



**BTO Research Report 595**

**Review of European flyways of  
the Lesser White-fronted Goose  
*Anser erythropus***

John H Marchant & Andrew J Musgrove

*A report to the UNEP/AEWA Secretariat*

Submitted: June 2011  
Final revised version: October 2011

BTO, The Nunnery,  
Thetford, Norfolk, IP24 2PU

Registered Charity No. 216652 (England & Wales), No. SC039193 (Scotland)

Recommended citation: **Marchant, J.H. & Musgrove, A.J. (2011) *Review of European flyways of the Lesser White-fronted Goose Anser erythropus*. Research Report 595. British Trust for Ornithology, Thetford.**

© British Trust for Ornithology and UNEP/AEWA Secretariat 2011

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form, or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the publishers.

## CONTENTS

<b>List of tables and figures</b> .....	4
<b>Glossary</b> .....	4
<b>Executive summary</b> .....	5
<b>1 Introduction</b> .....	7
1.1 Lesser White-fronted Goose and its status in the wild .....	7
1.2 Current threats and protected status.....	9
1.3 Reintroduction/supplementation projects for LWfG .....	10
1.4 The RECAP Committee .....	15
1.5 The terms of reference for this review .....	15
1.6 Plan for the review.....	16
<b>2 What exactly is a flyway?</b> .....	17
2.1 The concept of ‘flyways’ .....	17
2.2 How sharply should migration routes for geese be defined? .....	19
2.3 Change in goose migration routes over time .....	22
2.4 Causes of change in goose migration routes.....	24
2.5 Application of the flyway concept to western European LWfG .....	24
<b>3 Review of LWfG occurrence in western Europe</b> .....	27
3.1 Summaries of key literature .....	27
3.2 Additional information on LWfG occurrence in Britain .....	29
3.3 Specific comments on Kampe-Persson (2008) .....	32
3.4 Specific comments on Mooij & Heinicke (2008).....	34
3.5 Specific comments on Mooij <i>et al</i> (2008) .....	35
3.6 Publications since 2008.....	36
<b>4 Conclusions</b> .....	39
4.1 The knowledge base .....	39
4.2 Did an ‘Atlantic flyway’ exist historically for LWfG? .....	40
4.3 Likely explanations for the records of LWfG in western Europe .....	41
4.4 Can flyways change? .....	42
4.5 What future for the western migration route of LWfG? .....	42
4.6 Priorities for LWfG conservation in the western Palaearctic .....	42
<b>Acknowledgements</b> .....	44
<b>References</b> .....	45

## LIST OF TABLES AND FIGURES

### Tables

Table 1	Treatments in the major published literature of LWfG occurrences in western Europe .....	28
---------	--	----

### Figures

Figure 1	Breeding distribution of LWfG in Fennoscandia (excluding Russia) before 1950, during 1960–80, in the early 1990s and in 2005 .....	8
Figure 2	Global distribution of wild populations of LWfG for the period 2000–05 .....	20
Figure 3	Temporal distribution of British records of LWfG held by BBRC .....	30
Figure 4	Distribution of records of escaped LWfG in Britain during 1994–2009 .....	31
Figure 5	Distribution of LWfG observations in Fennoscandia during 1900–81 .....	36

## GLOSSARY

AEWA .....	African–Eurasian Migratory Waterbird Agreement
BBRC .....	British Birds Rarities Committee
BTO .....	British Trust for Ornithology
DOF .....	Dansk Ornitologisk Forening
IUCN .....	International Union for Conservation of Nature
LWfG .....	Lesser White-fronted Goose
NOF .....	Norsk Ornitologisk Forening
RECAP Committee .....	Committee for Captive Breeding, Reintroduction and Supplementation of Lesser White-fronted Geese in Fennoscandia
SOF .....	Sveriges Ornitologiska Förening
SOVON .....	SOVON Vogelonderzoek Nederland
UNEP .....	United Nations Environment Programme
ZMA .....	Zoological Museum Amsterdam

## EXECUTIVE SUMMARY

- 1 The Lesser White-fronted Goose *Anser erythropus* (hereafter LWfG) is a small, highly migratory, Arctic-nesting goose that occupies a breeding range from Scandinavia eastward to Chukotka in eastern Siberia. During the 19<sup>th</sup> and 20<sup>th</sup> centuries, the species underwent a massive population decline across all parts of its range. It is now highly protected under international conventions and the subject of an international action plan under the African–Eurasian Migratory Waterbird Agreement (AEWA).
- 2 Several attempts at reintroduction or restocking have been made in Fennoscandia. Releases in Sweden during 1981–99 were successful in re-introducing/supplementing a breeding population in Sweden. These birds migrate on a western migration route to the Netherlands, in contrast to the remnant wild Fennoscandian population, which migrates towards wintering areas in southeast Europe.
- 3 Views differ markedly among conservationists concerning the ethical and scientific merits of captive breeding, supplementation/reintroduction and flyway establishment or modification as conservation tools for LWfG, particularly with regard to the desirable timing for applying such measures. The management of future releases is now the function of the RECAP Committee.
- 4 An important question now posed by the RECAP Committee is whether the western migration route ('Atlantic flyway') used by the Swedish population is a natural one, either recreated or augmented by the Swedish releases, as has been claimed in some recent literature, or an artificial one. This report reviews this question with the aim of giving advice to the Committee.
- 5 The review finds no clear evidence that such a migration route existed before the Swedish releases began, although it might have done so, dying out before European ornithology had developed sufficiently to record it. We consider that the evidence available is insufficient to overturn the alternative, widely held view that LWfG reach western Europe having been diverted from their Central European migration route. This conclusion, that there is insufficient evidence for the existence of a historic western migration route, is in contrast to a recently published paper which states unequivocally that the traditional migration routes of the Scandinavian population were well separated from those of the North Fennoscandian population.
- 6 The case for the western migration route being a natural one seems to rest largely on the several hundred records of LWfG that exist for western European countries prior to 1981, rather than on evidence of how those birds reached western Europe. The main alternative explanation for the presence of these birds, which we support, is that they were diverted from their Central European migration route by being caught up with Greater White-fronted and Bean Geese moving southwest towards western Europe.

- 7 In Britain and perhaps some other western European countries outside the normal range of the current Swedish population, the large majority of LWfG now being recorded can almost certainly be accounted for by escapes from captivity. The first known British record of LWfG assigned to the escape category was in 1976, thus pre-dating Swedish releases, but small numbers of escapes might have been present in Europe much earlier.
- 8 We feel that the question of whether the western migration route is a natural one or not should not be an overriding issue. Migration routes cannot be defined closely, because the tracks taken vary between individuals and between years. Furthermore, the boundaries between natural and unnatural for goose movements and distribution are being blurred irrevocably by the presence of large and growing numbers of introduced and escaped geese in Europe.
- 9 Every effort should be taken to increase the supply of captive-bred Russian birds suitable for release. While the supply of captive-bred LWfG is limited, they should be released where they have the best chance of joining a breeding population. The RECAP Committee needs to consider all its options carefully.

## 1 INTRODUCTION

### 1.1 Lesser White-fronted Goose and its status in the wild

The Lesser White-fronted Goose *Anser erythropus* (hereafter LWfG) is a small, highly migratory, Arctic-nesting goose that occupies a breeding range from Scandinavia eastward to Chukotka in eastern Siberia, and in winter occurs in scattered localities between western Europe and eastern China (del Hoyo *et al* 1992). Escapes and a few vagrants have been recorded in North America but breeding populations are confined to the Palearctic. Although broad from west to east, the LWfG's breeding range occupies a narrow range of latitudes, essentially at the meeting of the tundra and taiga zones, overlapping with the southern edge of the range occupied by breeding Greater White-fronted Geese *A. albifrons albifrons* and *A. a. frontalis* in Arctic Russia. The main wintering grounds of LWfG are located in northeast Greece, on the coastal plains south and west of the Caspian Sea, in the Mesopotamian region of Iraq and in the Lower Yangtze Valley in southeast China. There are many records, however, of small parties or individual birds scattered at similar latitudes across the Palearctic, west to the UK and Spain.

Despite its breeding range extending across more than 160° of longitude and its main wintering areas being so widely separated, no subspecies have been described. No geographical variation is known in phenotype other than a clinal increase in size from west to east (Cramp & Simmons 1977, Ruokonen *et al* 2004).

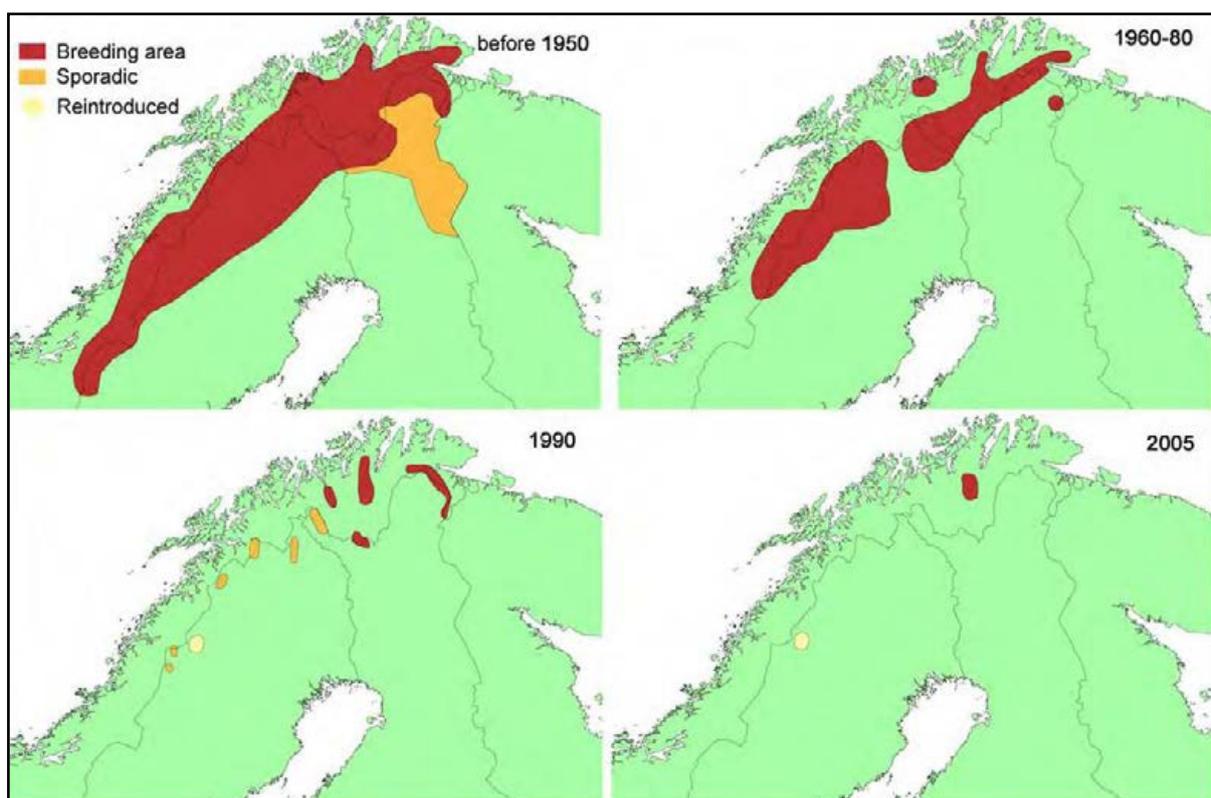
During the 19<sup>th</sup> and 20<sup>th</sup> centuries, the species underwent a massive population decline across all parts of its range. It has become one of the most severely threatened of Arctic-breeding birds. For the western Palearctic, Cramp & Simmons (1977) reported an abrupt decline since c 1950 in Finland (Soikkeli 1973), a decrease among the small Swedish population during the 1960s (Curry-Lindahl *et al* 1970), in Norway a decline in Börgerfjell and disappearance from the Vadsö area after 1950 (Haftorn 1971) and concurrent evidence of winter decreases in southeast Europe (Johnson & Hafner 1970).

The decrease in numbers has led to increasing fragmentation of the breeding range, to the extent that up to three distinct geographical subpopulations are now recognised for the purposes of population management – these are termed the Fennoscandian, the West Russian (or Western Main) (these two forming a single unit for population estimation; Delany & Scott 2006) and the East Russian (Eastern Main) populations. The Fennoscandian population breeds in the Nordic countries and the adjoining Kola Peninsula of northwest Russia, the West Russian population in northern Russia to the west of the Taimyr Peninsula and the East Russian population, which winters in China, from the Taimyr Peninsula eastwards. Genetic studies have indicated that a degree of genetic exchange exists between the Fennoscandian and West Russian populations but that divisions between these and East Russian birds have existed since the last Ice Age (Ruokonen *et al* 2004, 2007).

The Fennoscandian population currently comprises just a few dozen pairs in Norway and the Kola Peninsula in adjacent Russia, having declined from more than 10,000 birds, distributed widely across Lapland, as recently as the 1940s. The Norwegian population has most

recently been estimated at just 15–20 pairs, of which just 10–15 pairs are currently breeding (Øien & Aarvak 2008). The last fully confirmed nesting of wild birds in Sweden occurred in 1989 (von Essen 1999), although breeding may have continued until 1996 or 1998 (Naturvårdsverket in prep). In Finland, breeding ceased during the 1990s (Andersson & Larsson 2006).

The demise of the Fennoscandian population in Norway, Sweden and Finland has been mapped by Øien & Aarvak (2008). Their diagram showing the contraction of the breeding range since 1950 is reproduced here as Figure 1. By 1990, breeding in Sweden was at best sporadic and, by 2005, a single breeding area remained, in north Norway. Figure 1 does not show the additional breeding areas in the Kola Peninsula.



**Figure 1.** Breeding distribution of LWfG in Fennoscandia (excluding Russia) before 1950 (upper left), during 1960–80 (upper right), in the early 1990s (lower left) and in 2005 (lower right). Reproduced from Øien & Aarvak (2008). © NOF

The three subpopulations have all continued their declines in recent decades. BirdLife International (2011) has estimated that, across all subpopulations, a decrease in numbers of 30–49% occurred during the period 1998–2008 alone. The global population may now number as few as 20,000–25,000 mature individuals, with 8,000–11,000 individuals present in autumn in the western Palaearctic (BirdLife International 2011). Because the steep decrease in numbers is affecting all parts of the population, and appears to be continuing at

a rapid rate, fears have been growing for several decades that the species may be heading towards imminent extinction in the wild, first in Fennoscandia and then globally.

The current extent of the known global breeding population is described by Øien & Aarvak (2008) as follows:

- Fennoscandia (northern) and the Kola Peninsula, 20–25 pairs;
- tundra between the White Sea and the Urals (Malo & Bolshezemelskaya tundra) and the Ural Mountains, 250–400 pairs;
- Yamal Peninsula (southern), 350–500 pairs;
- Taimyr Peninsula (southern), 1,000–1,500 pairs;
- Putorana Mountains (south of Taimyr), 150 pairs; and
- northeast Siberia (Indigirka and Abyiskaya lowlands in Yakutia), 1,050–1,850 pairs.

These authors admit, however, that there are several unknown breeding areas in northern Russia, as well as areas that have not been investigated thoroughly in recent times, including Gydan, Taimyr, and large parts of Yakutia and Chukotka.

## 1.2 Current threats and protected status

The IUCN Red List regards LWfG as ‘Vulnerable’ and BirdLife International classify it as ‘SPEC 1’ within Europe, denoting a European species of global conservation concern (BirdLife International 2004, 2008). LWfG is listed in Appendix 1 of the Bonn Convention on the Conservation of Migratory Species, Annex 1 of the European Council Directive on the Conservation of Wild Birds (79/409/EEC 1979, 2009/147/EC 2009), in Column A Category I of the Action Plan under the African–Eurasian Migratory Waterbird Agreement (AEWA) and in Annex II ‘Strictly protected species’ of the Bern Convention.

Hunting throughout the range and habitat loss on the wintering grounds are believed to be the main reasons for population decline (Jones *et al* 2008, BirdLife International 2011). The species has legal protection from hunting in all 22 AEWA range states but illegal killing appears to be frequent along the whole eastern European and central Asian range of the species, particularly in Kazakhstan and Greece. A particular problem is the similarity of LWfG to Greater White-fronted Goose, which is a legal quarry species hunted intensively across most of its range. LWfG regularly forms mixed flocks with that species: hunters might therefore shoot some LWfG through honest mistakes in their identification of flying birds. Enforcement of legal protection from hunting is therefore unusually problematic.

A European action plan for LWfG was first published in 1996 (Madsen 1996). More recently, an updated and extended International Single Species Action Plan for the conservation of the western Palaearctic populations has been compiled (Jones *et al* 2008). This new plan

was adopted by the fourth Meeting of Parties to AEWA in Madagascar in September 2008 (AEWA 2008). Several key range states have published or are preparing national action plans (eg Savas & Nazirides 1999, Finnish Ministry of the Environment 2009, Norwegian Directorate for Nature Management 2011, Naturvårdsverket in prep).

The overall coordination of the international implementation of the action plan is maintained by a coordinator based at the UNEP/AEWA Secretariat.

### **1.3 Reintroduction/supplementation projects for LWfG**

Given the precarious conservation status of LWfG, and that methods for captive breeding and release of goose species have been well practised and have a long history, it is not surprising that several projects have been implemented or are being planned for national reintroduction or the supplementation of LWfG populations in Europe.

Reintroduction and supplementation for geese, and for other bird species, have sometimes been undertaken opportunistically, and with practical considerations overriding the species' wider conservation needs and the broader ecological implications. With improved understanding of conservation biology, it is now more widely recognised that such projects should never be undertaken lightly and should always be integrated with wider conservation efforts for existing wild populations.

Projects for the release of captive LWfG that were in operation before 1996 pre-date any international guidelines or action plan but subsequent ones must be guided by the international action plan, now co-ordinated by the UNEP/AEWA Secretariat. They should conform to the IUCN guidelines for reintroductions (IUCN 1998) and, for waterbirds, to the principles of the AEWA review of waterbird re-establishments (Lee & Hughes 2008). Current international guidelines stress the importance of completing a full feasibility study, before any releases are licensed, to establish the justification for the project as well as its practicability.

Views differ markedly among conservationists concerning the ethical and scientific merits of captive breeding, supplementation/reintroduction and the establishment or modification of migration routes as conservation tools for LWfG, particularly with regard to the desirable timing for applying such measures (Jones *et al* 2008). Even following the agreement of the international action plan, disputes exist between the range states as well as other stakeholders in Europe on how captive breeding, reintroduction and supplementation of LWfG in Fennoscandia should best be approached.

Projects that have been completed, are under way or at planning stages are discussed below by country and in approximate chronological order.

#### *Sweden: completed projects*

In response to the rapid decline of the LWfG breeding population in the Swedish mountains since the 1950s, the Swedish Association for Hunting and Wildlife Management (Svenska

Jägareförbundet) established a captive-breeding programme in the late 1970s (von Essen 1996, 1999, Andersson 2004). During 1981–99, 348 captive-bred individuals were released into the mountains in Arjeplog municipality in Norrbotten County, Swedish Lapland. The chosen site lies centrally within the western part of the former native range of the species in the Scandinavian mountains (Figure 1). It is well to the west of the remnant breeding range of the native Fennoscandian population in north Norway and the Kola Peninsula.

The captive-bred birds were released with Barnacle Geese *Branta leucopsis* taken from the Swedish breeding population, which winters in the Netherlands; when released alongside their foster parents, these geese flew with them to the Netherlands and established wintering grounds there. This method of release diverted the birds' migration routes and wintering grounds away from areas of high hunting pressure in eastern Europe and towards sites where non-breeding birds could most easily be protected.

Released birds have established a new Swedish breeding population, presently numbering around 100 birds, of which 10–15 pairs nest in Norrbotten County. All birds released from captivity were marked with coloured leg rings, but the young raised by these birds are mostly unmarked and the proportion of the population carrying rings is now low. Counts of non-breeding birds from this population in coastal provinces in the Netherlands reach 70–80 birds for the period October–February in most winters, with favoured sites including Oudeland van Strijen, Lauwersmeer and Abtskolk & de Putten (SOVON 2011). Sightings of marked birds from this population have been made also in the UK, Spain and both western and eastern Germany. This breeding group has high survival rates, in comparison with the native Fennoscandian population, that derive from relatively low hunting mortality. Despite releases having ceased in 1999, this is the only one among the western subpopulations that is not decreasing.

The breeding stock for the birds released in Sweden had been built up mainly with birds and eggs originating from wildfowl collections in the UK and continental Europe. In turn, these had included wild birds trapped in Hungary and the Netherlands. In 2000, genetic evidence was published that the population of birds being released had in the past shown some hybridisation with Greater White-fronted Geese (Ruokonen *et al* 2000). Releases ceased immediately upon this discovery. A subsequent analysis of nuclear genetic variation has shown that the genetic differentiation between the wild Fennoscandian population and the captive breeding stock is three times as large as between the wild population of Fennoscandia and that of central Asia; thus, from a genetic perspective, this captive stock is poorly representative of the original Fennoscandian population (Ruokonen *et al* 2007). The issue of the genetics of the Swedish population has recently been reassessed as being of low priority (Amato 2010) and the conclusion and recommendations of this report were accepted by the RECAP Committee in October 2010 ([http://www.unep-aewa.org/meetings/en/lwfg/lwfg3/recap3\\_minutes\\_final.pdf](http://www.unep-aewa.org/meetings/en/lwfg/lwfg3/recap3_minutes_final.pdf)).

Initially, the releases may have overlapped with the existence of a Swedish wild population breeding in the same area but, at some point during 1981–99, and perhaps as early as 1989, the already sporadic breeding of native LWfG in Sweden effectively ceased. Although this programme is usually referred to as a reintroduction, there is therefore a case for considering that it fulfils IUCN's (1998) criteria for a 'reinforcement' or 'supplementation' of

an existing population (Andersson & Holmqvist 2010). No evidence can be presented, however, that any wild birds participated in establishing the present Swedish breeding population, although it is conceivable that they might have done so.

It has been argued in Sweden that their releases have supplemented a part of the original Fennoscandian subpopulation and therefore that the present Swedish breeding birds are an integral part of the internationally recognised wild Fennoscandian subpopulation (*eg* Andersson & Holmqvist 2010, Naturvårdsverket in prep). The Norwegian BirdLife partner Norsk Ornitologisk Forening (NOF) and BirdLife Finland dispute this assertion vigorously on the grounds that, first, the Swedish birds are demonstrably different genetically from the wild Fennoscandian subpopulation and, second, that the migration route and non-breeding range of these birds is artificial and was never in use by wild birds. Øien & Aarvak (2008) take the stance that the Swedish birds, rather than making a positive contribution to the Fennoscandian subpopulation, present a real or potential threat to it in the forms of genetic contamination, alteration of migratory route and spread of disease.

The proposal within the draft Swedish national action plan is now to continue the previous programme of captive breeding and release, but using exclusively wild-caught birds from the West Russian population imported from Russia (Naturvårdsverket in prep). The first shipment of eight wild birds from Russia was received in Sweden in 2006 and by May 2008 a total of 24 had been received (Jones *et al* 2008).

A drawback of the use of Barnacle Geese as foster parents has been that some LWfG found breeding partners among the Barnacle Geese instead of their own species and raised hybrid young. An alternative method of release, pioneered for cranes and other species in the USA, that avoids using another bird species as foster parent, is to use modified ultra-light aircraft to guide the young birds on their first migration. In 1999, the French scientist Christian Moullec released 27 LWfG of mostly Belgian captive origin in central Sweden and guided them by ultra-light aircraft to the Lower Rhine area of Germany. Of these, 21 arrived at their destination. Most were later recaptured but a few remained free and have been observed in coastal areas of Finland (occasionally also in Denmark and eastern Germany) mainly with urbanised Barnacle Geese. One bird has been observed in Spain. None is thought to have joined an LWfG breeding population and this alternative release method may also have led to some hybridisation with Barnacle Geese, in Finland (Jones *et al* 2008).

In addition to the Fennoscandian and West Russian populations, the international action plan also takes into account the current Swedish population, treating it as a separate geographical subpopulation of the species (Jones *et al* 2008). According to previous agreements between the Fennoscandian range states, however, the main focus of the international action plan is the conservation of the remaining wild populations.

#### *Sweden/Germany: Aktion Zwerggans proposal*

Aktion Zwerggans (Operation Lesser White-front), a German-based international group founded in 2001, aimed to release up to 400 captive-bred Lesser White-fronted Geese in Swedish Lapland over a four-year period (Mooij 2001, Mooij *et al* 2006). The project would use specially modified slow-flying ultra-light aircraft to guide the birds from the release site

through Sweden, Denmark and northwest Germany to safe wintering grounds in the Lower Rhine Valley of Germany. Detailed and lengthy planning for this programme has already been conducted (Mooij 2005; [www.zwerggans.de](http://www.zwerggans.de)). The proposed migration route and wintering area is similar to that of the released Swedish population and might have formed part of a previous, naturally existing western migration route (eg Kampe-Persson 2008, Mooij 2010), although the previous existence of such routes is open to question.

On 20 October 2005, Naturvårdsverket decided to grant permission to Aktion Zwerggans, subject to certain conditions being met (including a thorough genetic screening of the birds concerned), for the release in Västerbotten County of up to 25 LWfG in both 2006 and 2007 and for the implementation of a pilot project on the use of ultra-light aircraft as a means of guiding the released geese on their first migration.

In November 2005, the Scientific Council of the Convention on Migratory Species concluded, as part of its wider recommendation on LWfG (Jones *et al* 2008: see pages 34–35 and Annex 9a), that:

- *“For the present, we do not support the introduction of Lesser White-fronted Geese into flyways where they do not occur naturally. We have borne in mind the powerful argument concerning the improved safety of birds in these flyways, as well as practical considerations, such as current proposals that could quickly be put into effect. However, we consider that modifying the natural behaviour of Lesser White-fronted Geese in this respect, as well as unknown ecological effects in the chosen new flyways, and other such considerations, make this technique inappropriate until such time as it may become essential, particularly when major disruption or destruction occurs of key components of the natural flyways. We do not believe that to be the case at present.”*; and
- *“our opinion that all appropriate efforts should also be made to conserve the wild populations of the species in its other flyways”*.

These findings had clear negative implications for the proposed Aktion Zwerggans project, since the Council was referring to both the movement of LWfG between Sweden and the Netherlands and the proposed route to the Lower Rhine Valley. Further, with reference to the existing Swedish population, they concluded:

- *“the above mentioned free-flying birds, or their descendants, may pose a risk to the genetic make-up of the wild Fennoscandian population, the Scientific Council is of the opinion that these birds should be caught or otherwise removed from the wild”*.

An outbreak of avian influenza across Eurasia prevented any releases in 2006. Following consultations in 2006 and 2007 between the German government, Aktion Zwerggans, the Fennoscandian range states and the UNEP/AEWA Secretariat, it was agreed that the Aktion Zwerggans experimental pilot project would be postponed for a further three years. This period would be used to enable sufficient stock to be built up derived entirely from wild-caught Russian birds, or to seek international acceptance, in particular of the results of a genetic analysis of captive and wild Lesser White-fronted Geese conducted in the

framework of the project (AEWA 2007; Annex 10). In 2010, the RECAP Committee ([http://www.unep-aewa.org/meetings/en/lwfg/lwfg3/lwfg\\_recap\\_3.htm](http://www.unep-aewa.org/meetings/en/lwfg/lwfg3/lwfg_recap_3.htm)) discussed the proposal again but was not in the position to reach a consensus on the project due to a number of pending issues.

### *Finland*

In 1986, a captive breeding population of LWfG was established in Finland under the auspices of WWF-Finland (Markkola *et al* 1999). Between 1987 and 1997, about 150 captive-bred birds were released in Finnish Lapland, including 20 adults or second-year birds, but high mortality occurred and none of the reintroduced birds made breeding attempts. Of ten reports of marked birds, seven were from birds shot by hunters. This reintroduction programme did not attempt to manipulate the migration routes of the released birds (Markkola *et al* 1999).

A first-winter LWfG with a leg ring and a blue neck-collar numbered 13 seen with European White-fronted Goose and Barnacle Geese at Slimbridge in southwest England in December 1990 (A.J. Musgrove pers obs) and at Dryslwyn in South Wales in February 1991 was believed to have been one of these birds. Two additional birds have been seen in Germany, one of which had also been observed over several winters in the Netherlands and Belgium.

In July 2004, and in contravention of a government moratorium, the Finnish NGO *Friends of the Lesser White-fronted Goose* released three LWfG goslings in northern Finland. The birds were released with Barnacle Goose foster parents, the male of which was satellite-tagged. One of the young LWfG was sighted among Barnacle Geese in the Netherlands in December 2004, though not in the company of its foster parents, nor with supplemented/reintroduced Swedish birds (<http://users.jyu.fi/~laurikah/Kotisivut/AnserErythropus/LWfG.html>). Captive breeding of LWfG by *Friends of the Lesser White-fronted Goose*, and perhaps also their reintroduction activities, are ongoing, despite legal challenges over the legitimacy of such releases.

### *Norway*

Lee *et al* (2010) conducted a full feasibility study for the reintroduction/supplementation of LWfG in Norway, using traditional migratory routes, and found that boosting the population with released Russian birds would be both feasible and desirable, even though the original causes of decline had not yet been eliminated.

In August 2010, an experimental release was made on the Valdak Marshes in north Norway of four young LWfG of Russian origin, raised at Nordens Ark in Sweden (Aarvak & Øien 2011). On release, the birds joined the small flock of wild birds also present at this site. One released bird was tracked by satellite to Finland and subsequently across the Baltic to south Sweden where it was observed to be on its own. In late May 2011, one of the birds was resighted back at Valdak Marshes. Although so far of limited success in returning birds to the wild, this pilot project has provided valuable information to guide further releases under the Norwegian national action plan (Norwegian Directorate for Nature Management 2011). Manipulation of migration routes is not permitted in Norway and only birds originating from

wild-caught Russian birds are to be released (Norwegian Directorate for Nature Management 2011).

#### **1.4 The RECAP Committee**

With the agreement in 2007 of government representatives from Sweden, Norway, Finland and Germany, a 'Committee for Captive Breeding, Reintroduction and Supplementation of Lesser White-fronted Geese in Fennoscandia' (the RECAP Committee) was founded, for the review of the long-term future of all reintroduction and supplementation programmes (AEWA 2007). The RECAP Committee is a thematic subgroup of the International Working Group for the Lesser White-fronted Goose and is convened and chaired by the UNEP/AEWA Secretariat, as part of its implementation of the international action plan (see [http://www.unep-aewa.org/meetings/en/lwfg/lwfg1/lfwg\\_recap\\_1.htm](http://www.unep-aewa.org/meetings/en/lwfg/lwfg1/lfwg_recap_1.htm)). It is a platform for exchange of information and for coordination and, if possible, future agreed action between the range states to the Fennoscandian population of the LWfG. It guides the future activities on captive breeding and release into the wild of the species in Fennoscandia, while taking full account of the development of the remaining wild Fennoscandian population.

#### **1.5 The terms of reference for this review**

The second meeting of the RECAP Committee, in September 2009, decided to commission an independent scientific review of both peer-reviewed and grey literature on the different historic flyways of LWfG in Europe. Terms of reference for this review were discussed at the third meeting in October 2010

([http://www.unep-aewa.org/meetings/en/lwfg/lwfg3/lfwg\\_recap\\_3.htm](http://www.unep-aewa.org/meetings/en/lwfg/lwfg3/lfwg_recap_3.htm)).

A key question formulated at the third meeting, directly concerning the Aktion Zwerggans project, is whether a flyway from Swedish Lapland to the Lower Rhine Valley has existed in the past, as Aktion Zwerggans has argued. The Aktion Zwerggans project would not receive the support of the AEWA Contracting Parties that are members of the RECAP Committee or the UNEP/AEWA Secretariat if the project were seen to be creating a new or unnatural flyway, when other natural flyways were still in use by the species. Lack of support from the RECAP Committee might signal the project's financial collapse, especially if the specially commissioned ultra-light aircraft owned by Aktion Zwerggans had to be sold. If on the other hand the flyway could be shown to have been used previously, this could open the way to new financial support and to the project's eventual completion.

This review addresses the slightly broader question of whether migration routes other than the ones currently linking the Norwegian breeding grounds to Hungary and Greece existed for LWfG in Europe before the 1980s, when the Swedish route to the Netherlands was established.

The functions of this review, as set out in the terms of reference agreed on by the RECAP Committee are to:

- Develop a solid information base of the relevant published literature (peer-reviewed and grey).
- Provide an objective expert judgment of the quality (strengths, weaknesses, flaws) of the scientific information obtained in each paper, and of the conclusions drawn.
- Help clarify past and present flyways and sub-populations in Europe (for each, information should be provided on geographical extent, numbers of birds and regularity of use, years when the flyway was used, and a measure of confidence in the available data and conclusions). Specifically, an assessment should be provided on to what extent Germany formed part of a former flyway, in particular as a wintering area for the Fennoscandian population.
- Assess remaining issues/weaknesses and information needed to fill knowledge gaps on the issues of LWfG flyways in Europe.
- To assess and review to what extent flyways may change or vary in a species similar to the LWfG and for what (likely) reasons.
- Provide the Committee with sufficient information on the European flyways (former and present) of LWfG for recommendations on joint conservation actions.

The UNEP/AEWA Secretariat terms of reference specifically request that critical reviews are undertaken of the following scientific papers:

- **Kampe-Persson, H. (2008)** Historical occurrence of the Lesser White-fronted Goose *Anser erythropus* in the Atlantic flyway. *Ornis Svecica* 18: 68–81.
- **Mooij, J.H. & T. Heinicke (2008)** Status, distribution and numbers of the Lesser White-fronted Goose *Anser erythropus* in Germany. *Vogelwelt* 129: 281–292.
- **Mooij, J.H., P. Hansson, H. Kampe-Persson & L. Nilsson (2008)** Analysis of historical observations of Fennoscandian Lesser White-fronted Geese *Anser erythropus* in Sweden and the West Palearctic. *Vogelwelt* 129: 269–280.

## 1.6 Plan for the review

Following the present introduction, this review concludes its brief under the following broad headings:

- a discussion of the nature of a flyway;
- a summary of information published prior to 2008 on the existence or otherwise of ‘an Atlantic flyway’ for LWfG;
- a review of papers published in 2008–10, with special attention to the three papers listed above; and
- conclusions from the review.

## 2 WHAT EXACTLY IS A FLYWAY?

The concept of ‘flyways’ for wildfowl may seem to be well developed but is a problematic one in terms of its definition and its relevance to wildfowl conservation. The meaning of the term appears to have shifted over time as knowledge of bird migration has increased. Even under current best practice, several definitions may correctly be applied depending on context, making discussion of ‘flyways’ potentially confusing.

This section of the review aims to expose some of the difficulties surrounding the word ‘flyway’ and to develop a more precise terminology to apply to the specific questions that we are required to address.

### 2.1 The concept of ‘flyways’

In 1948, the North American states and provinces with common boundaries and similar wildfowl problems were grouped into four north–south flyways (Pacific, Central, Mississippi and Atlantic), to facilitate the management of hunting. These political units were not useful for defining migration routes, however, which, as radar studies quickly showed, frequently crossed flyway boundaries on an east–west axis (Bellrose 1980). In summarising migration for North American wildfowl, Bellrose instead drew up migration ‘corridors’ for each goose and duck species, indicating more precisely the routes thought to be taken, with estimates of population size for each one.

Atkinson-Willes (1976) argued that, for purposes of population management, the flyway concept should be abandoned for common and widespread wildfowl in Europe, because of overlap of routes between populations and variability within populations between years. This approach was followed by Scott & Rose (1996), who defined population boundaries for wildfowl management mainly on the basis of their wintering grounds, often with the delineated ‘populations’ overlapping across large sections of the breeding grounds.

‘Flyways’ are more likely these days to mean the equivalent of Bellrose’s ‘corridors’, but described on the basis of far greater knowledge. For example, Madsen *et al* (1999) define five migratory routes for Greater White-fronted Geese in the west Palaearctic, naming each one a flyway, before going on to point out the high degree of mixing of birds between the different flyways. The same work, however, describes Atlantic and Central European flyways for the less migratory Greylag Goose simply by drawing a line of separation running from the Baltic southwards to northwest Italy, suggesting a return to the original North American model.

An important and authoritative contribution to resolving the meaning of the word ‘flyway’ was made by Boere & Stroud (2006). They state that, overall:

*“A flyway is the entire range of a migratory bird species (or groups of related species or distinct populations of a single species) through which it moves on an annual basis*

*from the breeding grounds to non-breeding areas, including intermediate resting and feeding places as well as the area within which the birds migrate.”*

These authors go on to say that there may be three rather different meanings within this overall definition, depending on the specific context in which the word ‘flyway’ is used:

- **Single species migration systems.** Boere & Stroud (2006) define ‘flyway’ in this context as *“The distributional extent of the annual migration of a species, or population within a species, encompassing breeding staging and non-breeding areas”*. They also say *“Whilst often described as the flyways of the species concerned, such annual distributional ranges are better described as the migration system of the species concerned”*.
- **Multi-species flyways.** For the purposes of the Ramsar Convention on Wetlands, ‘flyway’ is defined as follows (Ramsar Convention 2006): *“the concept developed to describe areas of the world used by migratory waterbirds and defined as the migration routes(s) and areas used by waterbird populations in moving between their breeding and wintering grounds. Each individual species and population migrates in a different way and uses a different suite of breeding, migration staging and wintering sites. Hence a single flyway is composed of many overlapping migration systems of individual waterbird populations and species, each of which has different habitat preferences and migration strategies. From knowledge of these various migration systems it is possible to group the migration routes used by waterbirds into broad flyways, each of which is used by many species, often in a similar way, during their annual migrations. Recent research into the migrations of many wader or shorebird species, for example, indicates that the migrations of waders can broadly be grouped into eight flyways: the East Atlantic Flyway, the Mediterranean/Black Sea Flyway, the West Asia/Africa Flyway, the Central Asia/Indian sub-continent Flyway, the East Asia/Australasia Flyway, and three flyways in the Americas and the Neotropics.*  
*“There are no clear separations between flyways, and their use is not intended to imply major biological significance; rather it is a valuable concept for permitting the biology and conservation of waterbirds, as with other migratory species, to be considered in broad geographical units into which the migrations of species and populations can be more or less readily grouped.”*
- **Global regions for waterbird conservation management.** Boere & Stroud (2006) say *“At a larger scale still are global regions containing species with similar migration systems that are the subject (actual or potential) of shared international conservation activity – what Hagemeyer (2006) describes as ‘political flyways’*. Thus, *the Agreement area for the African–Eurasian Agreement on the conservation of migratory waterbirds (AEWA) is the area that contains the migration systems of all migratory waterbirds that occur in Africa and western Eurasia. A similar approach has been applied to the main flyway systems of the Asia–Pacific region. It contains multiple flyways of different waterbird taxa, and its value is in terms of the political and governmental processes of international co-operation (eg Biber-Klemm 1991).*

*Accordingly, it has rather little descriptive value related to the exact movements of any bird.”*

Whereas the major multi-species flyways for waders (Scolopacidae) have been clearly defined and named on a global scale (eg Boere & Stroud 2006, Delany *et al* 2009) the picture for wildfowl is incomplete and relatively poorly defined. Ducks, geese and swans tend to migrate more often across landmasses than waders, being less dependent on intertidal habitats. There is more scope for differences between species and the migration systems of the different species fall less clearly into multi-species flyways. Isakov (1967) mapped four main geographical populations of Anatidae in western Eurasia, which he named the Northern White Sea/North Sea population, the European Siberia/Black Sea–Mediterranean population, the West Siberian/Caspian/Nile population and the Siberian–Kazakhstan/Pakistan–India population. These divisions do not work well, however, for species with strong east–west movements across Eurasia (such as Pochard *Aythya ferina*), nor for LWfG.

The word ‘flyway’ is used extensively in the RECAP Committee discussions and in the terms of reference for this review. We interpret it here to mean the migration system of a single species, rather than any multi-species or political concept. The wording ‘Atlantic flyway’ in reference to LWfG (eg Kampe-Persson 2008) is potentially highly misleading, since there is no internationally agreed definition of such a flyway as applied to European wildfowl, yet waders have an East Atlantic Flyway that links Europe with western and southern Africa. We have tried to avoid the wording ‘Atlantic flyway’ within our discussions. We also use the terms ‘migration route’ and ‘mapped migration route’ hereafter, in preference to ‘flyway’.

## **2.2 How sharply should migration routes for geese be defined?**

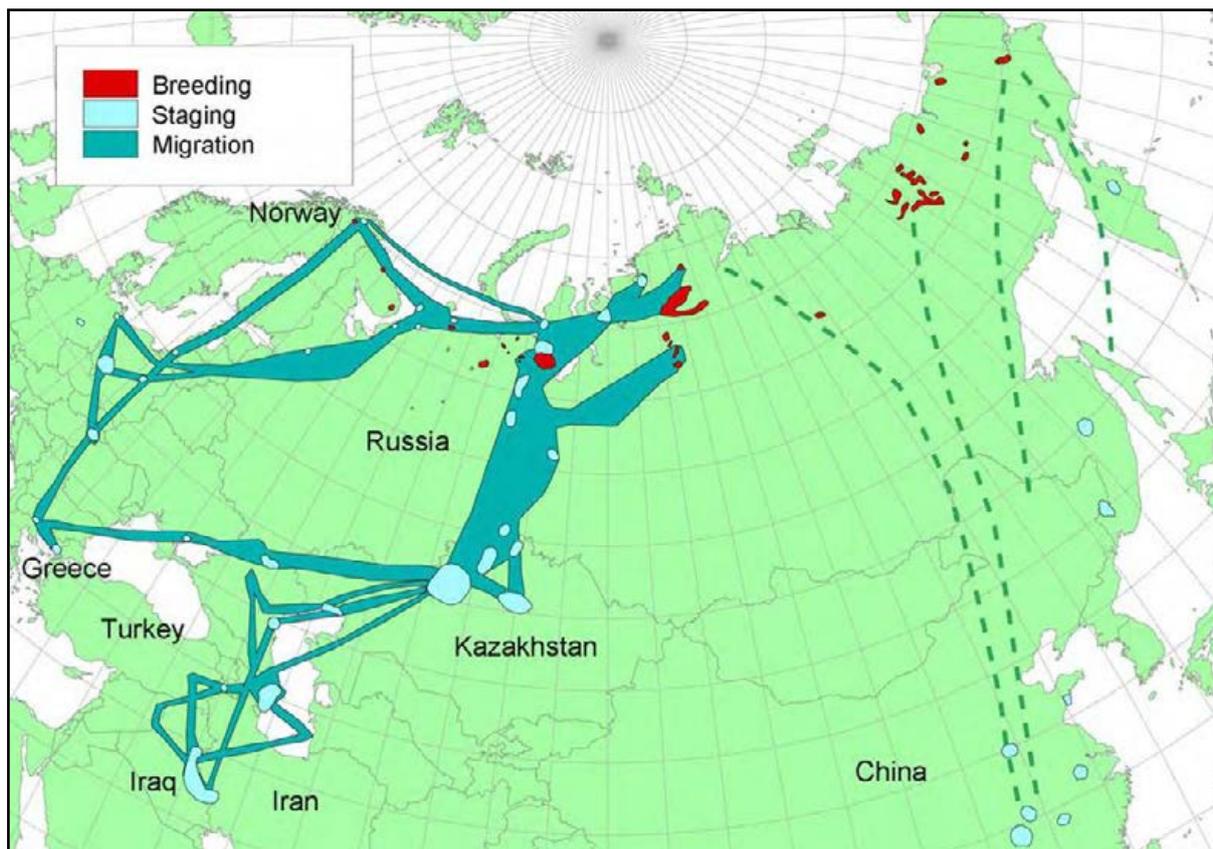
How sharply migration routes are defined is fundamental to questions of whether particular sites belong to migration routes, to which route or routes they belong and of whether migration routes have changed.

Satellite technology allows the actual flight-lines of birds such as geese to be followed very closely. It is technically possible, therefore, for maps to be drawn with great precision to show the routes actually flown by tagged birds. Such a map is already available for European LWfG populations (Øien & Aarvak 2008; Figure 2), although this map does not show the route established for the current Swedish population to wintering grounds in the Netherlands.

Although clearly a triumph of technology, to what extent such a map shows the migration routes or ‘flyways’ of the species is open to some debate: it may be incomplete, or the routes may be too broadly or too narrowly drawn. It must be borne in mind that there may be other routes taken by birds that were not tagged, or that would have been taken by the tagged birds in other years. For the Norwegian LWfG, it has been demonstrated that pairs that have bred successfully may follow one route and failed breeders another. Weather is known to be a major factor in affecting the routes of migration between years. For even the tagged birds, therefore, it is not clear at which points the route that was followed is the one

they were attempting to take. Tagging programmes are expensive to maintain and tend to follow birds for no more than a year or two: through stochastic variability alone, a repeat programme might not show exactly the same results.

For a mapped migration route to have a predictive capability and to be of greatest use for future population management, it should be defined broadly enough to encompass a high proportion of the variation between individual birds and between years, within individual birds. On the other hand, it should ideally be narrow enough to exclude sites unlikely to be used or overflowed.



**Figure 2. Global distribution of wild populations of LWfG for the period 2000–05. Dashed lines show the linkages between breeding and wintering areas for the East Russian population, but the precise migration routes followed are unknown. Reproduced from Øien & Aarvak (2008). © NOF**

Ringling and tagging bring our knowledge of migration routes into sharper focus, but the main source of data for assessing flyways has always been the observations of birds, in winter quarters or at stopover sites en route, or counted at migration watchpoints. It should always be borne in mind, however, that observations are hugely biased by the geographical distribution of observers and by their recording behaviour, which certainly changes over time and in ways that are poorly documented. Important elements of observer behaviour in the present context are that undue emphasis can often be given to

unusual sightings, and that birds thought to have escaped from captivity can sometimes be ignored by birdwatchers. In western Europe in particular, there has been huge growth in the numbers, skill and activity of birdwatchers, especially since the 1980s. The use of colour rings and neck collars has encouraged much close observation of goose flocks, which has provided many records of goose species outside their expected range.

Geese are a hugely popular subject for aviculture and many intentional and unintentional releases of birds of many species have resulted from this activity. Birds that have 'escaped from captivity' are a substantial and growing problem for students of goose migration. In most parts of Europe and North America, geese are held in captivity not only in zoos but also in a very large number of private collections. Birds that have escaped from such collections, permanently or temporarily, or have been deliberately released or allowed to roam free, are frequently observed by birdwatchers. In addition, hunters have bred and released geese of several species with the attention of improving the scope for shooting them, and sometimes in disregard for national or international legislation. All such birds and their descendants are referred to in this review loosely as 'escapes', although some may never or only briefly have been held in captivity and many may have been released deliberately. We do not intend this term to refer to the current Swedish breeding population of LWfG.

Escaped geese have recently been the subject of considerable research (*eg* Delany 1993, Voslamber *et al* 2010a, Kampe-Persson 2010) They continue to be very poorly recorded, however, and it is possible that some quite substantial naturalised breeding populations in Europe have yet to be noted in the published literature. Some escapes may be difficult or impossible to distinguish from wild birds, except through unusual behaviour or unseasonable occurrences. Escaped geese may undertake long movements, including seasonal migrations, and some might even rejoin their own species on Arctic breeding grounds.

Sites where birds are observed most regularly and in the greatest numbers must clearly be recognised as part of one or more migration routes, even where no ringing evidence is available to show how such sites are linked. A very large number of recorded observations may be from sites where the species occurs more sporadically, however – perhaps not annually, generally singly or in very small numbers, or generally within large flocks of another goose species. The extent to which such sites are included within mapped migration routes is likely always to be debatable.

Occupation of sites towards the ends of a migration route, most distant from the breeding grounds, may depend on the severity of winter weather along the flyway and thus be sporadic or perhaps show a clear trend over time. Such sites are probably best treated as belonging to a mapped migration route.

For geese, sites that arguably should not be included within a mapped migration route include:

- sites typically recording individuals or small groups that may have diverged from their expected route during adverse weather or become diverted by following other

goose species. Birds occurring at such sites may best be defined as ‘vagrants’ or ‘stragglers’, even where they remain on the migration route of another species for a long period of years and return repeatedly to places where their species would otherwise be rarely seen.

- sites at which the birds recorded are known or suspected to be escapes – that is, to have escaped from captivity, to have been deliberately released, for example as part of unregulated attempts at introduction or restocking, or to have descended from such birds.

Where birds occur singly or in very small numbers, they may best be treated as vagrants or escapes, as appropriate, even if the site is occupied regularly. Since geese that have bred successfully typically migrate as a family unit, the regular presence of family parties may indicate that a site belongs to a migration route, even if the numbers of birds there are very small.

### 2.3 Change in goose migration routes over time

There have been only a few decades in which knowledge of migration has been sufficiently detailed to allow changes in goose migration routes over time to be detected. It should be recognised that data collection has improved greatly over this period and that new methods of tagging and colour-ringing have fewer (but different) biases than previous methods of studying movements by ringing and ring recovery; these changes in methodology make it difficult to establish whether changes that are apparent have really occurred. Whether a change can be registered also depends very much on how narrowly a migration route is defined and whether similar concepts of a migration route have been applied over time.

Broad-scale changes that have been observed in goose migrations across Europe include:

- Icelandic Pink-footed Geese *A. brachyrhynchus* have extended their migration route southward to include more of the east-coast county of Norfolk within their winter range in the UK and, concurrent with a major population increase, the focus of the winter range has shifted from northwest England to Norfolk, where the birds feed extensively on sugar-beet tops (Gill *et al* 1997).
- European Greater White-fronted Geese no longer visit the furthest outposts of their winter range in Wales and western Britain in internationally important numbers, as they did in the 1950s and 1960s, probably in a response to better feeding conditions closer to the breeding range. Owen *et al* (1986) describe this as a classic case of ‘short-stopping’.
- As the population size of Tundra Bean Geese *A. fabalis rossicus* has increased, there have been changes to the migration pattern in central Europe since the 1980s, with far more birds wintering or staging at localities in southwest Poland and the Czech Republic and fewer birds reaching France and Spain (Madsen *et al* 1999). Although these authors state that Tundra Bean Geese are seen only occasionally in the UK,

mainly at the east coast with Taiga Bean *A. f. fabalis* and Pink-footed Geese, they have recently become regular in small numbers at scattered English localities (Calbrade *et al* 2010) and often occur in single-species groups.

- Introduced Canada Geese *Branta canadensis* in Europe have spontaneously developed migration routes, most notably from central and northern Sweden across the Baltic to northeast Germany. A moult migration of a few hundred English Canada Geese to northern Scotland was noted in the 1960s (Walker 1970) but may now be undetectable following a long period of exponential growth in the British population and an increase in urban birds living commensally with man.
- Barnacle Geese *Branta leucopsis* have established new breeding grounds on Baltic Sea coasts and islands since 1952, with rapid increase and spread since the 1980s. These birds have often been either ignored completely (*eg del Hoyo et al* 1992) or treated as an element of the Russian population, which migrates through this area, that spontaneously began 'short-stopping' en route to their breeding grounds. Human influence has previously been acknowledged in creating suitable habitat for these birds (*eg Madsen et al* 1999). According to Kampe-Persson (2010), however, this population exists, in all probability, only because of releases and escapes from captivity. Breeding populations in the UK and the Netherlands are conceptually similar to those in the Baltic and that of East Anglia may be linked to it by an extension of the original migration route across the North Sea.
- Greylag Geese have also become much more of a resident species. For example, marking studies in the Netherlands have shown an increase in residency and a marked reduction in movements to Spain (Voslamber *et al* 2010b).
- A particularly striking change has been observed for the Red-breasted Goose *Branta ruficollis*. Until the 1960s, the entire population spent the winter on the southwest coast of the Caspian Sea, particularly in the Kizil-Agach area in Azerbaijan. During the course of that decade, however, the entire population abandoned the Caspian coast and moved to winter on the western Black Sea coast, where large numbers were being recorded in Romania by the late 1960s. In the late 1970s, large flocks also began to reach Bulgaria. This major shift in wintering range has been attributed to reduced food availability in the southwest Caspian, because of a change from cereals and rice crops to cotton and vineyards, habitat loss, excessive hunting pressure, and possibly some other unknown factors (Isakov 1979, Dereliev 2006).

Mooij *et al* (2006) state that “*changing traditional migratory routes and wintering areas is not uncommon in wild goose species*”. The case of the Red-breasted Goose shows that such changes can be large in scale, relatively rapid and complete.

## 2.4 Causes of change in goose migration routes

The changes in goose migration routes that are detectable relate mostly to increases in population size or range. The converse, changes in migration routes due to population decrease or range contraction, might be harder to establish, since there may have been insufficient knowledge of a migration route, before it was lost, to distinguish its pattern of records from the effects of occasional vagrancy or the occurrence of escapes.

Climate change may become a major driver of change in goose migration routes. Some effects of recent warmer winters in western Europe may be seen in the reluctance of European Greater White-fronted Geese and Tundra Bean Geese to visit the most distant areas of the winter range.

Habitat change is strongly implicated in the shift in wintering grounds of Red-breasted Geese (Dereliev 2006) and may be important also in more subtle changes in migration routes, such as the short-stopping of European Greater White-fronted Geese. The driver might be a loss of previous food resources, as for Red-breasted Geese, or the provision of new feeding opportunities elsewhere, as for Pink-footed Geese.

The many translocations, escapes and deliberate releases of geese across Europe have enormous potential to disrupt the natural migration routes of native geese, but this appears to be a hugely under-researched subject. Major changes have occurred in the distribution and population structure of Barnacle and Greylag Geese that are largely attributable to this cause. In North America, Canada Goose has been subject to many translocations within its native range that have established large resident urban populations: in some areas these are disrupting established migration routes and blurring the previously highly developed pattern of geographical variation (Mowbray *et al* 2002).

## 2.5 Application of the flyway concept to western European LWfG

Figure 2 shows LWfG migration routes that lie on a largely southeast–northwest axis across Europe. These can be considered a ‘Central European flyway’. It connects the Fennoscandian breeding population with wintering grounds in Hungary and Greece. Not shown in Figure 2 is the route from Swedish breeding grounds across Sweden, Denmark and Germany to wintering areas mainly in the Netherlands. This route could be described as an ‘Atlantic flyway’.

This review seeks to establish whether an ‘Atlantic flyway’ for LWfG existed before 1980, when the present route from Sweden to the Netherlands was artificially established or re-established using Barnacle Geese as foster parents. Because ‘Atlantic flyway’ is a term open to various interpretations, however, we prefer ‘western migration route’.

In the context of this review, we use the term ‘western migration route’ specifically to refer to a migration route of LWfG from Sweden and Norway that includes non-breeding areas in the Netherlands and the Lower Rhine Valley in adjacent Germany. This is a broader concept than the present Sweden–Netherlands route, taking into account the relatively wide

breeding distribution of LWfG that existed before 1950 (Figure 1). It encompasses the route that Aktion Zwerggans plans to establish to wintering grounds on the German Lower Rhine.

Records of LWfG in Spain, France, Belgium, Denmark and the UK are relevant to the review, because these may provide evidence for the existence of a western migration route for LWfG that is independent of the present route between Sweden and the Netherlands. The wintering grounds for birds on the western migration route may not always have been centred in the Netherlands.

The 'Central European flyway' for LWfG encompasses movements through eastern Germany and could have provided many of the outlying records across Germany. On this basis, German records only from the Lower Rhine area are considered relevant to the question of a western migration route.

There are many records of LWfG across Europe prior to 1980 that do not lie on the Central European migration route. There is a widely accepted view, expounded as early as 1923 with regard to birds in the Netherlands (Blaauw 1923), that LWfG observed in western Europe are 'vagrants', having been diverted from their own migration route after joining flocks of another species. Because the axis of LWfG's Central European route crosses the migration routes of other geese, rather than running in parallel, there is high potential for LWfG that have been diverted in this way to winter in areas far removed from their main wintering grounds in southeast Europe. We use the term 'vagrants' for birds caught up with movements of other geese with some reluctance, because the word normally implies birds that are wandering or 'lost' on migration, whereas out-of-range LWfG may sometimes be being guided by another species.

The central question is whether records of LWfG in western Europe can be accounted for by vagrancy and escapes, or whether they provide evidence of a western migration route. A particular obstacle to answering this question is that LWfG has been contracting its range and in sharp population decrease for at least 60 years: any western migration routes that once existed could have been extinguished well before 1980 and perhaps before ornithologists were able to notice them.



### 3 REVIEW OF LWFG OCCURRENCE IN WESTERN EUROPE

#### 3.1 Summaries of key literature

The rich ornithological literature of Europe contains a number of major works that have sought to document the distribution of geese, or LWfG in particular, over a wide geographical or even global scale. To provide background to more specific discussions, we first summarise how the records of the species in western Europe up to 1981, in the period before the present Swedish route to the Netherlands was established, have been treated in the literature.

In summarising this published information, we have concentrated on studies that have integrated material from a large number of primary sources and those that include sources in the 'grey' literature. Comments from each publication are presented in tabular form, ordered by publication date (Table 1). Publications up to 1981 are of greatest interest in this regard but a western migration route, if it existed, might have disappeared well before that year. Publications after that date are relevant provided that they have a historical outlook.

Several works, especially very early and very recent ones, make statements that could be read as supporting the existence of a natural western migration route; these are picked out in Table 1 by highlighting the relevant cells. Table 1, although necessarily selective in its coverage, includes all the major publications we have found from which the existence of a western migration route could be inferred. In general, the evidence takes the form that the species was not clearly described as being rare in all the relevant western European countries in which it occurred.

*The Birds of the Western Palearctic* (Cramp & Simmons 1977) is a key work in this context because of its broad geographical scope, the exceptionally large volume of earlier literature consulted by the authors, and its publication being only a few years before LWfG releases began in Fennoscandia. Cramp & Simmons (1977) base their summary of movements particularly on Dementiev & Gladkov (1952), Bauer & Glutz (1968) and Johnson & Hafner (1970). The westernmost migration route they describe is the central European one, from Fennoscandia across Poland and Hungary towards probable wintering grounds in Romania, Bulgaria, Yugoslavia, Greece and Turkey. The distribution map shows wintering areas as far west only as present Croatia. Status in Czechoslovakia is described as "*regular in spring before 1960*" and in West Germany and in countries west to Ireland and France as "*accidental*". A bird that carried a ring from Swedish Lapland to central France is described as "*clearly a straggler*". The "*stragglers to west Europe*" described as almost annual in the Low Countries and Britain, are said to be due to them "*having presumably been caught up with*" flocks of Greater White-fronted and Bean Geese moving southwestwards across Europe and crossing the southeasterly migration route of LWfG.

**Table 1. Treatments in the major published literature of LWfG occurrences in western Europe. Highlighted cells indicate information possibly suggesting the existence of a western migration route before 1981.**

Authors/editors and year	Primary scope	Summary of LWfG occurrence in W Europe before 1981
Schlegel 1877	Netherlands	Observed everywhere in Europe in small numbers and regularly in the Netherlands
Alphéraky 1905	Russia	Appears rarely in Great Britain, more often in Germany, the Netherlands, Belgium, France and Spain (Seville region) in autumn and winter and more regular in Greece and Turkey ( <i>per Mooij et al 2008</i> )
Hartert 1912–21	Palaeartic	Regular wintering ( <i>per Kampe-Persson 2008</i> )
Niethammer 1938	Germany	Rare winter guest Germany and other W European countries
Witherby <i>et al</i> 1939	Britain	<i>“In winter to France, Germany... Accidental in Spain, Holland, Belgium...” “Very rare vagrant England”</i>
Dementiev & Gladkov 1952	Soviet Union	Found in low numbers, rare
Delacour 1954	global	Casual visitor to GB, Holland, Belgium, Switzerland, Italy, Spain...
Fog 1964	Denmark	Occasional, much rarer than other geese; appear to have become more common in recent years
Vaurie 1965	Palaeartic	Rare vagrant to British Isles and south to Spain
Uspenski 1965	N Europe	Winters in a considerable number of W European countries
Bauer & Glutz 1968	Middle Europe	By 1963, 29 records in Denmark and 61 in Great Britain
Timmerman <i>et al</i> 1976	Europe, W Asia, N Africa	No mention of a western migration route
Cramp & Simmons 1977	W Palaeartic	Stragglers/accidentals
Ogilvie 1978	global	<i>“regular visitor to north-west Europe, with from one to three birds being reported most winters among European Whitefronts in Britain and the Netherlands, and less often among Bean Geese”</i>
Owen 1980	global	<i>“one or two regularly occur in flocks of European Whitefronts in western and central Europe”</i>
Timmerman 1981	W Palaeartic	No mention of a western migration route
Norderhaug & Norderhaug 1982, 1984	Fennoscandia	Detailed maps of migration routes showing former wild population of central Scandinavia arriving/departing via the Baltic States
Nankinov 1992	W Eurasia	(uses census data to suggest possible migration routes)

Authors/editors and year	Primary scope	Summary of LWfG occurrence in W Europe before 1981
del Hoyo <i>et al</i> 1992	global	<i>“Occasionally mixes with flocks of A. albifrons and occurs much further W than normal range; regular in Britain”</i>
Scott & Rose 1996	Africa & W Eurasia	Reintroduced Sweden, these wintering in Netherlands
Lorentsen <i>et al</i> 1999	W Palaearctic	Reintroduced Sweden, these wintering in Netherlands (pre-1981 occurrence in W Europe not mentioned)
van den Berg & Bosman 1999	Netherlands	Rather rare 19 <sup>th</sup> century, rare 1900–68: 16 individuals 1908–49, 25 individuals 1950–68
Dubois <i>et al</i> 2000	France	Irregular and occasional – only 10 records by 1980
Fox 2005	global	<i>“Swedish population now extinct”</i> ; fragmentation of breeding range <i>“now makes historical analysis of migration routes impossible”</i>
De Smet 2005	Belgium	Singles, pairs or families recorded since 1959/60, as long as goose counts have been conducted
Mooij & Heinicke 2008	Germany	<i>“traditional wintering area in the Netherlands”</i>
Mooij <i>et al</i> 2008	W Palaearctic	regular occurrence at frequently checked sites in western Europe before 1981
Kampe-Persson 2008	Atlantic flyway	too many birds shot in Denmark to be accounted for solely by vagrancy
Mooij 2010	Europe	Previous regular winterer Netherlands, Britain and Spain

### 3.2 Additional information on LWfG occurrence in Britain

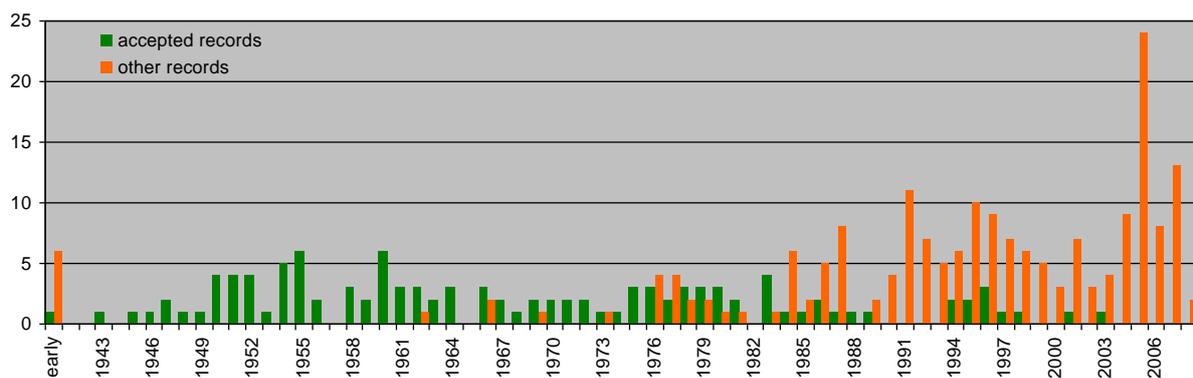
The authors of this review have access to some preliminary information from Britain that is as yet unpublished outside the ‘grey literature’ and which helps to elucidate the historical status of LWfG there. The species’ British status is of marginal relevance to the main subject of this review but there may be inferences for the wider pattern of records across western Europe, particularly with respect to the recent prevalence of escapes.

A compilation of accepted records of LWfG in Britain has been made from British Birds Rarities Committee (BBRC) annual reports and all available earlier sources (Naylor 1996, 1998) and updated to the end of 2008 (BirdGuides 2009). The compilation also includes records no longer accepted, normally because the birds, though correctly identified, were classified as escapes. Misidentification or suspected fraud may also be the reason for non-acceptance, especially for early specimen records. Non-accepted birds include marked birds from both Swedish and Finnish release schemes, despite the strong case that records of these birds should be fully accepted.

A record, in this context, could refer to any number of individuals at a particular site in a particular year but in practice only three records refer to more than one or two individuals.

There is a non-accepted record of seven or eight in 1894, of which two were reported shot, an accepted record from Slimbridge in Gloucestershire of six, possibly eight, during January–March 1956, and an accepted record of three immatures in Essex in 1986. The Slimbridge birds comprised two or three first-winter birds and four or five adults, distinguishable on size and plumage, with birds being observed mostly singly (Scott & Boyd 1956). There is thus no indication that Britain has ever been a winter destination for family groups of LWfG migrating together.

The distribution of records by year (Figure 3) shows a spate of records in the 1940s and 1950s, most of which were at Slimbridge, and a lower incidence of accepted records subsequently, with only two accepted records in the last ten years of the sequence. Some early records are not now accepted, perhaps because fraud is suspected or because specimens cannot be traced. A growing number of non-accepted records is evident since the 1960s, rising to 24 such records in 2005. These figures underestimate the total numbers of escaped individuals in Britain, of which 29 were recorded in 1991 including a group of 15 in a free-flying collection (Delany 1993): this is likely to be because many records of birds thought to be escapes never reach BBRC.



**Figure 3. Temporal distribution of British records of LWfG held by BBRC (BirdGuides 2009). Years between 1874 and 1906 are grouped as ‘early’.**

By 1980, there had been about 90 accepted records and 24 non-accepted records. The first British bird to be recorded as a possible escape was present in four counties in northwest England between February 1976 and January 1977, having summered in Cheshire. It is likely, however, that many escaped individuals seen previously had not been recorded at all.

In a separate data set, BTO has collected records of all LWfG recorded in ‘escapes’ sections of British county annual bird reports since 1995. Including incomplete totals of five records from 1994 and 16 from 2009, this data set contains 230 records – although with much duplication of individual birds between sites, counties and years. These records are additional to the 11 records accepted by BBRC over this period but there is much overlap with BBRC’s subset of non-accepted records.

**Figure 4. Distribution of records of escaped LWfG in Britain during 1994–2009 (data from county annual bird reports, collated by BTO).**



The BTO's bird report data set shows a wide scatter of records of escaped LWfG across lowland regions of England, Scotland and Wales (Figure 4). Most records were of single birds, several of which summered. Up to four have been seen together, in Kent in 1997 and on the Norfolk–Suffolk boundary since 2005. Several birds were tracked across localities and counties and some were thought to have returned to places where they had been seen in earlier years. Some were apparently paired with Greylag Geese but no true-breeding pairs of LWfG have yet been recorded in Britain.

The relevance of these observations from Britain to the subject of this review can be characterised as follows:

- It is incorrect to include Britain within the regular wintering area of LWfG. There have been no records to support such a view. The occasional occurrence of LWfG in Britain in the period before 1981 can be assigned almost entirely to vagrancy of wild birds caught up with migrating flocks of White-fronted and Bean Geese. Some individuals, including some that were recorded in summer, were believed to have been escapes from wildfowl collections.
- Similarly, British records should not be used, in conjunction with other western European records, as evidence for a western migration route for LWfG.
- Since 1981, wild birds have been recorded much less frequently but the total number of records has increased strongly. It is now difficult to distinguish any wild birds from the increasing number of escapes. We consider that the RECAP Committee should take the current prevalence of escaped geese, including LWfG, across western Europe into account in deciding how to respond to our review.

### 3.3 Specific comments on Kampe-Persson (2008): historical occurrence of LWfG in the Atlantic flyway

This paper is published in *Ornis Svecica* and follows on from the author's previously published researches on the status of LWfG in Spain (Persson 2000, 2004, Kampe-Persson 2004). The author states his aim as being "to discern, by the use of mainly published sources, if there once was one or more migration routes of the Lesser White-fronted Goose in the Atlantic flyway, or if all occurrences there can be explained by vagrancy." The term 'Atlantic flyway' is not explained but is contrasted with a 'Central European flyway', "where the main migration route of Fennoscandian birds went".

Making an impressively extensive use of published literature, the author summarises observations of LWfG in southern Sweden, southern Norway, Denmark, Great Britain, Germany, the Netherlands, Belgium, France and Spain, up to 1980 and after 1980, when Swedish releases had begun.

The discussion section of the paper begins with two important admissions: "it is always a delicate task to determine whether the observations represent a migration pattern or simply vagrancy"; "...the lack of reports of wintering flocks...in the Atlantic flyway". The discussion then builds a case that, even though reports of LWfG in western European countries are scarce, there might nevertheless have been regular migration routes, staging sites and wintering grounds that went undetected. The main points of evidence that the paper uses to dismiss the accepted view, that the relative paucity of records indicates that LWfG was a mere vagrant to western Europe, are as follows:

- observation networks were weak in many parts of western Europe before the late 1950s, by when the Fennoscandian population had already crashed;
- LWfG is an especially difficult goose to record, because of its similarity to Greater White-fronted Goose, its well-developed ability of concealment and its potential to migrate long distances at night – and even the known large numbers on the Central European flyway resulted in few birds seen; and
- too strong a passage is implied by the Danish hunting statistics to be accounted for solely by vagrancy.

Danish hunters reported killing nine, two and 16 LWfG in 1961, 1965 and 1966 respectively (Fog 1977). Kampe-Persson extrapolates from this, assuming that the reports were accurate and representative of all hunters, that the average hunting kill over these years in Denmark was 25 birds per year. Such a high figure is questionable and is out of line with Danish views that the species is rare.

In considering the migration routes followed by birds recorded on passage in southern Sweden and in Denmark, the author suggests that some may have wintered in Britain but the majority probably continued to winter quarters in either the Netherlands/Belgium or Spain. He admits, however, that "birds recorded at Kalmar Sound and those shot in Bornholm were maybe heading for staging areas in the eastern parts of Germany and

*Hungary*". Had there been a western migration route for LWfG, it is very surprising that, as Kampe-Persson reports, no records were made at Falsterbo, where intensive migration watches had been conducted since 1942 (Ulfstrand *et al* 1974).

Denmark spans a wide range of longitude from the North Sea east to Bornholm, where seven shot birds were reported in 1966. A migration via Bornholm, which lies to the north of the Polish coast, is much too close to the accepted eastern European migration route of LWfG to be considered evidence of a western route. It is not possible to make a case for a western migration route by considering all Danish records together.

The author presents no evidence that numbers wintering in the Netherlands and Belgium pre-1980 were ever other than small. While it is certainly plausible that LWfG may have wintered in Spain when breeding numbers in Scandinavia were still relatively high, the author described the available material from Spain before 1980 as *"extremely scanty"*. The discussion includes much speculation on the possibility that the Spanish steppes held substantial wintering flocks of LWfG, using the many observations since 1986 to infer the species' status pre-1980. Observations since 1986 in Spain include one from Moullec's ultra-light aircraft project, two or three from Finnish restocking and at least two or three from other Swedish releases. Kampe-Persson says that LWfG in Spain most likely comprise birds from the native Fennoscandian and Russian populations and descendants of birds released in Sweden. The official Spanish view, that LWfG in Spain are vagrants (Clavell *et al* 2005) is not incompatible with Swedish, Fennoscandian and Russian populations being indeed the origins of the birds concerned. In their wording *"vagrants from naturalised populations abroad"*, Clavell *et al* (2005) are presumably referring to birds released in Sweden.

The abstract of the paper makes the following clear statements:

- *"the species was still migrating through south Sweden and wintering in north-western Europe in low numbers when releases started in Swedish Lapland"*
- *"there is no scientific basis to state that these released Lesser White-fronted Geese follow an unnatural migration route. Instead, it is more than likely that they revived a traditional route."*

The first of these statements is argued with more circumspection in the paper itself, which also discusses at length the likelihood of there being important wintering grounds in Spain. The second statement is not made so clearly and directly in the paper itself. Rather, the author's closing sentence is *"...one can with today's best knowledge not eliminate that the species' western migration route went along the Atlantic flyway also before the Swedish reinforcement project was launched"*. The abstract of the paper is thus rather misleading as to its actual conclusions.

In the opinion of the reviewers, the data that are presented are mostly in line with the currently accepted view that the Scandinavian breeding population that existed prior to 1980 migrated towards southeast Europe via the eastern Baltic (including eastern parts of Germany). All records in western Denmark, western Germany, Spain and other west

European countries can be accounted for by vagrancy and by escapes. We agree, however, with the author's conclusion that the previous existence of a western migration route for LWfG cannot be ruled out using today's best knowledge.

### **3.4 Specific comments on Mooij & Heinicke (2008): status, distribution and numbers of LWfG in Germany**

The study investigates more than 790 observations of more than 1,540 individuals obtained during 1977–2000. Most records had been authenticated by the German rarities committee but for earlier records the authors admit that some wrong identifications might have been made.

Records in Germany could be ascribed firmly to all of the following origins:

- leg-ringed and unringed birds of the Swedish re-establishment project,
- neck-collared birds of the Finnish re-establishment project,
- birds of the original Fennoscandian population, transmitted in Norway,
- leg-ringed birds of the ultra-light project test flight of Christian Moullec in autumn 1999,
- marked and unmarked birds escaped from captivity,
- unmarked birds, presumably birds of the Russian population.

Examples are given of each type. In the reviewers' opinion, too little emphasis is given to unmarked escapes: only ringed birds are mentioned under the 'Escaped birds' subheading. The problem of distinguishing the growing number of unringed birds from the released Swedish population from birds originating from the Russian population is discussed, but not the confounding problem of unmarked escapes from captivity. The discussion makes it clear that 'Russian population' is meant to encompass both Fennoscandian and West Russian birds.

Table 2 compares the frequency distribution of group sizes in the three regions providing the most records – eastern Germany, the Lower Rhine area and the North Sea coast, Dollart and Lower Elbe. No more than five were recorded together in the Lower Rhine area but flocks of 20 or more were observed, although rarely, in the other regions. LWfG in the Lower Rhine and eastern Germany were associating mostly with Greater White-fronted and Bean Geese and those on the North Sea coast almost exclusively with Barnacle Geese.

This paper provides a valuable and timely exposition of the status of LWfG in Germany and calls for increased levels of its protection and the development of a German national action plan. Whereas some earlier German literature describes LWfG as a rare straggler, the paper reinforces some more recent assessments that the species has been a regular visitor in small numbers to North Rhine–Westphalia and Mecklenberg–Western Pomerania. Although the introduction makes passing reference to "*traditional wintering area in the Netherlands*" for the Swedish released population, the paper otherwise makes no controversial claims about migration routes.

LWfG was placed in category D (occurrence most probably due to escape from captivity, only exceptionally from wild origin) of the German bird list until 2005, when it was moved to category A (recorded in an apparently natural state). It must not be inferred from this that every LWfG seen in Germany is now thought to be wild. The authors refer to exceptional summer records, which are likely to include escapes. In the opinion of the reviewers, there is likely to be a growing number of escaped LWfG, in Germany and elsewhere in Europe, mostly unringed – and the problem of distinguishing these from wild or re-established birds has been somewhat understated in this paper.

### **3.5 Specific comments on Mooij *et al* (2008): analysis of historical observations of Fennoscandian LWfG in Sweden and the West Palaeartic**

The introduction makes it clear that the specific aim of this paper is to investigate whether birds on the Swedish re-establishment project are following a traditional migratory route or a newly installed one. The aim and approach of the paper are very similar to those of Kampe-Persson (2008) and even the conclusion as summarised by the abstract is worded almost identically.

The methods section is brief and refers particularly to data collection for LWfG records in Sweden for the period up to 1980/81.

Results begin with an extensive summary of LWfG's status in the western Palaeartic, as documented by the historical literature. Although the information given relates almost exclusively to the period before 1981, there is also coverage of more recent status in Germany (with reference to Mooij & Heinicke 2007, 2008), France and Spain.

The paper then characterises the 'commonly accepted knowledge' of LWfG migration, that it wishes to challenge, as stemming particularly from the work of Norderhaug & Norderhaug (1982, 1984), who indicated that the migration routes of LWfG from Scandinavia followed the eastern side of the Baltic. By the time these papers were written, the authors argue, LWfG was already gone from the southwestern part of its breeding range. Evidence is drawn from a thorough investigation of Swedish records of LWfG up to 1981. The authors provide a map as Figure 7, reproduced here as Figure 5, to show additional sightings not mapped by Norderhaug & Norderhaug (1984).

Figure 5 shows, in blue, a large number of records in south Sweden that were apparently outside the pattern considered by Norderhaug & Norderhaug (1984). Mooij *et al* (2008) argue that these records show that, before the Swedish re-establishment, LWfG also migrated to some extent over southern Sweden. Their conclusion is that the regular occurrence of LWfG at frequently checked sites in western Europe before 1981 shows that there is no scientific basis to state that the Swedish re-established LWfG follow an unnatural migration route, but rather it is likely they have revived a traditional route.

**Figure 5. Distribution of LWfG observations in Fennoscandia during the period 1900–81, from data collated by Norderhaug & Norderhaug (1984; red dots) and Mooij *et al* (2008; blue dots). Reproduced from Mooij *et al* (2008).**



The records presented for Sweden include those submitted to SVALAN, the Swedish online bird sightings database (part of Artportalen, the Swedish ‘species gateway’). It is likely that, since the authors made their extract, some additional, previously unavailable, pre-1981 records have been input to Artportalen or to other relevant online databases.

### 3.6 Publications since 2008

#### *Mooij 2010*

For a more recent paper, Mooij (2010) has compiled a database of 986 records of LWfG across Europe for the period up to 1982, of which about three quarters dated from after 1960. Online databases held by BTO, DOF, SOVON, SVALAN and ZMA were consulted, and the records extracted were integrated with those from a variety of published sources and personal contacts.

The geographical and seasonal distribution of the records are mapped and described. The author’s Figure 5 shows all records up to 1982 for the months of September, October and November. There is a large cluster of records between the Netherlands, southern Sweden and eastern Germany, to the west of the accepted central European migration route. If a western migration route existed, birds in the west of this area would have arrived there by regular direct movements from the Swedish breeding grounds, rather than irregularly via the eastern Baltic, caught up with Bean or Greater White-fronted Geese, as is more commonly supposed.

Figure 8A in the paper is summary of main sites of occurrence with arrows to indicate migration routes: this shows similar routes to the map reproduced in this review as Figure 2, but with the addition of wintering grounds in the UK, Spain and the Netherlands, which are linked with arrows to the south Baltic coast, and an arrow from the then-existing Swedish breeding grounds to the southwest Baltic.

Without presenting any evidence of the routes the birds had followed to reach the places at which they were recorded, the author concludes from the existence of the records that “*in former times a migratory route to western Europe very well could have existed*”. Although we feel that proof that a western migration route did exist is lacking, we concur with the conclusion that such a route might have existed in the past.

*Kampe-Persson 2010*

The title of this paper, published in *Ornis Svecica*, is “*Naturalised geese in Europe*”. Under LWfG, it contains the following statement, with reference to the present Swedish population:

- “*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).*”

In contrast to the earlier papers we have reviewed, this paper makes an unequivocal claim that distinct traditional routes for the Scandinavian population existed and that the same routes have been partly revived by the Swedish releases. There is no mention within the paper of the controversy that surrounds such a statement. The 2009 paper referred to as its source is published in *Fåglar i Västerbotten* and has not been examined as part of this review.

According to Kampe-Persson (2010), a pair of LWfG nested outside captivity in Medelpad province, central Sweden, in 2006 (Allberg & Marklund 2006) and further pairs are nesting in the Netherlands (Voslamber *et al* 2010a).

The paper estimates that there were more than 800,000 naturalised geese in Europe at the end of the 2009 breeding season.



## 4 CONCLUSIONS

The conclusions we draw from our review are summarised below in numbered paragraphs.

### 4.1 The knowledge base

- 1 There is an extensive published literature on the occurrence of LWfG across Europe, especially since the late 1800s. The recent papers that are the focus of this review have reported valuable new data.
- 2 Some early treatments of LWfG distribution in the literature gave too broad an account of wintering grounds, including for example France, from where there were only a handful of records. It is possible that some early authors were misled by assuming that LWfG migration directions were generally similar to those of other geese, and therefore that even a few records in western Europe might indicate regular wintering.
- 3 Early literature is also likely, however, to be incomplete, because of the lack of recording at the time from some remote areas, such as the Spanish steppes, where unrecorded wintering grounds could have existed.
- 4 Modern treatments that readers might assume are complete often omit certain classes of record. For example, del Hoyo *et al* (1992) omit introductions, while mentioning vagrancy, while Lorentsen *et al* (1996) do not mention occurrence in western Europe other than in the Netherlands. Most reference sources for waterfowl omit all information on escapes and on introduced populations that are not yet established. There are a few dedicated sources of information on escaped waterfowl, but even these may omit information on birds that are not breeding. It is thus difficult to gather a complete picture of distribution, for LWfG and other waterfowl.
- 5 Escapes have been greatly under-recorded – they may be ignored by birdwatchers or, even if reported, excluded from local reports. National and international summaries of the number and distribution of escapes, where attempted, may therefore be incomplete. It is likely that the likelihood that an escape will be recorded has improved greatly in most western European countries in recent decades. Lack of information on escapes – current numbers, trends in numbers, breeding status, movements – is a significant gap in knowledge for LWfG and many other waterfowl.
- 6 Online databases of bird records are a relatively recent but valuable source of records (although there can be particular problems in validating older records). Such online databases have already been used in recent reviews of LWfG's historical distribution, although it is possible that some additional, previously unavailable, pre-

1981 records have been input subsequently to Artportalen or to other relevant online databases.

- 7 Information gathered from ringing and tagging LWfG across Europe is fragmentary and it would be useful to gather it all into a single publication. For each individual showing a movement, any available information on the provenance and release of that individual should be provided.

#### **4.2 Did an 'Atlantic flyway' exist historically for LWfG?**

- 8 An 'Atlantic flyway' for geese is not a well-defined concept, nor uniquely interpretable, but conveys the sense of movements of several goose species from Fennoscandia close to North Sea and Atlantic coasts of Europe, linking such countries as Spain, France, UK, the Netherlands, Belgium and Denmark with breeding grounds in Fennoscandia. Such a flyway is best exemplified by Scandinavian Greylag Geese and Taiga Bean Geese that follow species-specific migration routes towards France and Spain.
- 9 Birds seen within a particular flyway may not necessarily be following that flyway, nor belong to it. There is thus a fundamental conceptual difference between migration routes that are part of a flyway and records of birds that have been seen within the area of the flyway. The authors of the recent papers we have reviewed do not seem to have made this critically important distinction. Rather, occurrence at sites within the 'Atlantic flyway' is equated with evidence of movement along that flyway.
- 10 In our opinion, it would be possible to establish the existence of a flyway only by showing that birds moved along that flyway. It is of course unrealistic to look for the level of evidence pre-1981 that could be expected today. Had there been such a flyway for LWfG, however, we might expect there to have been observations of flightlines and stopover points that were used regularly by the species, moving predominantly in single-species flocks that included family parties. Such evidence appears to be lacking for LWfG on the Atlantic flyway prior to 1981.
- 11 Thus the western migration route presently used by Swedish birds may never have been in use by wild LWfG. Similarly, there is no evidence that the route to the Lower Rhine area proposed by Aktion Zwerggans has been used previously by wild LWfG. We consider that the evidence available is insufficient to overturn the alternative, widely held view that LWfG reach western Europe having been diverted from their Central European migration route.
- 12 It cannot be denied that a western migration route for LWfG might have existed at one time, perhaps when the species' breeding distribution was at its greatest extent. The Atlantic flyway of LWfG might have been abandoned long before there were ornithologists able to notice it.

- 13 Evidence of a western migration route from old literature, as quoted in the recent papers, is very weak. In no publication did we find compelling evidence that LWfG ever followed a western migration route, prior to 1981. Thus, the unqualified statements already published that such a route did exist are, we believe, not justified by the evidence.
- 14 If a natural western migration route for LWfG had existed, it is perhaps surprising that it did not persist for longer. Hunting pressure along the western route is known to be lower now than along the still-extant Central European route, and it is unlikely that habitat loss or change would have affected western European wintering grounds.

#### **4.3 What are the likely explanations for the records of LWfG in western Europe?**

- 15 There has been a history of records of LWfG in western Europe, to the west of the Central European migration route, that long pre-dates the Swedish releases. Birds occur rarely west to Britain, Ireland and Spain.
- 16 Especially when LWfG was breeding in central Scandinavia in significant numbers, it is possible that some of these birds might have arrived direct from the breeding grounds by birds on a western migration route that was separate from the Central European route. In the absence of any evidence for direct movements of this kind, however, it is useless to speculate that a western migration route was used.
- 17 Our interpretation of the 'commonly accepted knowledge' of LWfG migration is that all Fennoscandian birds, even those in regions where the species is now extinct, would have set off southeastwards at the end of the breeding season towards the southern shore of the Baltic and followed the Central European route towards wintering grounds in southeast Europe. Where this journey intercepted those of Greater White-fronted and Bean Geese, and possibly Greylag Goose, some LWfG would have been diverted westwards.
- 18 Eastern Germany and probably eastern Denmark form part of the Central European route for LWfG and are not relevant to the question of a western migration route.
- 19 Birds seen to the west of these areas may have mostly been diverted by encountering flocks of other geese at mutual stopover sites. Such birds would subsequently appear at sites within an 'Atlantic flyway', but without having migrated along that flyway.
- 20 Since 1981, when the route with Barnacle Geese to the Netherlands was established, the Swedish population is likely to account for a high proportion of LWfG seen along the Atlantic flyway.
- 21 In Britain and perhaps some other western European countries outside the normal range of the current Swedish population, the large majority of LWfG now being

recorded can almost certainly be accounted for by escapes from captivity. The first known British record of LWfG to be labelled as an escape was in 1976, thus pre-dating Swedish releases, but small numbers of escapes might have been present in Europe much earlier.

- 22 The recent increase in records in Spain may be due to visitors from the Swedish release programme and to an increase in records of escapes. The alternative suggestion, that there have always been LWfG wintering in Spain but that they have been overlooked until recently, is supported only by very weak evidence.

#### **4.4 Can flyways change?**

- 23 There is good evidence that goose flyways can change spontaneously.
- 24 Instances of flyway change have been attributed to increase or contraction in breeding range, climatic factors, or loss or gain of feeding resources. It is perfectly conceivable that the extinction of breeding LWfG in central Scandinavia could have extinguished a natural western migration route.
- 25 The presence of more than 800,000 naturalised geese in Europe, together with unknown numbers of other non-naturalised 'escapes', has probably already had major effects on the natural migration behaviour of wild goose populations and has the potential to inflict further major disruption to migration routes. There is a pressing need for further research in this area.

#### **4.5 What future for the western migration route of LWfG?**

- 26 Whether the western migration route is a natural one or not should not necessarily be an overriding issue. Migration routes cannot be defined closely, because the tracks taken vary between individuals and between years. Furthermore, the boundaries between 'natural' and 'unnatural' for goose movements and distribution are being blurred irrevocably by the presence of large and growing numbers of introduced and escaped geese in Europe.

#### **4.6 Priorities for LWfG conservation in the western Palaeartic**

- 27 Further ringing and tagging studies are required to provide information on the variability of LWfG migration routes and whether they are changing.
- 28 Continuing research is needed into the causes of decline for the Fennoscandian population. Meanwhile, every effort needs to be made to reduce hunting pressure as far as possible throughout its migration routes.

- 29 Every effort should be made to increase the supply of captive-bred Russian birds suitable for release.
- 30 While the supply of captive-bred LWfG remains limited, they should be released where they have the best chance of joining a breeding population. The RECAP Committee needs to consider all its options carefully.

## **ACKNOWLEDGEMENTS**

This review has been funded, through the RECAP Committee, by the UNEP/AEWA Secretariat. We are very grateful to Nina Mikander, AEWA Coordinator for the Lesser White-fronted Goose, for encouragement and for assistance with sourcing reference material. Our BTO colleague Richard Thewlis and a volunteer, Rachel Portnall, extracted LWfG records from British county bird reports.

Comments on an earlier version of this review, as circulated at the fourth meeting of the RECAP Committee in June 2011, have contributed to this final, revised version. We are grateful to Nina Mikander for minuting the comments made verbally at the meeting and to Dr Johan H. Mooij and to Dr Per Sjögren-Gulve, who each sent extensive written comments over subsequent months. We believe we have corrected all the factual errors in the June version that have been drawn to our attention. Some sections have been extended, where our meaning had evidently been unclear. Over matters of opinion and interpretation, however, we have not always responded to differing views: the overall conclusions of this review remain our own, and are unchanged since the June version.

## REFERENCES

- Aarvak, T. & Øien, I.J. (2011) *Forsterking av dverggåsbestanden på Stabbursnes, Finnmark 2010 – feltoppsummering*. NOF-notat 2011-6. NOF, Trondheim.
- AEWA (2007) *Final report from the Lesser White-fronted Goose negotiation mission in January 2007*. AEWA Secretariat, Bonn. Unpublished report. [http://www.unep-aewa.org/meetings/en/lwfg/lwfg1/lwfg\\_recap\\_1.htm](http://www.unep-aewa.org/meetings/en/lwfg/lwfg1/lwfg_recap_1.htm)
- AEWA (2008) *Fourth Meeting of the Parties (MOP 4)*. [http://www.unep-aewa.org/meetings/en/mop/mop4\\_docs/mop4.htm](http://www.unep-aewa.org/meetings/en/mop/mop4_docs/mop4.htm)
- Allberg, B. & Marklund, I. (2006) Fjällgås – ny häckfågelart för landskapet. *Fåglar i Medelpad* 29: 19–21.
- Alphéraky, S. (1905) *The Geese of Europe and Asia*. Rowland Ward, London.
- Amato, G. (2010) *A review of the conservation genetics issues confronting the Lesser White-fronted Goose recovery program*. Report to the UNEP/AEWA Secretariat.
- Andersson, Å. (2004) The reintroduction of the Lesser White-fronted Goose in Swedish Lapland – a summary for 2000–2003. In *Fennoscandian Lesser White-fronted Goose conservation project. Report 2001–2003* (eds T. Aarvak & S. Timonen), pp 51–52. WWF Finland Report No. 20 & Norwegian Ornithological Society, NOF Rapportserie Report No. 1-2004.
- Andersson, Å. & Holmqvist, N. (2010) The Swedish population of Lesser White-fronted Goose *Anser erythropus* – supplemented or re-introduced? *Ornis Svecica* 20: 202–206.
- Andersson, Å. & Larsson, T. (2006) Reintroduction of Lesser White-fronted Goose *Anser erythropus* in Swedish Lapland. In *Waterbirds around the world* (eds G.C. Boere, C.A. Galbraith & D.A. Stroud), 635–636. The Stationery Office, Edinburgh. [http://jncc.defra.gov.uk/PDF/pub07\\_waterbirds\\_part5.1.9.pdf](http://jncc.defra.gov.uk/PDF/pub07_waterbirds_part5.1.9.pdf)
- Atkinson-Willes, G.L. (1976) The numerical distribution of ducks, swans and coots as a guide in assessing the importance of wetlands in midwinter. In *Proceedings of the international conference on the conservation of wetlands and waterfowl, 2–6 December 1974*, 199–254. Heiligenhafen, Germany.
- Bauer, K.M. & Glutz von Blotzheim, U.N. (1968) *Handbuch der Vögel Mitteleuropas*. Band 2. Akademische Verlagsgesellschaft, Frankfurt am Main.
- Bellrose, F.C. (1980) *Ducks, Geese and Swans of North America*. Third edition. Stackpole Books, Harrisburg PA.
- Biber-Klemm, S. (1991) International legal protection instruments for the protection of migratory birds: an overview for the West Palearctic–African flyways. In: *Conserving migratory birds* (ed T. Salathé), 315–344. ICBP Technical Publication 12.
- BirdGuides (2009) *Online Guide to Rarer British Birds*. <http://www.birdguides.com/rbcd/index.asp>
- BirdLife International (2004) *Birds in Europe: population estimates, trends and conservation status*. BirdLife Conservation Series No. 12. BirdLife International, Cambridge. [http://www.unep-aewa.org/activities/working\\_groups/lwfg/lwfg\\_population\\_estimate\\_birds\\_europe.pdf](http://www.unep-aewa.org/activities/working_groups/lwfg/lwfg_population_estimate_birds_europe.pdf)
- BirdLife International (2008) *Anser erythropus*. In *IUCN Red List of Threatened Species*. Version 2010.4. <http://www.iucnredlist.org/apps/redlist/details/141446/0> Downloaded on 9 May 2011.

- BirdLife International (2011) *Species factsheet: Anser erythropus*.  
<http://www.birdlife.org/datazone/speciesfactsheet.php?id=377#FurtherInfo>  
 Downloaded on 9 May 2011.
- Blaauw, F.E. (1923) On the breeding of *Anser erythropus* at Gooilust. *Ibis* 65: 415–417.
- Boere, G.C. & Stroud, D.A. (2006) The flyway concept: what it is and what it isn't. In *Waterbirds around the world* (eds G.C. Boere, C.A. Galbraith & D.A. Stroud), 40–47. The Stationery Office, Edinburgh.  
[http://jncc.defra.gov.uk/PDF/pub07\\_waterbirds\\_part1\\_flywayconcept.pdf](http://jncc.defra.gov.uk/PDF/pub07_waterbirds_part1_flywayconcept.pdf)
- Calbrade, N.A., Holt, C.A., Austin, G.E., Mellan, H.J., Hearn, R.D., Stroud, D.A., Wotton, S.R. & Musgrove, A.J. (2010) *Waterbirds in the UK 2008/09: The Wetland Bird Survey*. BTO/RSPB/JNCC in association with WWT, Thetford.
- Clavell, J., Copete, J.L., Gutiérrez, R., de Juana, E. & Lorenzo, J.A. (2005) *List of the birds of Spain*. Sociedad Española de Ornitología, Madrid.
- Cramp, S. & Simmons, K.E.L. (eds) (1977) *Handbook of the Birds of Europe, the Middle East and North Africa: the birds of the Western Palearctic*. Volume I. Ostrich to Ducks. Oxford University Press, Oxford.
- Curry-Lindahl, K., Esping, L.-E. & Höjer, J. (1970) Status of wildfowl occurring in Sweden. *Proc. Int. Reg. Meet. Cons. Wildfowl Resources, Leningrad 1968*: 88–96.
- De Smet, G. (2005) Status and origin of rare geese in Belgium. *Oriolus* 71 (supplement): 76–89.
- Delacour, J. (1954) *The Waterfowl of the World*. Volume 1. Country Life, London.
- Delany, S. (1993) Introduced and escaped geese in Britain in summer 1991. *British Birds* 86: 591–599.
- Delany, S. & Scott, D. (2006) *Waterbird population estimates*. Fourth edition. Wetlands International, Wageningen.
- Delany, S., Scott, D., Dodman, T. & Stroud, D. (eds) (2009) *An Atlas of Wader Populations in Africa and Western Eurasia*. Wetlands International, Wageningen.
- Dementiev, G.P. & Gladkov, N.A. (1952) *Birds of the Soviet Union*. Volume 4. 1967 translation, Israel Program for Scientific Translation, Jerusalem.
- Dereliev, S.G. (2006) The Red-breasted Goose *Branta ruficollis* in the new millennium: a thriving species or a species on the brink of extinction? In *Waterbirds around the world* (eds G.C. Boere, C.A. Galbraith & D.A. Stroud), 619–623. The Stationery Office, Edinburgh. [http://jncc.defra.gov.uk/PDF/pub07\\_waterbirds\\_part5.1.5.pdf](http://jncc.defra.gov.uk/PDF/pub07_waterbirds_part5.1.5.pdf)
- Dubois, P.J., Le Maréchal, P., Oliosio, G. & Yésou, P. (2000) *Inventaire des Oiseaux de France*. Nathan, Paris.
- von Essen, L. (1996) Reintroduction of Lesser White-fronted Goose (*Anser erythropus*) in Swedish Lapland (1981–1991). *Gibier Faune Sauvage* 13: 1169–1180.
- von Essen, L. (1999) The Swedish reintroduction project on Lesser White-fronted Geese. In *Fennoscandian Lesser Whitefronted Goose conservation project – Annual report 1998* (eds P. Tolvanen, I.J. Øien & K. Ruokolainen), 22–23. WWF Finland Report 10 & Norwegian Ornithological Society, NOF Rapportserie no. 1-2000.
- Finnish Ministry of the Environment (2009) *Kiljuhanhen (Anser erythropus) suojeluohjelma*. Ympäristöministeriö, Helsinki.
- Fog, M. (1964) The migration of geese through Denmark. *Dansk Ornithologisk Forenings Tidsskrift* 58: 147–165.
- Fog, M. (1977) Geese, goose research and goose problems in Denmark. *Vogelwelt* 98: 121–141.

- Fox, A.D. (2005) Lesser White-fronted Goose *Anser erythropus*. In *Ducks, Geese and Swans* (ed J. Kear), volume 1, pp 286–289. Oxford University Press, Oxford.
- Gill, J.A., Watkinson, A.R. & Sutherland, W.J. (1997) Causes of the redistribution of Pink-footed Geese *Anser brachyrhynchus* in Britain. *Ibis* 139: 497–503.
- Haftorn, S. (1971) *Norges Fuglar*. Universitetsforlaget, Oslo.
- Hagemeijer, W. (2006) Site networks for the conservation of waterbirds. In *Waterbirds around the world* (eds G.C. Boere, C.A. Galbraith & D.A. Stroud), 697–699. The Stationery Office, Edinburgh.  
[http://jncc.defra.gov.uk/PDF/pub07\\_waterbirds\\_part5.3.9.pdf](http://jncc.defra.gov.uk/PDF/pub07_waterbirds_part5.3.9.pdf)
- Hartert, E. (1912–21) *Die Vögel der paläarktischen Fauna*. Volume 2. R. Friedländer & Sohn, Berlin.
- del Hoyo, J., Elliott, A. & Sargatal, J. (eds) (1992) *Handbook of the Birds of the World*. Volume 1. Lynx Edicions, Barcelona.
- Isakov, Y.A. (1967) MAR Project and conservation of waterfowl breeding in the USSR. In *Proceedings of the Second European Meeting on Wildfowl Conservation, Noordwijk aan Zee, The Netherlands, 9–14 May 1966* (ed Z. Salverda), 125–138. Ministry of Cultural Affairs, Recreation and Social Welfare, the Netherlands.
- Isakov, Y.A. (1979) Migration of the Red-breasted Goose. In *Migration of birds of Eastern Europe and Northern Asia: Anseriformes* (ed D.S. Pavlov). Nauka Publication, Moscow.
- IUCN (1998) *IUCN Guidelines for re-introductions*. IUCN Species Survival Commission Specialist Group on Reintroductions, Gland, Switzerland, and Cambridge, UK.  
[http://www.unep-awea.org/meetings/en/lwfa/consultation\\_docs/lwfa\\_ssap\\_inf4\\_iucn\\_reintro.pdf](http://www.unep-awea.org/meetings/en/lwfa/consultation_docs/lwfa_ssap_inf4_iucn_reintro.pdf)
- Johnson, A.R. & Hafner, H. (1970) Winter wildfowl counts in southeast Europe and western Turkey. *Wildfowl* 21: 22–36.
- Jones, T., Martin, K., Barov, B. & Nagy, S. (compilers) (2008) *International Single Species Action Plan for the Conservation of the Western Palearctic Population of the Lesser White-fronted Goose Anser erythropus*. AEWA Technical Series no. 36. Bonn, Germany. [http://www.unep-awea.org/activities/working\\_groups/lwfa/lwfa\\_ssap\\_130109.pdf](http://www.unep-awea.org/activities/working_groups/lwfa/lwfa_ssap_130109.pdf)
- Kampe-Persson, H. (2004) Is Doñana of importance for the Lesser White-fronted Goose *Anser erythropus*? *Anuario Ornitológico de Doñana* 1: 217–225.
- Kampe-Persson, H. (2008) Historical occurrence of the Lesser White-fronted Goose *Anser erythropus* in the Atlantic flyway. *Ornis Svecica* 18: 68–81.
- Kampe-Persson, H. (2009) Vart flyttade de svenska fjällgässen? *Fåglar i Västerbotten* 34: 29–43.
- Kampe-Persson, H. (2010) Naturalised geese in Europe. *Ornis Svecica* 20: 155–173.
- Lee, R. & Hughes, B. (2008) *Review of Waterbird Re-establishment in the AEWA region*. Unpublished report to AEWA. [http://www.unep-awea.org/meetings/en/mop/mop4\\_docs/meeting\\_docs\\_pdf/mop4\\_11\\_re\\_establishment\\_review.pdf](http://www.unep-awea.org/meetings/en/mop/mop4_docs/meeting_docs_pdf/mop4_11_re_establishment_review.pdf) Downloaded on 9 May 2011.
- Lee, R., Cranswick, P.A., Hilton, G.M. & Jarrett, N.S. (2010) *Feasibility study for a re-introduction/supplementation programme for the Lesser White-fronted Goose Anser erythropus in Norway*. WWT Report to the Directorate for Nature Management, Norway.

- Loretsen, S.-H., Øien, I.J., Aarvak, T., Markkola, J., von Essen, L., Farago, S., Morozov, V., Syroechkovskiy, E. Jr & Tolvanen, P. (1999) Lesser White-fronted Goose *Anser erythropus*. In *Goose populations of the Western Palearctic: a review of status and distribution* (eds J. Madsen, G. Cracknell & A.D. Fox), 144–161. Wetlands International Publication 48. Wetlands International, Wageningen, the Netherlands, and National Environmental Research Institute, Rönne, Denmark.
- Madsen, J. (1996) Lesser White-fronted Goose. In *Globally threatened birds in Europe: action plans* (eds B. Heredia, L. Rose & M. Painter). Council of Europe Publishing, Strasbourg. [http://www.unep-awea.org/activities/working\\_groups/lwfg/lwfg\\_1996\\_int\\_action\\_plan.pdf](http://www.unep-awea.org/activities/working_groups/lwfg/lwfg_1996_int_action_plan.pdf)
- Madsen, J., Cracknell, G. & Fox, A.D. (eds) (1999) *Goose populations of the Western Palearctic: a review of status and distribution*. Wetlands International Publication 48. Wetlands International, Wageningen, the Netherlands, and National Environmental Research Institute, Rönne, Denmark.
- Markkola, J., Timonen, S. & Nieminen, P. (1999) The Finnish breeding and restocking project of the Lesser White-fronted Goose: results and the current situation in 1998. In *Fennoscandian Lesser White-fronted Goose conservation project – Annual report 1998* (eds P. Tolvanen, I.J. Øien & K. Ruokolainen), 47–50.
- Mooij, J.H. (2001) Reintroduction project for the Lesser White-fronted Goose (*Anser erythropus*) by help of ultralight aircraft. *Casarca* 7: 137–149.
- Mooij, J.H. (2005) *Feasibility study of a project for the protection of the Lesser White-fronted Goose (Anser erythropus) by creating safe migratory routes and wintering sites*. Unpublished.
- Mooij, J.H. (2010) Review of the historical distribution of the Lesser White-fronted Goose *Anser erythropus* in Europe. *Ornis Svecica* 20: 190–201.
- Mooij, J.H. & Heinicke, T. (2007) Neue Erkenntnisse zum Auftreten und Schutz der Zwerggans *Anser erythropus* in Deutschland. *Charadrius* 43: 171–184.
- Mooij, J.H. & Heinicke, T. (2008) Status, distribution and numbers of the Lesser White-fronted Goose *Anser erythropus* in Germany. *Vogelwelt* 129: 281–292.
- Mooij, J., Paulsch, A. & Scholze, W. (2006) Reintroduction of the Lesser White-fronted Goose *Anser erythropus* in Fennoscandia with the help of microlight aircraft. In *Waterbirds around the world* (eds G.C. Boere, C.A. Galbraith & D.A. Stroud), 633–634. The Stationery Office, Edinburgh. [http://jncc.defra.gov.uk/PDF/pub07\\_waterbirds\\_part5.1.8.pdf](http://jncc.defra.gov.uk/PDF/pub07_waterbirds_part5.1.8.pdf)
- Mooij, J.H., Hansson, P., Kampe-Persson, H. & Nilsson, L. (2008) Analysis of historical observations of Fennoscandian Lesser White-fronted Geese *Anser erythropus* in Sweden and the West Palearctic. *Vogelwelt* 129: 269–280.
- Mowbray, T.B., Ely, C.R., Sedinger, J.S. & Trost, R.E. (2002) Canada Goose (*Branta canadensis*). In *The Birds of North America Online* (ed A. Poole). Cornell Lab of Ornithology, Ithaca. <http://bna.birds.cornell.edu>
- Nankinov, D. (1992) Lesser White-fronted Goose (*Anser erythropus*) migration routes, wintering sites and conservation in Western Eurasia. *Gibier Faune Sauvage* 9: 257–268.
- Naturvårdsverket (in prep) *Åtgärdsprogram för bevarande av fjällgås Anser erythropus*. Naturvårdsverket, Stockholm. Unpublished draft.
- Naylor, K.A. (1996) *A reference manual of rare birds in Great Britain and Ireland*. Volume 1. K.A. Naylor, Nottingham.

- Naylor, K.A. (1998) *A reference manual of rare birds in Great Britain and Ireland*. Volume 2. K.A. Naylor, Nottingham.
- Niethammer, G. (ed) (1938) *Handbuch der Deutschen Vogelkunde*. Volume 2. Akademische Verlagsgesellschaft, Leipzig.
- Nijman, V., Aliabadian, M. & Roselaar, C.S. (2010) Wild hybrids of Lesser White-fronted Goose (*Anser erythropus*) x Greater (*A. albifrons*) (Aves: Anseriformes) from the European migratory flyway. *Zoologischer Anzeiger* 248: 265–271.
- Norderhaug, A. & Norderhaug, M. (1982) *Anser erythropus* in Fennoscandia. *Aquila* 89: 93–101.
- Norderhaug, A. & Norderhaug, M. (1984) Status of the Lesser White-fronted Goose *Anser erythropus* in Fennoscandia. *Swedish Wildlife Research/Viltrevy* 13: 171–185.
- Norwegian Directorate for Nature Management (2011) *Norwegian action plan for the Lesser White-fronted Goose Anser erythropus*. DN-report 4-2011. Norwegian Directorate for Nature Management, Trondheim. [https://www.dirnat.no/multimedia/48474/DN-rapport-4-2011\\_net.pdf&contentdisposition=attachment](https://www.dirnat.no/multimedia/48474/DN-rapport-4-2011_net.pdf&contentdisposition=attachment)
- Ogilvie, M.A. (1978) *Wild geese*. T. & A.D. Poyser, Berkhamsted.
- Øien, I.J. & Aarvak, T. (2002) Fortsatt håp for den syngende gåsa. *Vår Fuglefauna* 25: 117–122.
- Øien, I.J. & Aarvak, T. (2008) *Lesser White-fronted Goose in Norway: status of knowledge and proposal for National Action Plan*. Norsk Ornitologisk Forening Rapport 3-2008. Norsk Ornitologisk Forening & BirdLife Norway, Trondheim. [https://www.dirnat.no/multimedia/48474/DN-rapport-4-2011\\_net.pdf&contentdisposition=attachment](https://www.dirnat.no/multimedia/48474/DN-rapport-4-2011_net.pdf&contentdisposition=attachment)
- Owen, M. (1980) *Wild geese of the world*. B.T. Batsford, London.
- Owen, M., Atkinson-Willes, G.L. & Salmon, D.G. (1986) *Wildfowl in Great Britain*. Cambridge University Press, Cambridge.
- Persson, H. (2000) Occurrence of the Lesser White-fronted Goose in Spain, up to 1999. In *Fennoscandian Lesser White-fronted Goose conservation project – Annual report 1999* (eds P. Tolvanen, I.J. Øien & K. Ruokolainen), 51–52. WWF Finland Report No 13 & Norwegian Ornithological Society, NOF Rapportserie Report No 1-2001.
- Persson, H. (2004) Lesser White-fronted Geese shot in Spain in the winters 1985/86–2000/01. In *Fennoscandian Lesser White-fronted Goose conservation project – Report 2001–2003* (eds T. Aarvak & S. Timonen), 50. WWF Finland Report No 20 & Norwegian Ornithological Society, NOF Rapportserie report no. 1-2004. Helsinki & Klæbu.
- Ramsar Convention (2006) *Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance of the Convention on Wetlands (Ramsar, Iran, 1971)*. Third edition. [http://www.ramsar.org/cda/en/ramsar-documents-guidelines-strategic-framework-and/main/ramsar/1-31-105%5E20823\\_4000\\_0](http://www.ramsar.org/cda/en/ramsar-documents-guidelines-strategic-framework-and/main/ramsar/1-31-105%5E20823_4000_0)
- Ruokonen, M., Kvist, L., Tegelström, H. & Lumme, J. (2000) Goose hybrids, captive breeding and restocking of the Fennoscandian populations of the Lesser White-fronted goose (*Anser erythropus*). *Conservation Genetics* 1: 277–283.
- Ruokonen, M., Kvist, L., Aarvak, T., Markkola, J., Morozov, V.V., Øien, I.J., Syroechkovski, E.E. Jr, Tolvanen, P. & Lumme, J. (2004) Population genetic structure and conservation of the lesser white-fronted goose (*Anser erythropus*). *Conservation Genetics* 5: 501–512.

- Ruokonen, M., Andersson, A.-C. & Tegelström, H. (2007) Using historical captive stocks in conservation. The case of the Lesser White-fronted Goose. *Conservation Genetics* 8: 197–207.
- Savas, K. & Nazirides, T. (eds) (1999) *National Action Plan for the Lesser White-fronted Goose (Anser erythropus Linnaeus, 1758)*. WWF Greece, Hellenic Ornithological Society & Society for the Protection of Prespa, Thessaloniki.  
<http://www.piskulka.net/documents/English%20NAP%20nan.pdf>
- Schlegel, H. (1877) *De Vogels van Nederland*. Funke, Amsterdam.
- Scott, P. & Boyd, H. (1956) Lesser White-fronted Geese in Gloucestershire, 1956. *British Birds* 49: 228.
- Scott, D.A. & Rose, P.M. (1996) *Atlas of Anatidae Populations in Africa and Western Eurasia*. Special Publication 41. Wetlands International, Wageningen.
- Soikkeli, M. (1973) Decrease in numbers of migrating Lesser White-fronted Geese *Anser erythropus* in Finland. *Finnish Game Research* 33: 28–30.
- SOVON (2011) *Watervogels in Nederland in 2008/2009*. SOVON-monitoringrapport 2011/03. <http://www.sovon.nl/pdf/Mon2011-03wavorap.pdf>
- Timmerman, A. (1981) On the occurrence of geese in the western Palearctic. In *Proceedings of the Symposium on the mapping of waterfowl distribution, migrations and habitats* (eds G.V.T. Matthews & Y.A. Isakov), 73–108. All-Union Research Institute of Nature Conservation and Natural Resource Management/Ministry of Agriculture/Institute of Geography, USSR Academy of Sciences.
- Timmerman, A., Morzer Bruyns, M.F. & Philippona, J. (1976) Survey of the winter distribution of Palearctic geese in Europe, western Asia and North Africa. *Limosa* 49: 230–292.
- Ulfstrand, S., Roos, G., Alerstam, T. & Österdahl, L. (1974) *Visible bird migration at Falsterbo, Sweden*. Report 60 from Falsterbo Bird Station. Vår Fågelvärld supplement 8, Lund.
- Uspenski, S.M. (1965) *Die Wildgänse nordeurasiens*. Neue Brehm Bücherei 352. Ziemsen Verlag, Wittenberg-Lutherstadt.
- van den Berg, A.B. & Bosman, C.A.W. (1999) *Rare Birds of the Netherlands*. Avifauna van Nederland 1. GMB Uitgeverij & Stichting Uitgeverij van de KNNV, Haarlem/Utrecht.
- Vaurie, C. (1965) *The Birds of the Palearctic Fauna. Non-Passeriformes*. H.F. & G. Witherby, London.
- Voslamber, B., van der Jeugd, H. & Koffijberg, K. (2010a) Breeding goose populations in The Netherlands. *De Levende Natuur* 111: 40–44.
- Voslamber, B., Knecht, E. & Kleijn, D. (2010b) Dutch Greylag Geese *Anser anser*: migrants or residents? *Ornis Svecica* 20: 207–214.
- Walker, A.F.G. (1970) The moult migration of Yorkshire Canada Geese. *Wildfowl* 21: 99–104.
- Witherby, H.F., Jourdain, F.C.R., Ticehurst, N.F. & Tucker, B.W. (1939) *The Handbook of British Birds*. Volume 3. Witherby, London.