. About one third of the breeding Pink-footed geese in Jameson Land breed in the affected area. The possible effects of the mining activities were assessed in relation to three disturbance scenarios, expressed by distances of 1.5, 5 and 10 km from the activities. The worst case scenario (10 km zone) could affect 4,900 moulting Pink-footed and 530 moulting Barnacle geese and at least 30 successfully breeding pairs of Pink-footed geese. In the proposed Ramsar replacement area in Jameson Land, moulting geese numbered c. 3,000 Pink-feet and 4,700 Barnacles. A monitoring study and a study of yet another replacement area are proposed.

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Introduction

In 1988, the Ramsar site Heden in East Greenland (centre c. 71°00'N; 24°00'W) was designated primarily to protect internationally important populations of moulting Pink-footed geese *Anser brachyrhynchus* and Barnacle geese *Branta leucopsis* (Greenland Home Rule 1990, Egevang & Boertmann 2001). The area held at that time 2% of the Iceland/Greenland flyway population of Pink-footed geese and 7% of the total Greenland flyway population of Barnacle geese (Mosbech et al. 1989, Boertmann 1991). Of importance for the designation were also other breeding birds like Red-throated Diver *Gavia stellata*, Long-tailed Skua *Stercorarius longicaudus* and Arctic Skua *Stercorarius parasiticus*, Dunlin *Calidris alpina*, Turnstone *Arenaria interpres*, Red Phalarope *Phalaropus fulicaria* and Red-necked Phalarope *Phalaropus lobatus*, as well as uncommon breeding birds like Sabine's Gull *Larus sabini* and Whimbrel *Numenius phaeopus* (Boertmann 2007).

In 2008, the mining company Quadra Mining Ltd. was granted an exploitation license that covered the Malmbjerget area situated about 75 km north of the Ramsar site Heden. The company plans to exploit a large molybdenum ore and develop the north western part of Heden (Cessford 2007, Quadra Mining Ltd. 2008). The planned activities inside the Ramsar site, around Gurreholm (Figure 1), include the construction of a port with a large container terminal, a gravel road from the port north along the east side of the Schuchert River and a 2,000 m long air strip. Large trucks will transport molybdenum concentrate in containers to the port from where ships during the open water period in July–October will sail the concentrate out of the area. About 100 flights per year with aircraft, ranging from smaller fixed wing aircraft, over medium sized jet planes to Hercules transport planes are planned to service the area. The Greenland Self-Government has claimed the mining project of "urgent national interests". The Ramsar Convention Secretariat is in dialogue with the Greenland Self-Government and has accepted that the project can proceed provided that the impact of the activities is monitored and that an appropriate replacement area is found in advance.

Figure 1. The four study areas in the northern part of Jameson Land, Greenland, where ground studies were conducted during 16 July–2 August 2008. The airport Constable Pynt and the settlement Ittoqqortoormiit are shown.
Kort over Jameson Land med angivelse af de fire undersøgelsesområder hvor der blev udført intensive undersøgelser i perioden 16. juli til 2. august 2008. Lufthavnen Constable Pynt og bygden Ittoqqortoormiit er vist.

In July 2008 the National Environmental Research Institute (NERI), Denmark, conducted biological studies in the Ramsar site and other areas in Jameson Land. These studies were performed for the Bureau of Minerals and Petroleum, the Greenland Self-Government. On the basis of different disturbance scenarios the number of possibly impacted geese and other bird species were assessed and a larger area around the Ørsted Dal (Figure 1) was suggested as a replacement area (Glahder et al. 2008, 2010).

The study area

Jameson Land is situated in East Greenland around 71°15'N; 23°30'W. It is a lowland area compared to the generally rugged mountainous east coast of Greenland. The western and southern part is delimited by the World's largest fjord system Scoresby Sund while the northern and eastern part is fringed by high mountains and open sea. The western part is covered by tundra with a rather high proportion of wetland areas. To the east the area gradually raises to drier tundra and low mountains of about 1,000 m a.s.l. Jameson Land is intersected by many large rivers and relatively lush valleys.

The aerial survey covered most lowland areas of Jameson Land while ground studies were performed in the four areas of Gurreholm, Tyskit Nunaat, Draba Sibirica Elv and Ørsted Dal (Figure 1). Gurreholm is a wetland area with a high number of smaller and larger lakes, many marshes and smaller and larger rivers that drains the area. The higher ground in-between the wetland areas is dominated by dwarf scrub heath. Tyskit Nunaat is characterised by drier dwarf scrub heath with rather few rivers. There is only one large lake and relatively few smaller lakes and marshes. Draba Sibirica Elv is a lowland tundra area with a continuous dwarf scrub heath. The area is intersected by rivers and contains some lakes; marshes are found along rivers, streams and lakes and salt marshes along the coast of Scoresby Sund. Ørsted Dal is a 4–7 km wide, u-shaped valley that runs east-west for about 50 km. Many smaller and larger rivers run into the main river and the valley floor contains scattered ponds and lakes. The valley slopes are mostly covered by barren ground. Mossy fens are extensive along rivers and lakes while the river bed is covered by gravel and sand with only little vegetation.

Methods

During the period 16 July–2 August 2008 field work was performed by three different study groups from NERI. The one group conducted an aerial survey of moulting geese in the entire Jameson Land and the two other groups counted birds from the ground in four selected areas in Jameson Land (Figure 1).

The aerial goose survey was carried out on 17 and 18 July 2008, about one week before the first non-breeding geese attain their flying abilities. Weather conditions were optimal, with unlimited visibility, no winds and sky clear. The surveys were a replica of the surveys carried out in 1987, 1988 and 1989 (Mortensen et al. 1988, Mosbech et al. 1989, Mosbech & Glahder 1990). Aircraft, pilot and one observer were the same as in the 1980s. The plane was a Partenavia P-68 Observer equipped with Plexiglas front and bubble windows. The flown routes were carried out as "total counts" (Laursen et al. 2008) and duplicated as far as possible from the routes in 1987–1989. Navigation

was visual and aided by GPS. Survey speed and altitude was the same as in 1987–1989 i.e. 90 knots (160 km/hour) and 250 feet (85 m) above ground. The two observers were placed in the co-pilot seat (watching to the right) and the seat behind the pilot (watching to the left). Observations were recorded on tape-recorders with indication of time of the day (hour, minute, second) and subsequently written into a spreadsheet. The observation file was then by the time signal merged with the position file from the GPS resulting in positions of each single observation. The airport Constable Pynt (CNP) close to Ittoqqortoormiit/Scoresbysund was the base of the flights.

The ground surveys in the Gurreholm and Ørsted Dal areas were performed 17–25 July 2008 and in the reference areas Tyskit Nunaat and Draba Sibirica Elv during 25–31 July. The teams of two persons were moved to, from and between camp sites by a helicopter based at CNP. Each day, trips of 5–20 km were walked and during the study period 50–100 km was traversed in each study area. Routes formed radii from the camp sites to the areas' delimitations with a special focus on lakes and rivers. Thereby land areas of 48.6–68.9 km^2 were covered. Binoculars (Leica & Zeiss 10× magnification) and spotting scopes (Carl Zeiss Diascope 85 TFL 20–60×) were used for observations and GPS (Garmin Etrex and Trimble Recon©) for positions. All birds and mammals were registered with species, number, age, behaviour and position. Positions were either GPS positions, calculated from observations plotted in the field on false colour infrared ASTER and Landsat satellite images from 15–17 July 2004 (1:25,000) or calculated from estimated distances and angles from the observer to the animals. Geese were separated in non-breeding moulting geese and breeding geese in family flocks which included young birds. For other bird species it was noted if birds were breeding or non-breeding; a breeding bird was defined as a bird connected to a nest with eggs or chicks, juvenile birds or a bird that performed territorial behaviour (e.g. lure or chase intruders, or sing). In mammals, fox dens and cubs were registered. All animal observations, camps, routes, observed lakes and observations points were plotted on false coloured satellite images (1:25,000) and if necessary verified by false coloured aerial photos (c. 1:22,000, 1980s).

Results

The total number of Pink-footed and Barnacle geese recorded in Jameson Land during the aerial survey was 19,068 and 16,603, respectively (Table 1, Figures 2 and 3). Almost all geese were moulting non-breeding birds. However, a total of 24 Pink-footed and 45 Barnacle goslings were seen. Only 21 Pink-footed and 8 Barnacle geese were recorded flying.

The number of moulting Pink-footed geese and families counted in the four study areas either from the air or from the ground is shown in Table 2. Table 3 shows corresponding numbers for Barnacle geese. The average number of young per breeding pair of Pink-footed geese in the Gurreholm area was 2.80 (n=76) and in Ørsted Dal 2.70 (n=10). In Barnacle geese, the average number of young per pair in Ørsted Dal was 1.71 (n=17) and in Draba Sibirica Elv 3.83 (n=6).

The number of other successfully breeding birds than geese in the four study areas is shown in Table 4. Breeding bird species included waders (Common Ringed Plover *Charadrius hiaticula*, Red Knot *Calidris canutus*, Sanderling *Calidris alba*, Dunlin, Ruddy Turnstone, Whimbrel and Red Phalarope), ducks (Common Eider *Somateria mollissima*, King Eider *Somateria spectabilis* and Long-tailed Duck *Clangula hyemalis*), skuas (Long-tailed and Arctic), Red-throated Diver, Rock Ptarmigan *Lagopus muta*, Arctic Tern *Sterna paradisaea* and Sabine's Gull. Non-breeding Sabine's Gulls were observed in relatively high numbers in Gurreholm (50–60) and Draba Sibirica Elv (20–30).

Table 1. Changes in the global flyway populations of Pink-footed Goose and Barnacle Goose and in the number moulting geese in Jameson Land during 1983–2008 (Mitchell 2008, Mitchell & Walsh 2008, Mosbech & Glahder 1990, the present study in 2008).
Ændringer i de globale flyway populationer af Kortnæbbet Gås og Bramgås og i antallet af fældende gæs i Jameson Land i perioden 1983–2008.

Goose species	Global flyway population		Jameson Land population	
	1990	2007/2008	1983–1989	2008
Pink-footed	190,000	290,000	6,243	19,068
Barnacle	35,000	70,500	6,071	16,603

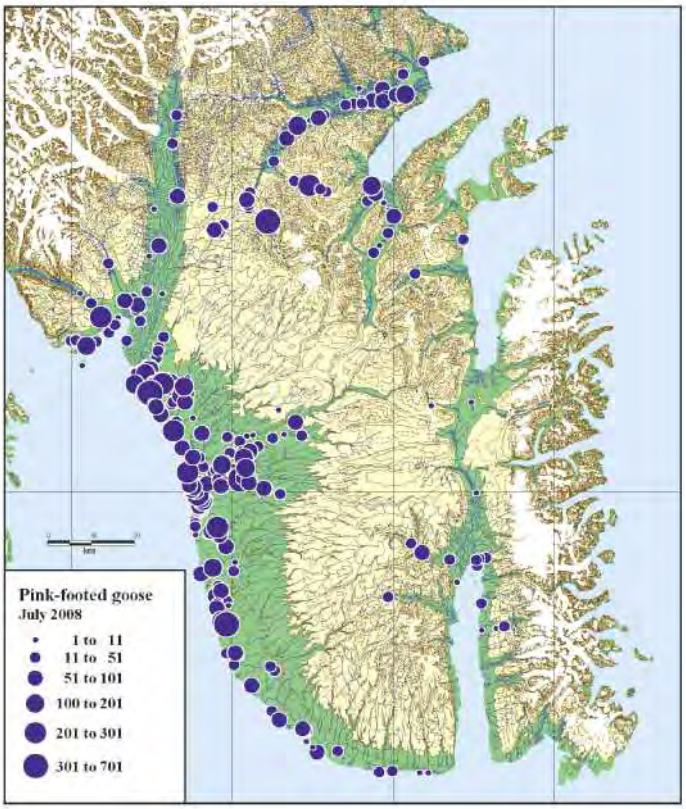

Figure 2. Distribution of flocks of Pink-footed geese in Jameson Land recorded during aerial surveys on 17 and 18 July 2008. Flock sizes are indicated by the size of the signature. In total 384 flocks with a total of 19,068 birds were recorded (corrected for birds recorded more than once).
Udbredelsen af flokke af Kortnæbbede Gæs i Jameson Land optalt fra luften d. 17. og 18. juli 2008. Størrelsen af flokken er angivet ud fra signaturens størrelse. Der blev i alt optalt 384 flokke med i alt 19.068 gæs. Antallet er korrigeret for gentagelser.

Table 2. Moulting Pink-footed Geese and family geese (separated in adults and young) counted in the four study areas either from the air or from the ground.
Fældende Kortnæbbede Gæs og familier af arten optalt i de fire undersøgelsesområder fra henholdsvis luften og på jorden.

Study area	Aerial survey	Ground count			
	Moulting	Moulting	Family	Adults	Young
Gurreholm	3971	2752	834	442	392
Tyskit Nunaat	969	1090	83	57	26
Draba Sibirica Elv	2483	2756	770	338	432
Ørsted Dal	408	166	54	27	27

Table 3. Barnacle Goose moulting and family birds (separated in adults and young) counted in the four study areas either from the air or from the ground.
Fældende Bramgæs og familier af arten optalt i de fire undersøgelsesområder fra henholdsvis luften og på jorden.

Study area	Aerial survey	Ground count			
	Moulting	Moulting	Family total	Adults	Young
Gurreholm	284	167	8	6	2
Tyskit Nunaat	269	201	0	0	0
Draba Sibirica Elv	1122	240	37	14	23
Ørsted Dal	542	696	123	82	41

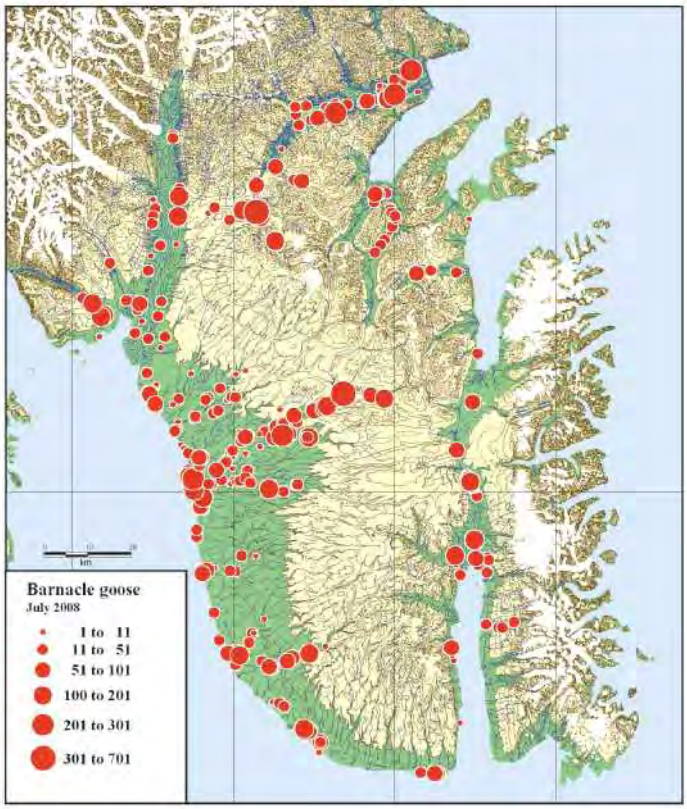

Figure 3. Distribution of flocks of Barnacle geese in Jameson Land recorded during aerial surveys on 17 and 18 July 2008. Flock sizes are indicated by the size of the signature. In total 431 flocks with a total of 16,630 birds were recorded (corrected for birds recorded more than once).
Udbredelsen af flokke af Bramgæs i Jameson Land optalt fra luften d. 17. og 18. juli 2008. Størrelsen af flokken er angivet ud fra signaturens størrelse. Der blev i alt optalt 431 flokke med i alt 16.630 gæs. Antallet er korrigeret for gentagelser.

Table 4. The number of breeding bird pairs and species (geese excluded) in the four study areas in Jameson Land. Breeding birds are successfully pairs only. Species are mainly waders, ducks, divers and skuas.
Antallet af ynglende par og arter (gæs indgår ikke) i de fire undersøgelsesområder i Jameson Land. Ynglefuglene omfatter kun succesfulde par. Arterne omfatter primært vadefugle, ænder, lommer og kjover.

Study area	Gurreholm	Tyskit Nunaat	Draba Sibirica Elv	Ørsted Dal
Area (km^2)	68.9	48.6	65.6	53.2
Breeding bird pairs	64	22	20	30
Breeding birds species	11	10	9	5

Discussion

Methods, aerial goose census

We believe that the results from the present survey and the surveys performed in the 1980s are comparable because the methodology used was as identical as possible regarding aircraft, personnel and census route. In 1988 and 1989 photographic verification was added to the aerial surveys (Mosbech et al. 1989, Mosbech & Glahder 1990). The numbers of observed Pink-footed Geese and Barnacle Geese were adjusted according to photographed flocks to give true numbers. In general, flocks below 75 geese were overestimated by 13.6% while flocks above 75 geese were underestimated by 3.2%. In 2008, no photographs were taken, but if we use the above results on our flocks, the total count of Pink-footed Geese and Barnacle Geese should be reduced by 2% and 3%, respectively. Due to these small differences we have kept the observed numbers in this paper.

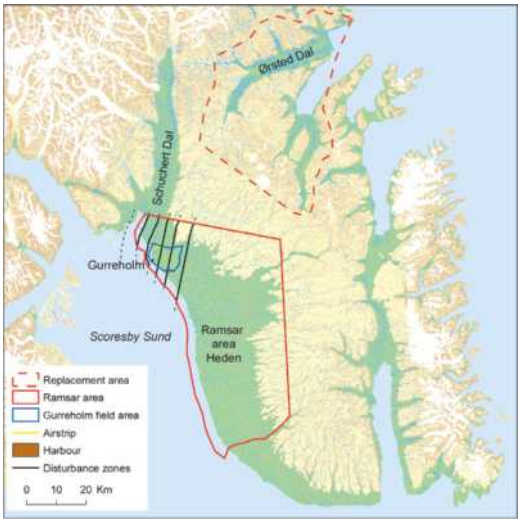

Figure 4. Map of Jameson Land with the Ramsar site Heden, Gurreholm and the air strip and the port. The three disturbance zones of 1.5, 5 and 10 km from the mining works are shown in black lines. The proposed replacement area around the Ørsted Dal is shown.
Kort over Jameson Land med Ramsar området Heden, Gurreholm, landingsbane og havn. De tre forstyrrelseszoner med afstande på 1,5, 5 og 10 km fra mineanlæggene er vist med sorte linjer. Det foreslåede erstatningsområde ved Ørsted Dalen er vist.

Methods, ground surveys

Ground surveys in the four study areas were performed identically with special focus on moulting and breeding geese. The aim was to obtain full coverage of moulting geese and family flocks inside the study areas. This was done by daily walking trips and observations from vantage points covering all major water bodies and wetland areas. Moulting geese counted from the air and the ground in the four study areas differed, but not systematically. Pink-footed Geese counted from the ground differed from the aerial count in most cases between 70% and 113%, yet with only 41% found in Ørsted Dal. In Barnacle geese the differences varied in most cases between 60% and 128% with only 21% found in the Draba Sibirica Elv area. The large difference in Ørsted Dal could be due both to the different census periods and to the possibility of the geese to move along the main river and out of the study area. In Draba Sibirica Elv many of the moulting Barnacle Geese counted from the air were observed along the coastline and these flocks could have moved out of the study area when the ground team arrived about one week later. The most marked difference between the two methods was that the ground counts observed a total of 1741 Pink-footed family geese and 168 Barnacle Goose family birds, while only 2 Barnacle Goose family birds were observed in the study areas from the air. Family birds are not observed from the air either because they blend into the moulting geese or they are invisible while feeding on the tundra or in marsh areas.

The ground observations of other birds than geese from the four study areas were focusing on breeding birds. In July, birds are either incubating or attending young birds, so at this time of the breeding season we will observe only successfully breeding birds. Failed breeders constitute a major part of the breeding population and in July, these birds have gathered in flocks. Therefore, numbers of breeding birds represent minimum. A more comprehensive method of counting breeding birds is given by Meltofte (2001).

Goose populations in Jameson Land

During 1983–1989 the moulting geese from the two populations were censused from the air in 1983, 1984, 1987–1989 (Mosbech & Glahder 1990). On average 6,071 (SD=634, n=5) Barnacle Geese and 6,243 (SD=1,012, n=5) Pink-footed Geese were counted. The global flyway populations of the two species were in 1990 estimated at 35,000 Barnacle Geese and 190,000 Pink-footed Geese and in 2007 and 2008 to 70,500 Barnacle Geese and 290,000 Pink-footed Geese (Table 1, Mitchell 2008, Mitchell & Walsh 2008). It appears from Table 1 that the global populations during the 20 years period have increased 1.5–2 times while the moulting geese from the two populations in Jameson Land have tripled their numbers. The proportion of Barnacle Geese in Jameson Land of the total population has increased over the period from 17% to 24% and for Pink-footed Geese from 3% to 7%. The increase of the two species in Jameson Land over the 20 years period is not evenly distributed. In the Ørsted Dal replacement area proposal (Figure 4) both species have more or less doubled their number (Barnacle Goose from 2377 (average 1983–1989) to 4106, and Pink-footed Goose from 960 to 1952). In the Gurreholm area, on the other hand, the number of Barnacle Geese has decreased to nearly the half (from 430 to 284), while Pink-footed Geese have

increased their number six fold (from an average of 634 to 3971). In the Draba Sibirica Elv area numbers of the two species have not changed much in the 20 year period (Barnacle Goose 1980s-average of 1114 compared to 1122 in 2008, and Pink-footed Goose numbers have increased slightly from 2030 to 2483). Especially in the Gurreholm area the expanding Pink-footed Goose population has been able to find unexploited habitats. Consequently, about 25% of the entire Jameson Land population of moulting Pink-footed Geese are today using the Gurreholm area as a moulting ground.

Breeding geese in Jameson Land

In the four ground study areas we have counted 1741 family group individuals of Pink-footed Geese and 168 family group individuals of Barnacle Goose. This gives about 370 successfully breeding pairs of Pink-footed Geese and 30–45 pairs of Barnacle Geese in the four study areas. During the 1980s the total Jameson Land breeding population of the Pink-footed Goose was estimated at 300–500 pairs in 1982–1984 (Madsen et al. 1985) and 600 in 1988 (Mosbech et al. 1989). The breeding population of the Barnacle Goose was in 1982–1984 estimated at 300–400 pairs. In the Ørsted Dal the breeding population was, on the basis of juveniles, estimated at about 60 pairs in 1963 and 1974 (Hall & Waddingham 1966; Ferns & Mudge 1976) and 201 nest in 9 colonies in June 1984 (Cabot et al. 1984).

Birds in the Gurreholm area

The Gurreholm area is very rich in bird species and individuals compared to the other three studied areas. The number of breeding and moulting Pink-footed Geese (more than 800 individuals in families and c. 4000 moulting birds) as well as other breeding birds (11 species with 64 successfully pairs) is high (Table 2 and 4). The area is not very important for Barnacle Geese where the highest number of breeding birds (123 individuals) was observed in Ørsted Dal and the highest number of moulting birds (c. 1100) was counted in the Draba Sibirica Elv area. The reason for this relative high biodiversity is the high number of different habitats such as many larger and smaller lakes and rivers, fens and salt marshes. This mosaic of wet areas is dominating over the dryer dwarf scrub heath. The Tyskit Nunaat area is dominated by dwarf scrub heath with only few lakes, rivers and fens, while the Ørsted Dal and Draba Sibirica Elv areas are intermediate between the two areas described above.

Possible effects of mining activities

The possible effects of the mining activities on geese and other bird species in the Gurreholm area were evaluated in relation to three disturbance scenarios, expressed by the distance at which birds are predicted to be displaced. The size of these three zones of 1.5, 5 and 10 km (Figure 4) are based on knowledge from reactions of moulting geese to helicopter disturbances (Mosbech et al. 1989, Mosbech & Glahder 1991) and breeding geese to airstrips and walking persons (de Korte 1988, Mosbech et al. 1989, Mosbech & Glahder 1990). When a large helicopter approached moulting Pink-footed Geese they stayed alert at a distance of about 10 km from the plane and fled to a lake or river at distances of 7–8 km. A smaller helicopter caused the two latter reactions at distances of 4–6 km. When geese, still able to fly, are searching for suitable moulting sites they probably will avoid moulting habitats that are inside the 10 km disturbance zone. This is based on observations of Pink-footed Geese that avoided a valley in Jameson Land in late June after passage of large helicopters at distances of about 5 km. No geese moulted in the valley that year. Breeding geese are more tolerant to disturbances and observations in Jameson land indicate little or no effects at distances of 1–2 km from the source. A similar disturbance effect was found in breeding Pink-footed Geese in Iceland (Sigurdsson 1974) and in Svalbard, Pink-footed Goose families showed an escape response at a distance of almost 2 km from approaching humans (Madsen et al. 2009). According to these observations we have chosen a disturbance zone of 1.5 km to breeding geese and other breeding birds. A worst case scenario is represented by the 10 km disturbance zone inside which we expect that no geese will start moulting (Figure 4). The more moderate scenario anticipates the geese to initiate their moult in areas situated more than 5 km from the disturbances, but inside the 5 km zone no geese will moult. Breeding geese and other breeding birds are expected to avoid the area inside the 1.5 km disturbance zone.

Inside the disturbance zone of 10 km about 4900 moulting Pink-footed Geese and 530 moulting Barnacle Geese were observed in 2008, while the disturbance zone of 5 km held c. 3900 moulting Pink-footed Geese and 400 moulting Barnacle Geese. Inside the 1.5 km disturbance zone a minimum of 150 Pink-footed Geese in family flocks

(equal to c. 30 successful pairs) and a minimum of 8 breeding pairs of other breeding birds were located. It is likely that all lakes used by foraging non-breeding Sabine's Gulls will be affected by the constructions.

The proposed replacement area in Ørsted Dal

In Jameson Land, we found the Ørsted Dal area to be the only relevant potential replacement area. The area had to be extended to that shown on Figure 4, because the Ørsted Dal study area, similar in size to the Gurreholm study area, held too few moulting and breeding Pink-footed Geese. Also, it was doubtful if the area was sufficient to replace the diversity of other breeding species. On the other hand, Barnacle Geese are fully replaced. This extended Ørsted Dal area held c. 3000 moulting Pink-footed Geese or about 60–80% of the 3900–4900 geese potentially lost inside the two disturbance zones in the Gurreholm area. In return, the extended Ørsted Dal area supports c. 4700 moulting Barnacle Geese giving protection under the Ramsar Convention to an extra 7% of the Barnacle Goose flyway population. This is of importance because the population is still relatively small despite its current rapid growth. With our current knowledge, it is difficult to judge if the replacement area can fully compensate the loss of breeding Pink-footed Geese and other breeding birds. The south-eastern valleys in the area (Figure 4) are suitable only to moulting geese and not to most breeding birds because of snow and ice coverage until late June.

Because of the uncertainties to assess the impact of the mining activities on the moulting and breeding birds in the Gurreholm area of the Ramsar site we suggest a monitoring program be initiated at mine start. If the proposed Ørsted Dal replacement area can not compensate for the loss of moulting and breeding birds in the Gurreholm area, yet another replacement area should be delimited elsewhere along the East Greenland coast.

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Sammenfatning

Ramsarområdet Heden i Østgrønland (71°00'N; 24°00'W) blev i 1988 udpeget for at beskytte internationalt vigtige populationer af fældende Kortnæbbede Gæs og Bramgæs. På det tidspunkt udgjorde antallet i området henholdsvis 2% og 7% af de to populationer. Et mineselskab fik i 2008 tildelt en udnyttelsestilladelse for Malmbjerget der ligger ca. 75 km nord for Ramsarområdet. Det er mineselskabets plan at udnytte en stor molybdænforekomst og bygge infrastruktur i det nordvestlige hjørne af Heden, kaldet Gurreholm (Figur 1). Byggerierne omfatter en havn, en grusvej og en 2 km lang landingsbane. Mineprojektet er af "højeste nationale interesse" for Grønlands Selvstyre. Ramsarkonventionens secretariat har accepteret, at mineprojektet kan fortsætte, hvis påvirkningen fra mineaktiviteterne moniteres og der findes et passende erstatningsområde inden minestart. Danmarks Miljøundersøgelser, Aarhus Universitet, udførte i juli 2008 en række biologiske undersøgelser i Ramsarområdet og i det øvrige Jameson Land. Jameson Land er et lavlandsområde sammenlignet med den meget bjergrige Grønlandske østkyst. Jameson Land er mod vest afgrænset af Verdens største fjordsystem Scoresby Sund og mod nord og øst af høje bjerge og det åbne hav. Mod vest er området dækket af tundra der er præget af relativt mange vådområder. Mod øst rejser landet sig gradvist og går over i lavere bjerge. Området er gennemskåret af adskillige store elve med relativt frodige dale. Optællingen fra fly dækkede de fleste lavlandsområder, mens undersøgelserne på jorden omfattede tre områder i Ramsarområdet og et udenfor. Undersøgelserne blev udført i perioden 16. juli til 2. august 2008. Optællingen fra fly blev foretaget d. 17. og 18. juli og den var sammenlignelig med undersøgelserne i samme område fra 1987–1989, idet fly, pilot, observatør og ruter var identiske. Ruterne blev fløjet som "total counts". Studieområderne blev dækket af ruter på i alt 50–100 km, der udgik som radier fra lejrene og der blev specielt fokuseret på søer og elve. Fra luften blev der i alt optalt 19.068 fældende Kortnæbbede Gæs og 16.603 Bramgæs (Tabel 1, Figurerne 2 & 3). I hvert af de fire undersøgelsesområder blev der optalt fældende gæs og familieflokke både fra luften og fra jorden (Tabellerne 2 & 3). Desuden blev antallet af succesfulde ynglefugle af andre arter registreret i de fire områder (Tabel 4). Disse ynglefugle omfattede vadefugle, ænder, kjover og andre arter som f.eks. Sabinemåge. Antallet af fældende gæs talt fra luften og fra jorden varierede, men ikke systematiskt. Den mest markante forskel på de to optællingsmetoder var, at der fra jorden blev observeret i alt 1.741 Kortnæbbede Gæs i familier og 168 Bramgæs, men der fra luften stort set ikke blev set gæs i familier. Grunden til, at der ikke bliver set familiegæs fra luften skyldes dels, at disse forsvinder i de tætte flokke af fældegæs og dels, at de ofte opholder sig på tundraen eller i kærområder, hvor de er særdeles vanskelige at opdage. I perioden 1983–1989 blev der i gennemsnit observeret ca. 6.000 fældegæs af hver af de to arter. I perioden fra 1990 til 2007/2008 er antallet af de to flyway populationer forøget med 1,5–2 gange, mens de fældende gæs fra de to populationer i samme periode har forøget deres antal i Jameson Land med tre gange (Tabel 1); i Gurreholm området er antallet af Kortnæbbede Gæs øget seks gange. Det betyder, at ca. 25% af de fældende Kortnæbbede Gæs i Jameson Land i dag opholder sig i Gurreholm området. Mineaktiviteternes mulige påvirkninger af gæs og andre fugle i Gurreholm området blev vurderet ud fra tre forstyrrelsesscenarier, udtrykt som den afstand til kilden hvor fuglene vil blive bortjaget. Størrelsen af de tre zoner på 1,5, 5 og 10 km (Figur 4) er baseret på forstyrrelsesreaktioner som fældende og ynglende gæs har udvist i Jameson Land. Indenfor 10 km zonen blev der i 2008 observeret ca. 4.900 fældende Kortnæbbede Gæs og 530 fældende Bramgæs, mens der indenfor 5 km zonen blev observeret ca. 3.900 fældende Kortnæbbede Gæs og 400 fældende Bramgæs. Indenfor 1,5 km zonen blev der set ca. 30 succesfulde ynglepar af Kortnæbbet Gås og her ligger også de søer, hvor der blev set flokke af ikke-ynglende Sabinemåger. Ørsted Dal området var det eneste relevante po-

tentielle erstatningsområde i Jameson Land (Figur 4). I dette område blev der set ca. 3.000 fældende Kortnæbbede Gæs, hvilket udgør 60–80 % af de gæs der potentielt bortjages fra de to forstyrrelseszoner. På den anden side blev der observeret ca. 4.700 fældende Bramgæs, således at yderligere 7% flere af denne population vil blive beskyttet af Ramsarkonventionen. Det er foreslået, at der efter minestart foretages en monitering af konsekvenserne og at der i nærmeste fremtid undersøges andre mulige erstatningsområder.

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A working model for preventing crop damage caused by increasing goose populations in Sweden

En arbetsmodell för att förebygga skador på gröda orsakade av växande gåspopulationer i Sverige

MIKAEL HAKE, JOHAN MÅNSSON & ANNE WIBERG

Abstract

The populations of several goose species have increased rapidly in Sweden, as well as in other parts of Europe, particularly during the last decade. As a consequence, the damage caused by the birds to commercially grown agricultural crops has increased. In 2008, the Swedish government paid about 500,000 € for preventive measures and subsidies to affected farmers. To reduce the economical losses and conflicts between the geese and humans, it is necessary to establish and maintain communication between the different interest groups and to implement measures to prevent the damage. We here present a working model, which is currently used for reducing human–geese conflicts in Sweden. The working model is based on the initiation of management groups which may develop a management plan on the basis of information collected about the behaviour of the birds and the temporal and spatial variations of crop damage caused within local areas. We give an overview of the preventive measures taken within these plans and discuss how effective they may be to reduce conflicts between geese and humans.

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Introduction

The populations of several European goose species have increased considerably during the last decades. Between 1995 and 2008, the number of wintering geese in north-western Europe increased by 24%, from about 3,500,000 to 4,300,000 (Fox et al. 2010). The grazing and trampling by the geese may have a large impact on vegetation, including commercially grown agricultural crops (McIvor & Conover 1994, Zacheis et al. 2001, Jefferies et al. 2004). As a consequence, the aggregation of grazing geese within farmland may cause conflicts between the birds and humans, particularly farmers (Lorenzen & Madsen 1986, Summers 1990). The aggregations mainly occur at staging sites during migration, at breeding colonies or when non-breeding birds flock at attractive foraging sites (Zacheis et al. 2001, Samelius & Alisauskas 2009).

Also in Sweden, the populations of several goose species have increased rapidly, particularly during the last 10–15 years. Annual national counts of geese have been conducted during autumn and winter since the late 1970s. These counts reveal that all goose species except the Bean Goose *Anser fabalis* and the Lesser White-fronted Goose *Anser erythropus* have increased since the surveys were introduced (Nilsson 2009). The Greylag Goose *Anser anser* has, for example, increased more than tenfold (from about 20,000 to 225,000 birds) during 1984–2009, and a similar pattern has been found for the Barnacle Goose *Branta leucopsis* (Nilsson 2009). Breeding populations of these two species have shown similar substantial increases. At the eutrophic lake Tåkern in south-central Sweden (Figure 1), the number of breeding Greylag Geese increased from about 100 to 1,000 pairs between 1996 and 2002 (Gezelius 2009), and the total number of breeding Barnacle Geese in Sweden has increased from very few to about 5,000 pairs during the last two decades (e.g. Feige et al. 2008).

The increase in population sizes of geese in Sweden has, like in the rest of Europe, brought an increase in crop damage in agricultural areas due to grazing birds, and this has resulted in conflicts between the birds and farmers. These conflicts are particularly pronounced for protected species, i.e. species which cannot be hunted during the periods

when they cause the damage. The conflicts do not only result in financial losses for farmers affected, but may also lower the acceptance for geese and birds in general. As a consequence, landowners may be more reluctant to agree on setting off their land as reserves to protect vulnerable birds and other organisms (Gordon 2009). Thus, it is important that these conflicts are mitigated, as they may have severe consequences for both economics and the possibility to implement successful conservation measures.

In Sweden, the regulations for managing damage caused by protected wildlife were renewed in 1995. The current regulations state that such damage should primarily be prevented by hunting. In situations where this is not possible, e.g. if the species

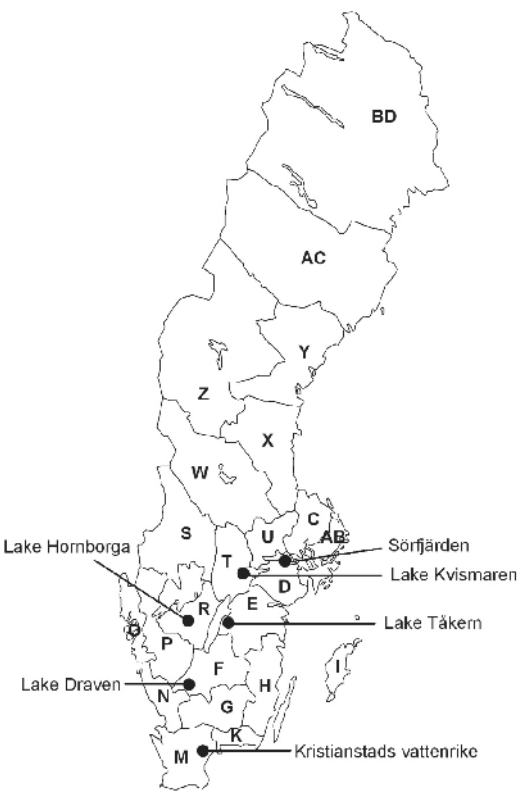

Figure 1. Map of Sweden showing the 21 counties and the location of six important breeding and staging sites for geese, cranes and whooper swans, mentioned in the text: lake Tåkern, lake Hornborga, lake Kvismaren, lake Draven, Sörfjärden and Kristianstads Vattenrike.
Karta över Sverige med de 21 länen och läget för sex viktiga områden för häckning och rastning för gäss, tranor och sångsvanar som nämns i texten: Tåkern, Hornborgasjön, Kvismaren, Draven, Sörfjärden och Kristianstads vattenrike.

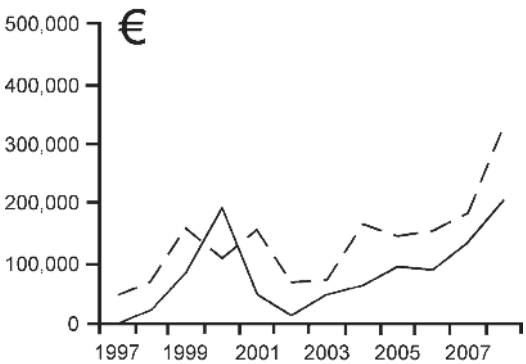

Figure 2. Amount of money paid for preventing and compensating crop damage caused by protected birds in Sweden 1997–2008. Dashed line = subsidies for damage, solid line = subsidies for preventive measures.
Belopp betalda för att förhindra och kompensera skördeskador orsakade av fridlysta fåglar i Sverige 1997–2008. Streckad linje = ersättning för skador, heldragen linje = ersättning för att förebygga skador.

causing damage are protected or if damage occurs within nature reserves or national parks, it should be prevented by other methods. If damage still occurs, the administration boards in the 21 counties (Figure 1) have the mandate to compensate affected stakeholders for their financial losses to mitigate the conflicts. The governmental subsidies for preventing damage on commercially grown crops and compensating farmers in agricultural areas have increased (Figure 2) as a result of the increasing populations of geese, Common Cranes *Grus grus* and Whooper Swans *Cygnus cygnus*. In 2008, the Swedish government paid about 200,000 € for preventing crop damage and an additional 300,000 € for subsidies to farmers affected by damage caused by grazing birds (Figure 2).

To promote the development of methods for preventing damage caused by protected wildlife and the conflicts this may bring, the government set off money to establish the organization Wildlife Damage Centre in 1995. The mission of this organization is to collect and distribute information among stakeholders concerned about how the damage caused by different kinds of protected animals vary in time and space and about the ecology and population development of the animals causing the damage (for further information, see: www.viltskadecenter.se). In this paper, we present a working model, developed by the Swedish Wildlife Damage Centre, which is used to prevent crop damage caused by protected bird species (including geese) in agricultural areas in Sweden. Examples of how

the different measures included in this model may be used are provided and experiences of implementing the model are discussed.

Methods and tools within the working model

In Sweden, there are many agricultural areas where conflicts between grazing geese and farmers occur. These areas are mainly connected to breeding, staging and wintering sites of geese, Whooper Swans and Cranes in the southern parts of Sweden and along the coast of the Gulf of Bothnia further north. The conflict areas are sometimes related to nature reserves which provide good conditions for breeding and staging, e.g. lake Tåkern, lake Hornborga and lake Kvismaren (Figure 1) and in such areas it is, as mentioned earlier, particularly important to mitigate the conflicts.

Thus, the Wildlife Damage Centre has developed a working model, in which all interest groups may be involved in the collection of information needed, management decisions and implementation of management actions. This working model involves four major steps, which are taken in turn: (1) found a group with representatives from all stakeholders affected by the conflict, (2) collect information about the ecology and behaviour of the birds and the temporal and spatial variations of the damage they cause, (3) implement preventive measures, and (4) evaluate the measures taken so that the management strategy may be adaptively improved.

Founding management groups

Establish and maintain communication between all stakeholders by founding a group with representatives from all interest groups affected by the conflict. This group may be composed as shown in Figure 3 and should, for practical reasons, preferably not include more than 15 members. The group should have regular meetings to discuss and develop a management plan for preventing crop damage in the area of interest.

Collecting information

To develop a management plan, it is necessary to collect as much basic information as possible about the ecology and behaviour of the birds and the spatial and temporal variations of the damage they cause. This information is important for guiding where, when and how preventive measures should be implemented in the area of interest. Therefore, the next step should be to collect such

Figure 3. An example of how a management group may be composed. In Sweden, these groups have been founded on the initiative of managers and decision makers at the county administration boards.
Exempel på hur en förvaltningsgrupp kan vara sammansatt. I Sverige har dessa grupper bildats genom initiativ från länsadministrationen.

information by field surveys and by using already existing knowledge within the management group (e.g. information gained by local ornithologists and farmers).

Implementing preventive measures

Implementation of preventive measures involves four types of action.

Setting off accommodation fields. Set off accommodation fields where the birds are allowed to feed and may be undisturbed. These fields should be situated in areas the birds prefer to visit as revealed by results from field surveys or already existing local knowledge. If necessary, provide supplementary food in these areas to attract the birds during periods of the season when the risk of crop damage is particularly high.

Scaring of birds. Scare the birds away from vulnerable fields with a combination of scaring devices and protective hunting. If necessary, employ one or more persons who can help the farmers with scaring and hunting the birds.

Fencing. If necessary, put up fences to protect vulnerable crops on fields situated close to the breeding grounds of the geese. Preferably, specially designed fences to prevent crop damage caused by breeding and moulting geese should be used. These fences are about 1 m high and have a mesh size of maximum 50 mm, at least at the bottom third, preventing small goslings from getting through.

Farming strategy. If possible, adopt a farming

strategy that minimises the risk of crop damage caused by the geese. This may include many different actions, e.g. to grow crops that the birds do not prefer, growing vulnerable crops in areas less preferred by the birds, and growing varieties of crops that germinate and may be harvested earlier or later in the season. We know, for instance, that some crops are less attractive for the birds, e.g. rye and oats are less preferred than wheat and barley (Kjellander at al. 2002, Axelsson 2004). We also know that geese, as well as Common Cranes and Whooper Swans, are less prone to visit fields close to roads, houses or other devices connected to human activities (Kjellander et al. 2002, Wildlife Damage Centre, unpubl. data).

Evaluating the measures taken

Evaluate the effect of the preventive measures implemented by surveying the change in behaviour and numbers of birds, frequency of damage, costs and benefits and how people affected by the conflict experience the situation. The evaluation may be conducted at different spatial and temporal scales, e.g. from effects of single measures taken on specific fields to the total effects of all measures implemented within the working model.

Results and discussion

Founding management groups

Since 2002, management groups have been founded in 11 of the 21 counties in Sweden (Table 1, Figure 1). Crop damage occurs also within the other 10 counties, but so far to a lesser extent. The management groups have been founded on the initiative of the county administration boards, which are responsible for the regional wildlife management. Our general experience is that these groups are highly appreciated, as they promote communication and understanding between different interest groups such as decision-makers, farmers, ornithologists and hunters (Figure 3). Moreover, the local knowledge among members of these interest groups, e.g. about where and when crop damage occurs, population sizes and behaviour of birds and hunting strategies, is more easily picked up. In three counties, local management plans for preventing crop damage caused by geese, cranes and swans have been produced by the management groups (Table 1).

The founding of management groups has not only lead to increased communication among stakeholders but also provided a good working climate. The groups have also organised regular meetings to inform the public about their work and management decisions at least once a year. The importance of involving the public to enhance the acceptance of management decisions and the ability to respond more directly to management concerns has been highlighted for ecosystem management in general (Endter-Wada et al. 1998), large carnivore management (Skogen 2003), as well as planning of nature reserves (Jacobson & McDuff 1998).

Collecting information

Following instructions worked out by established management groups, the administration boards in eight of the Swedish counties have initiated and conducted field studies of geese in local areas experiencing problems with grazing birds (Table 1). From these investigations, information about numbers, site fidelity and local movements of birds has been collected. This information has then been used as a basis for deciding which preventive measures that should be taken within the areas. For example, a thorough survey of numbers and spatial distribution of geese was made at lake Tåkern (Figure 1) during 2003–2004 (Axelsson 2004). As geese are normally traditional in their selection of feeding sites (for a review, see Vickery & Gill 1999), this information was used to guide where and during which periods of the season accommodation fields should be set off in the agricultural areas surrounding the lake (Axelsson & Modin 2006b). Similar surveys have been conducted at lake Kvismaren during 1996–1998 and lake Draven (Figure 1) during 2006–2008 (Wildlife Damage Centre, unpubl. data, Truvé 2006, 2008).

In some areas, local counts of the number of geese present during different parts of the year are made. At lake Tåkern, these counts have been conducted since 1970 (Gezelius 2009) and the information obtained is used to make predictions about how much damage one might expect during forthcoming years. For the same reason, information about breeding geese is collected through annual aerial surveys of the number of breeding geese in some "high-risk" areas, e.g. for the greylag goose in Kristianstads Vattenrike (Figure 1, Olofsson 2008).

To investigate where and when crop damage occurs, questionnaires have been sent out to farmers within local areas in three counties so far; at lake Tåkern, Sörfjärden and at the island of Öland in county H (Table 1, Figure 1). In addition, these questionnaires were designed to reveal information about how the farmers experience the conflicts with

Table 1. Measures implemented within the working model to prevent conflicts between grazing birds and humans in the 21 counties during 2002–2009, i.e. since the first management group was founded in Sweden. Letters indicating the different counties refer to Figure 1. Y=Yes, -=No.
Åtgärder som vidtagits inom arbetsmodellen för att förhindra konflikter mellan betande fåglar och människor i de 21 länen 2002–2009, dvs. sedan den första arbetsgruppen bildades i Sverige. Länskoderna finns i Figur 1. Y=Ja, -=Nej.

County *Län*	Management group *Arbetsgrupp*	Management plan *Förvaltningsplan*	Field survey *Kunskapsinsamling*	Questionnair *Enkätundersökning*	Accomodation field *Viltbetesåkrar*	Scaring consultant *Skrämselkonsult*	Fencing *Stängsling av gäss*	Farming strategy *Odlingsstrategi*	Evaluation *Utvärdering*
AB	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-
D	Y	-	Y	Y	-	-	Y	-	-
E	Y	-	Y	Y	Y	Y	Y	Y	Y
F	Y	Y	Y	-	Y	-	-	-	Y
G	-	-	-	-	-	-	-	-	-
H	Y	-	Y	Y	Y	-	-	Y	-
I	Y	Y	Y	-	Y	Y	-	-	Y
K	Y	-	-	-	-	-	-	-	-
M	Y	Y	Y	-	Y	Y	Y	-	-
N	-	-	-	-	-	-	-	-	-
O	Y	-	Y	-	Y	-	Y	Y	Y
S	Y	-	-	-	-	-	-	-	-
T	Y	-	Y	-	Y	Y	Y	-	Y
U	-	-	-	-	-	-	-	-	-
W	Y	-	-	-	Y	Y	-	-	-
X	-	-	-	-	-	-	-	-	-
Y	-	-	-	-	-	-	-	-	-
Z	-	-	-	-	-	-	-	-	-
AC	-	-	-	-	-	-	-	-	-
BD	-	-	-	-	-	-	-	-	-

the birds and whether measures taken to prevent crop damage on the initiative of the management groups are appreciated (Axelsson & Modin 2006b, Administration board in county H, unpubl. data).

Implementing preventive measures

Accomodation fields have been set off for geese and cranes in agricultural areas subjected to crop damage in eight of the Swedish counties since 2002 (Table 1). These fields vary in size between 5 and 20 ha and ranges in number between 1 and 6 depending on the size of the areas and the number of birds causing damage. At these fields, food is provided for the birds in various ways depending on which kind of birds one want to attract and during which time of the year the accommodation areas are supposed to be effective (e.g. Axelsson & Modin 2006a, Hake 2006). The effect of this measure on the movement patterns of birds has been evaluated for geese as well as for the Common Crane, which cause similar crop damage as geese, in five Swedish counties (Table 1). At lake Tåkern, Axelsson & Modin (2006a) found that the geese and Cranes frequently used five accommodation fields, set off in the agricultural areas surrounding the lake, during most of the vegetation season. The proportion of geese and common cranes counted on these fields differed over time, but ranged between 20-60%. Moreover, they found that fields bordering the accommodation fields received relatively few visits from grazing birds. At lake Kvismaren, between 80-100% of the common cranes present in the surrounding agricultural areas used an accommodation field set off during May–July 2005 (Hake 2006). Similarly, at lake Draven (Figure 1),

Truvé (2006) found that a high proportion of the common cranes staging in the area used an accommodation field set off during 2006 as long as food was provided. The effective use of accommodation areas has earlier been shown in several studies (see Vickery & Gill 1999 for a review). Thus, setting off accommodation fields seems to be an effective method to prevent crop damage by attracting birds to areas where they do not cause any damage. The accommodation areas reduce the possible risk of just moving the problem from one vulnerable field to another when the birds are scared from such fields, as they provide a refuge for the birds. However, setting off accommodation fields should preferably be combined with scaring of birds from fields with vulnerable crops, as this may make the accommodation areas even more preferred.

Scaring of birds can be done in numerous ways. To scare birds away from fields susceptible to damage caused by geese (see Conover 2002 for a review), the most commonly used methods in Sweden (e.g. Kjellander et al. 2002, Axelsson & Modin 2006b) are propane cannons, "the Hulk" (an inflatable scarecrow that pops up from a box at irregular intervals), fireworks, wooden figures and flags. In five Swedish counties, one or more persons have been employed by the county administration boards as "scaring consultants" to help the farmers with scaring birds (Table 1). These persons may be contacted by the farmers when there is a risk of crop damage. They respond immediately and provide scaring devices or actively assist the farmers by scaring the birds and/or participating in protective hunting. Also, the "scaring consultants" normally have good knowledge of the movements of the birds and what kinds of crops that is grown within the local area. Thus, they can, on short notice, give priority to preventive measures which may minimize the damage, costs and conflicts between birds and farmers.

Fencing has been used in five of the Swedish counties. Specially designed fences have been put up to prevent crop damage made by geese close to breeding sites (Table 1). This measure is currently most extensively used at lake Tåkern, where about 11 km of such fence has been put up during the last five years (Karl-Martin Axelsson, pers. comm.). Quantitative evaluation of this method has not yet been conducted, but the general impression is that farmers growing crops close to breeding areas of Greylag and Barnacle Geese face less problems when fences are put up (County administration boards, pers. comm.). It is also interesting to note that after the fences were put up at lake Tåkern, the number of breeding Greylag Geese has decreased (Gezelius 2009), and less subsidies for crop damage caused by geese have been paid (Karl-Martin Axelsson, pers. comm.). However, a proper evaluation of this method should be prioritized in the future.

Farming strategy adjustment to prevent crop damage caused by grazing birds may be restricted by regulations on both a European and Swedish level and the farmers´ need to use certain crop schemes on the fields e.g. to minimize the risk for pathogens and the use of fertilizers. However, adjustments in the farming strategy are regularly made in at least three of the Swedish counties (Table 1). A good example comes from lake Hornborga (Figure 1), where a farmer grows a special variety of barley on several fields. This variety grows fast and is possible to harvest 2–3 weeks before the conventional varieties. As a consequence, large areas of stubble fields appear early in the autumn, when geese and crane starts to aggregate in the area. The stubble fields then serve as accommodation areas for cranes and geese (e.g. Kjellander 2003, Axelsson 2004) during this period and hence prevent the birds to cause damage to vulnerable crops. This variety of barley produces a lower harvest than the conventional ones, but the financial loss is subsidized to the farmer by the county administration board.

Evaluating the measures taken

The measures implemented within the working model presented in this paper may be evaluated on different spatial and temporal scales. So far, evaluations have been made in five of the Swedish counties (Table 1), but only on a relatively small scale mainly concerning the change in numbers and behaviour of birds. Also, questionnaires have been sent out to evaluate how farmers in different areas experience the conflict with the birds and the preventive measures taken (e.g. Axelsson & Modin 2006a). The information achieved has been adaptively implemented within the management plans produced by the management groups.

However, there are also needs for developing methods to evaluate measures taken at a larger scale, i.e. within the entire working model. This includes not only ecological aspects, i.e. the change in behaviour of birds, economical aspects, i.e. the economical losses of affected farmers, but also psychological aspects, e.g. how the "quality of life" is affected for the stakeholders involved. To develop such methods, there are several problems

which must be dealt with. To evaluate the measures taken on an economical scale, it is important that all farmers report their damage. From questionnaires, we know that still relatively few farmers do so (Axelsson & Modin 2006b). Therefore, it is difficult to evaluate the economical benefits, as we currently do not know how much "hidden" damage we may avoid by taking the preventive measures. Also, the psychological benefits are difficult to measure, as this aspect is rather vague and preferably measured through questionnaires and interviews with affected stakeholders. Thus, no good methods for performing a complete evaluation of the effectiveness of the working model are currently available, and it is of primary importance that the development of such methods is prioritized in the future.

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Sammanfattning

Populationerna av flera gåsarter har ökat kraftigt såväl i Sverige som i övriga Europa under de senaste 10–15 åren. I Sverige visar årliga höst- och vinterräkningar att grågåsen *Anser anser* t.ex. har tiofaldigat sin populationsstorlek under perioden 1985–2009, från ca 20.000 till 225.000 ex. I nordvästra Europa har antalet övervintrande gäss under perioden 1995–2008 ökat med 24%, från ca 3,5 till 4,3 miljoner individer. Detta har medfört att de skador fåglarna orsakar på kommersiellt odlade grödor genom avbetning och nedtrampning har ökat kraftigt. Enligt svensk lagstiftning skall skador som orsakas av vilt i första hand förebyggas genom jakt. När detta inte är möjligt, t.ex. om skadorna orsakas av fredade arter, skall skadorna förebyggas med andra metoder. Om skador uppstår trots att man har vidtagit förebyggande åtgärder, kan länsstyrelserna (Figur 1) söka statliga medel för att kompensera lantbrukarnas förluster. Länsstyrelserna kan även

söka bidrag från staten för att vidta förebyggande åtgärder. Därigenom kan konflikterna mellan betande fåglar och lantbrukare mildras. 2008 betalade staten ut 4,9 miljoner i bidrag till förebyggande åtgärder och ersättning för skador på gröda (Figur 2). Förutom ekonomiska konsekvenser kan skadorna även medföra att acceptansen minskar för åtgärder som kan gynna den biologiska mångfalden, t.ex. restaurering av våtmarker och bildande av naturreservat. Det är därför viktigt att konflikterna mildras även ur ett naturvårdsperspektiv.

Viltskadecenter är en myndighet som arbetar på uppdrag av Naturvårdsverket. Centret har till uppgift att underlätta arbetet med att förebygga konflikter mellan fredade djur och människan, och har, under de senaste åren, utvecklat en arbetsmodell för att dämpa konflikterna mellan lantbrukare och fredade fåglar i jordbruksområden. Vi redovisar här de olika åtgärder som ingår i denna modell och diskuterar hur effektiva de är och kan bli på sikt. Arbetsmodellen bygger på fyra steg som bör tas i tur och ordning:

Bilda en arbetsgrupp med representanter från berörda intressegrupper

Arbetsgruppen bör bestå av representanter från alla intressegrupper som berörs av konflikten (se exempel i Figur 3). Vidare bör gruppen ha regelbundna möten där man upprättar och vidareutvecklar en förvaltningsplan som syftar till att minska konflikterna i det aktuella området.

Samla in information om fåglarnas beteende och skademönster

För att kunna vidta kostnadseffektiva skadeförebyggande åtgärder behöver man samla in grundläggande information om fåglarnas beteende och hur skadorna varierar i tid och rum. Detta kan man göra t.ex. genom fältstudier av de skadegörande fåglarnas antal och utbredning och genom att undersöka vilka kunskaper som finns lokalt om skadorna och fåglarnas beteende hos lantbrukare och ornitologer.

Vidta förebyggande åtgärder

Den information man har fått genom fältstudier och övrig kunskapsinsamling skall ligga till grund för att vägleda skadeförebyggande åtgärder. I det förebyggande arbetet är det fyra åtgärder som är speciellt viktiga att jobba med.

Avsätt viltåkrar. Avsätt åkrar på vilka fåglarna kan söka föda ostört. Dessa fält måste anläggas i områden där man vet att gässen tycker om att vistas. Åkrarna skall göras så attraktiva som möjligt genom att man odlar grödor som fåglarna tycker om. Man kan även utfodra fåglarna på viltåkrarna under perioder då det är särskilt stor risk för att skador skall uppstå.

Skrämsel. Skräm fåglarna från känsliga fält till de avsatta viltåkrarna med hjälp av lämpliga skrämselanordningar och skyddsjakt. Om risken för skador är stor, anställ resurspersoner som kan rycka ut med kort varsel och hjälpa drabbade lantbrukare med skrämseln och skyddsjakten.

Stängsling. I områden där odlingsmark gränsar till lämplig häckningsbiotop för gäss kan det vara nödvändigt att sätta upp speciella stängsel för att hindra häckande och ruggande gäss från att gå upp och beta på fält med skadekänslig gröda.

Odlingsstrategi. Anpassa, om möjligt, odlingsstrategin i det aktuella området så att risken för skador minimeras. Man kan t.ex. odla grödor som gässen inte tycker om och/eller odla skadekänsliga grödor i områden där gässen inte tycker om att vistas pga. mänsklig aktivitet.

Utvärdera effekten av vidtagna åtgärder

För att utveckla och förbättra de förebyggande åtgärder som vidtas, måste de använda metodernas effektivitet utvärderas. Detta kan man t.ex. göra genom att följa upp förändringar i de skadegörande fåglarnas antal och beteende, skadefrekvens, ekonomiska kostnader och attityder hos människor som är berörda av konflikterna.

Resultat och diskussion

Sedan 2002 har 12 arbetsgrupper i 11 län upprättats på initiativ av respektive länsstyrelse (Tabell 1). Detta har ökat förståelsen och kommunikationen mellan olika intressegrupper och bidragit till att skapa ett mer positivt klimat i arbetet för att hantera skadeproblematiken. Arbetsgrupperna har dessutom initierat kunskapsinsamling angående fåglarnas beteende och skadornas utbredning genom fältstudier och sammanställning av befintliga kunskaper hos berörda parter genom frågeenkäter. I tre län har även förvaltningsplaner upprättats (Tabell 1).

En rad olika skadeförebyggande åtgärder har vidtagits på initiativ av grupperna. En kombination av skrämsel och avsättning av viltåkrar har visat sig vara speciellt effektiv för att styra fåglarna till områden där de inte orsakar några skador. I vissa ”högriskområden” har länsstyrelsen anställt resurs-

personer som hjälper lantbrukarna med skrämsel och skyddsjakt (Tabell 1). Kunskapsinsamlingen har även gett tips om var man skall sätta upp stängsel för att förhindra häckande och ruggande gäss att gå upp och beta på åkrar som angränsar till områden med lämplig häckningsbiotop för gässen (Tabell 1).

För att öka förståelsen för viltförvaltning rent allmänt är det viktigt att allmänheten kan få information om och möjlighet att påverka de beslut som tas. Arbetsgrupperna bjuder därför in allmänheten till årliga möten, vid vilka alla som närvarar kan få delge sina synpunkter på de skadeförebyggande åtgärder man vidtagit och de resultat man har uppnått.

Om man skall kunna utveckla förvaltningsarbetet i framtiden måste man utvärdera effekterna av de skadeförebyggande åtgärder som vidtagits. Sådana utvärderingar har hittills gjorts på en liten rumslig skala. Man har exempelvis gjort utvärderingar av hur avsättningen av viltåkrar i kombination med skrämsel påverkar de skadegörande fåglarnas beteende (Tabell 1). Däremot har man ännu inte gjort utvärderingar på en större rumslig skala, t.ex. av hur de förebyggande åtgärderna som har vidtagits påverkat skadefrekvens, ekonomi och de människor som påverkas totalt sett. Sådana utvärderingar är svårare att göra, och en utveckling av metoder för att analysera detta måste prioriteras i framtiden.

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