Report 6-2016

A critical review of Lesser White-fronted Goose release projects

Tomas Aarvak, Ingar Jostein Øien & Paul Shimmings

Norsk ornitologisk forening

NORSK ORNITOLOGISK FORENING

BirdLife INTERNATIONAL

Partnership for nature and people

A critical review of Lesser White-fronted Goose release projects

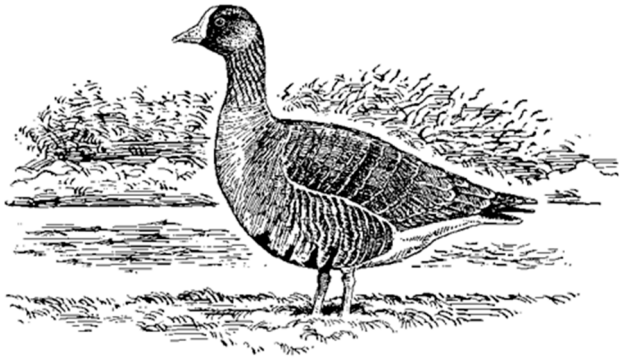


Illustration: © Trond Haugskott

Tomas Aarvak, Ingar Jostein Øien & Paul Shimmings

BirdLife Norway 2016

E-mail: nof@birdlife.no

Publication type: Digital document (pdf) / 75 printed copies October 2016.
Front page picture: Lesser White-fronted Geese in the holding pen at the Valdak Marshes, Finnmark, Norway. Photo: Tomas Aarvak
Key words: Lesser White-fronted Goose, release project, reintroduction, translocation, illegal, genetic, distribution, population, court case, hybrid, barnacle goose, carrier species

Recommended citation: Aarvak, T., Øien, I.J. & Shimmings, P. 2016. A critical review of Lesser White-fronted Goose release projects. NOF-report 2016-6. 218 pp.

ISSN: 0805-4932
ISBN: 978-82-78-52140-3

PREFACE

Conservation of species can be implemented at an international, regional or a local level. Many species are migratory, and cross political boundaries. For such migratory birds an international approach is often the best option, often supplemented by regional or local actions. Single actions in one country can have an enormous impact throughout the whole of the range of a particular population. For some species there are international flyway plans, which cover all range states for that particular species. Such is the case for the Lesser White-fronted Goose *Anser erythropus*.

The wild Fennoscandian population is the smallest of the three world populations of Lesser White-fronted Goose, all of whom have exhibited declines in numbers in recent decades. Conservation efforts directed towards the Fennoscandian population of this enigmatic goose involve many persons in an international network of people that monitor this population very closely. The amount of time and energy involved have paid dividends! The population has begun to increase thanks to conservation measures in many of the range states in which it naturally occurs. But, it is still in a perilous position, and it would take little to tip the balance in the opposite direction. Due to targeted conservation actions, from predator control in the breeding areas, through habitat protection at stopover sites on migration, to guarding by surveillance cameras and active patrolling in its winter quarters, as well as information campaigns and changes in hunting practices, then the future looks brighter today than it has for many decades for this remnant population.

However, in parallel to the intense ongoing conservation work for the Fennoscandian Lesser White-fronted Goose population, there has been a long ongoing debate regarding the value and implications of the reintroduction of the species in Sweden. The reintroduction activities have not been accepted unanimously by the international bodies working to safeguard the Lesser White-fronted Goose, and are considered to pose a real threat to the survival of the Fennoscandian population. The releases of captive-reared Lesser White-fronted Geese in Sweden have given cause for concern, not least due to our fears that birds from the reintroduced population might enter into the wild Fennoscandian population. Our fears have not been unfounded, as birds from the current release project in Sweden have been reported within the range of the wild Fennoscandian population, both during winter as well as at spring-staging sites. Released birds have also been observed within the natural range of the population in areas we hope might in future be recolonised naturally from the wild population. In addition to genetic aspects/hybridisation problems in the free-flying Swedish population, the released birds follow a human-modified flyway and utilise unnatural habitats during their life cycle. Extensive conservation efforts to safeguard the wild population across the whole of its range risk being jeopardised due to such careless and uncontrolled releases.

An adult pair of Lesser White-fronted Goose in the breeding area in Finnmark, Norway summer 2015. Photo: Tomas Aarvak.

The aim of this current report is to present an overview of the release initiatives as well as a critical review of the

effects that releases of Lesser White-fronted geese have had, or might have, upon the wild population. Work on this report commenced in 2014, four years after the start of the current releases of Lesser White-fronted Geese in Sweden, when it became evident that the release activities would carry on and escalate, even though it was well known that these actions were likely to be detrimental, rather than beneficial, to conservation of the Lesser White-fronted Goose in both Fennoscandia and along the entire flyway.

The report looks in detail at aspects of goose biology in general, at the effects and experiences of previous Lesser White-fronted Goose release projects, and the situation for both the wild Fennoscandian population and various releases (both legal and illegal). We discuss impacts that such releases have had, or are likely to have, upon the wild birds, and we have summarised currently available knowledge about release projects, and the numbers of birds involved where known, as well as assessed the viability of the released birds. This task has not been an easy one, and we have searched both published literature and greyer works for information. Thankfully, we have received much help and support in translating various articles and reports which were considered relevant to this report. The main persons involved are listed at the end of the document, but all who have forwarded information, no matter how small they may feel their contribution may have been, have been important in ensuring that the background data is as reliable as possible. We thank all who have taken the time to report their observations either directly to us or via their own national databases. We are also indebted to the innumerous people who have responded to our specific requests for further information. We are also grateful to all of the photographers whom have freely allowed us to reproduce their work in this report. It ought also to be pointed out here that not all of those whom we approached have been willing to assist in supplying information we requested towards the making of this report. We have for several years made repeated requests to The Swedish Species Information Centre (Artdatabanken) for data on the occurrence of Lesser White-fronted Geese in Sweden from the Swedish Species Observation System for birds (Artportalen). Such requests remained unanswered, until April 2016 when a refusal to supply sensitive data was received.

Despite the fact that certain institutions have been unwilling to assist us, we have persevered and found most of the necessary information through other channels. The report has been the result of countless hours of ploughing through literature, of telephone calls, correspondence with a network of observers, wildlife managers and other key persons. Production of this report has involved unsociable working hours and many cups (or rather many litres!) of coffee.

A series of ongoing disagreements regarding the captive breeding, supplementation and reintroduction of Lesser White-fronted Geese in Europe have severely hampered the implementation of conservation action for the wild populations of Lesser White-fronted Geese by repeatedly drawing away the focus of the international discussion from the urgent conservation priorities for the species. The data presented in this critical review should make it clear to everyone why we cannot accept releasing of Lesser White-fronted Geese and the negative effects of release projects upon the existing wild population in Fennoscandia. The majority of the European range states to the species as well as the wider international conservation community now consider the Swedish Lesser White-fronted Goose population to be a serious threat to the wild Fennoscandian population. It is therefore difficult to understand how these activities can still continue and be an issue for discussion that is obstructing important conservation progress of the original wild populations, including revision of the International Single Species Action Plan (ISSAP) for the species, which has now been ongoing for four years.

In Enare Sami, one of ten or more Sami languages (which belong to the Uralic language family), the species is known as “Lavláçuonja”, or “the singing goose”. We hope that by halting the further

releases of Lesser White-fronted Geese we can ensure that this enigmatic bird species continues to sing in the countries where the species naturally occurs or once occurred. The existence of the Fennoscandian population can be safeguarded by international cooperative efforts, and must not be threatened by actions that work against internationally agreed conservation priorities for the species.

By cooperating at all levels, we can together save the Lesser White-fronted Goose! We cannot accept that projects that are not part of an international flyway plan, and which may place the species in an even more perilous state than today, be allowed to continue. The Fennoscandian Lesser White-fronted Goose Conservation Project are indeed working towards a reestablishment of Lesser White-fronted Geese in the former breeding range of the species, also in Sweden. We warmly welcome Swedish colleagues to cooperation to reach this goal by following the scientifically founded and internationally agreed conservation priorities for the species in the future.

Tomas Aarvak Ingar Jostein Øien Paul Shimmings

Trondheim 27th October 2016

Lesser White-fronted Geese resting along the shoreline at the Valdak marshes, Finnmark, Norway, autumn 2016. Foto: Tomas Aarvak.

EXECUTIVE SUMMARY

Introduction

The Lesser White-fronted Goose *Anser erythropus* remains globally threatened and critically endangered within Europe, following a rapid decline during the past decades. Three original wild populations of Lesser White-fronted Geese are internationally recognised. These are the Fennoscandian population (breeding in Norway, Finland and the Kola Peninsula of NW Russia), the Western Main population (nesting in northern Russia to the west of the Taymyr Peninsula), and the Eastern Main population (nesting from the Taymyr Peninsula eastwards and wintering in China). In addition to these three wild populations a small population exists in Western Europe (henceforth called the Swedish population), which was established by releasing captive-bred birds within the former range of the Fennoscandian population in Sweden and which migrate to wintering grounds in the Netherlands using a human-mediated flyway.

International conservation activities for Lesser White-fronted Geese within the Western Palearctic follow the priorities outlined in the AEWA International Single Species Action Plan (ISSAP) adopted in 2008, the focus of which is clearly on the conservation of the original wild populations. Both this International Action Plan, as well as its predecessor adopted under the framework of the Council of Europe in 1996, express concerns regarding the potential threat posed to the existing Fennoscandian population by the free-flying Lesser White-fronted Geese released in Sweden.

The ongoing disagreements regarding the captive breeding, supplementation and reintroduction of Lesser White-fronted Geese in Europe have over the years severely hampered the implementation of conservation action for the remaining wild populations of Lesser White-fronted Geese by repeatedly drawing away the focus of the international discussion from the urgent conservation priorities for the species. Repeated attempts to revise the International Single Species Action Plan for the Lesser White-fronted Goose have, for example, effectively been halted due to these ongoing controversies. In addition, and more worryingly, the release projects themselves are increasingly considered to be directly detrimental to the conservation and future of the Fennoscandian population.

As such, and in light of the continued debate surrounding these releases of Lesser White-fronted Geese into the wild in Europe and their supposed conservation value, the Norwegian Ornithological Society (NOF/BirdLife Norway) has undertaken this critical review of both past and present release projects.

In addition to reviewing the release projects themselves, this report addresses a wide range of topics related to Lesser White-fronted Geese, such as their historical distribution and population size, as well as the current situation regarding released birds and their impact on the original wild Fennoscandian Lesser White-fronted Goose population. In doing so, the review draws upon information from a wealth of publications and internal documents, as well as from information provided by conservation experts. The review also presents conclusions and recommendations for next steps based on the information presented.

Releases of captive-bred Lesser White-fronted Geese in Europe

Following the continued decline of the species throughout the Nordic range states, several release projects or experiments were implemented from the late 1980s onwards. These included the release of captive-bred birds in Finland (1987-1997), the release of captive-bred birds in Sweden in 1999 as part of a French micro-light project as well as a pilot project implemented in Norway which resulted in the release of captive-bred goslings in 2010 and 2011. These efforts were all subsequently abandoned after it was concluded that the attempts to supplement the existing population had failed (i.e. the mortality of the released birds was very high, they did not follow the wild birds etc.). Following the government imposed ban on releases in Finland, there have also been three recorded cases of illegal releases in that country.

By far the most consequential of these endeavors, the Swedish project to reintroduce Lesser White-fronted Geese by releasing captive-bred birds at a former breeding site in Swedish Lapland during 1989-1999 managed to establish a small population. The birds were released together with Barnacle Geese *Branta leucopsis* as foster parents, and the Lesser White-fronted Geese followed their foster parents to their wintering areas in the Netherlands, and subsequently returned to the area of release the following spring, thus effectively establishing a new modified migratory route to wintering grounds that were considered safer than along the traditional flyway. The population built up gradually until 2002, and thereafter fluctuated between 110-130 individuals between 2003-2011, based on winter counts conducted in the Netherlands. After 1999, the releases were stopped, following the detection of alien genes in some of the captive-breeding stock.

In 2010, the efforts to supplement the existing Swedish population by releasing more captive-bred birds were started once again, this time using wild individuals captured from the Western Main population in Russia for the captive breeding programme. Between 2010 and 2015 a total of 213 individuals have been released in the mountainous region around Arjeplog in Swedish Lapland, as well as in the public park in Hudiksvall which is used as a moulting site by some of the Swedish Lesser White-fronted Geese. Most of the released birds have been goslings, but also some yearlings (second calendar-year) have been released. Unlike the previous project in Sweden, these birds have been released without any parent geese.

In addition, a pilot project aiming to introduce an additional new migration route for Lesser White-fronted Geese by imprinting newly-hatched goslings on a micro-light aircraft was founded in 2001 by Aktion Zwerggans in Germany. The plan has been to release birds in northern Sweden and to guide them with the aircraft along the Swedish Baltic coast, through Denmark and to the Lower Rhine in Germany. The project has not yet carried out any releases, but the stakeholders involved are still active. It is unclear, however, as to why this project would want to establish a new wintering area for Lesser White-fronted Geese in Europe. It should also be noted that no independent impact assessment of the project is available.

Why do the past and present releases pose a threat to the remaining wild Fennoscandian population?

Already in the mid-1980s, concerns were raised by many, including the International Council for Bird Preservation (ICBP, now BirdLife International), about the Swedish reintroduction project because of the possible negative effects of artificial rearing and human-induced change of the migration route that would put the remaining wild population under further pressure. Additionally, diverting resources from the conservation work on the wild populations towards reintroduction activities was

considered to be counterproductive. Since then, a variety of threats posed by the released birds to the Fennoscandian population - if and when birds from the two populations should meet - have been identified. These are briefly outlined below and are described in more detail throughout the review.

Genetics

As mentioned above, genetic studies had revealed that some birds used in the first Swedish release project carried genetic material from other species, notably Greater White-fronted and Greylag Geese. Hybridisation between Lesser White-fronted and Greater White-fronted Geese has been recorded in captivity, but although hybridisation between these two species in the wild might be possible, there is little or no evidence to show this to be the case.

Following recommendations provided by two genetic experts, the Swedish authorities have revised their captive-breeding programme by attaining new breeding stock from the Western Main population in Russia. It was further recommended, that by introducing “pure” captive-bred birds into the free-flying population, this might dilute the existing hybrids in the Swedish population over time. There is, however, no evidence available that the Lesser White-fronted Geese released after 2010 have in fact mixed and successfully bred with the extant population. As such, it must be concluded that the genetic impurities resulting from the use of impure stock continue to exist unchanged in the Swedish population today.

Hybridisation

In addition to the genetic issues mentioned above, the Swedish population includes a number of hybrids between Lesser White-fronted Geese and Barnacle Geese. The first of these stem from hybridisation between the released captive-bred offspring and their foster parents and date back to at least 1999. Hybrids between these two species continue to be recorded in the population, although efforts have been made to cull these. Despite claims to the contrary, second-generation hybrids have also been recorded in Sweden.

There are many recorded observations of the captive-bred Lesser White-fronted Geese that have been released in Sweden from 2010 onwards, associating with other goose species, and indeed with other Anatidae species, both along the human-modified migration route and in the Dutch wintering areas, as well as in other countries. Such associations increase the chances of released individuals spreading throughout the migratory routes of Anatidae in Europe (including outside the species ordinary distribution range) as well as the chance of hybridisation.

Changes in migratory patterns and routes

Birds which stem from the previous release project in Sweden between 1980-1999 mainly follow the human-modified migration route to wintering sites in the Netherlands, although there are re-sightings of birds from countries outside of this flyway, for example from Norway, Estonia and Spain. Birds released in Sweden since 2010 have been recorded mainly in the Netherlands during winter. However, there are also records of these birds turning up in other countries, including Belgium, Germany, Poland, Denmark, Norway, the United Kingdom, Hungary, Lithuania, and Estonia. In addition, released birds have started wintering in Sweden with up to 21 individuals recorded in 2014-2015.

More worryingly, as of March 2016, birds released in Sweden have been recorded at sites that are also used by the wild Fennoscandian Lesser White-fronted Geese, including at the Valdak Marshes in

Norway, the Nemunas Delta in Lithuania, at Hortobágy National Park in Hungary and in Poland. That Lesser White-fronted Geese originating from Swedish releases are now observed at sites used by the Fennoscandian birds illustrates just how easy it is for Swedish birds to potentially enter into the Fennoscandian population.

In geese, young birds learn the migration route by following their parents and the family unit is extremely important for their development. Since 2010, Lesser White-fronted Geese have been released in Sweden without any parents, in the hope that they might find other conspecifics breeding in the Arjeplog mountains or at Hudiksvall and subsequently follow them to the wintering grounds. Many of these released geese have instead travelled in all irrelevant directions from the release site and have not followed the others along the human-modified migration route. In addition to increasing the risk that birds released in Sweden will thus mix with the Fennoscandian flock, releasing birds without previous parental guidance or the necessary life-skills into the wild also poses ethical questions as to the merits of the current release project.

It should also be noted that at least during some years, a high proportion of captive-bred males, and on occasion even exclusively males, have been released in Sweden. Female geese have a higher degree of nest philopatry, whereas males are the sex that disperse from the natal area. This increases the chances of dispersal to new areas, again heightening the risk of Swedish released birds entering into the Fennoscandian flock. Releasing an overabundance of males will of course lead also to an imbalance in the sex ratio of the Swedish population.

Changes in habitat preferences

Wild, natural populations of Lesser White-fronted Geese are habitat specialists, almost exclusively exploiting natural steppe and saltmarsh habitat during migration and winter, as well as short-grazed semi-natural grasslands (including grazed coastal meadows), although also at times cereal stubbles. Although this preference for natural habitats, which have diminished throughout their range, may be one of the original causes behind the long term decline of the species, it is also one of the key characteristics of the original wild Lesser White-fronted Geese.

The Swedish birds, however, have made the transition to feed on cultural habitats/farmland during winter, as well as park lawns during summer and autumn. This may lead to conflicts between geese and agriculture if this population should grow and could potentially also be one of the factors behind the lower viability of the Swedish population (see below), although no studies are available to confirm this.

Behavioural changes

A typical phenomenon attributed to birds kept and/or raised in captivity are changes associated with their behaviour. Reduced shyness is a common behavioural trait of captive birds, and released captive-bred Lesser White-fronted Geese have exhibited such a change. Reduced anti-predator behavior has also been proposed to explain the higher insensitivity of such released birds, with a loss of anti-predatory responses and escape abilities. The Lesser White-fronted Geese released in Sweden have proved to be very tame, allowing people to approach them closely, and do not react negatively to potential predators (such as dogs and cats in the park in Hudiksvall).

Diseases

Geese are subject to a number of contagious and indeed fatal diseases, and the most common ones are listed in the main body of the report. Bacterial infection from *E. coli* which resulted in the failure

of the liver and spleen was the probable cause of death of one of the birds used in the supplementation attempt in Norway in 2010, which had been received from the Swedish captive-breeding programme.

Decreased viability

All of the issues concerning the Swedish population related above contribute to the decreased viability of the individual birds and the population as a whole.

The mortality of the Swedish released population is higher than that experienced by the wild Fennoscandian population, and the return rate to the release area is lower. Additionally, the average brood size is lower for the Swedish birds compared to that of the Fennoscandian population (2.7 young per brood in Sweden, 3.3 young per brood in Norway). The proportion of broods produced in the Swedish reintroduced population is also far lower. The Swedish population produces on average 0.14 young per adult, while the corresponding figure for the Fennoscandian population is 0.47. Since the releases in Sweden were resumed in 2010, the population has crashed, and the causes of this decline remain currently unexplained. Predation by Red Fox and by White-tailed Eagle has been cited as an important mortality factor in the release area. However, an increase in predation levels cannot fully explain the decrease in population size despite the continued releases of birds since 2010.

There was, as expected, a significant positive correlation between the numbers of birds released and the population development in the years 1989-1999, based upon the population size estimated from counts during winter in the Netherlands. However, after the new releases began in 2010, there is now a significant negative correlation between release numbers and estimated population size during winter for the years 2010-2015. Possible explanations include that the newly released birds (from 2010 onwards) have an unusually high mortality (due to various reasons). This high mortality may also affect the population that was already present in the release area (for example by attracting predators into the area in search of easy prey).

International attempts to reach consensus

There have been several meetings between the respective range state governments as well as key stakeholders attempting to reach an agreement on the conflicting positions with regard to the release projects, the history and details of which are included in this review. The current main points of controversy within the international discussion, in addition to the identified threats mentioned above, are listed below.

The status of the Swedish population as supplemented or reintroduced

In the Swedish Lesser White-fronted Goose National Action Plan adopted in 2011, the Swedish reintroduced population is described as a reinforcement of the existing wild Fennoscandian Lesser White-fronted Goose population (and as such should be considered part of the original Fennoscandian population), based on the claim that some wild Fennoscandian Lesser White-fronted Geese still existed in the reintroduction area when the releases started in the early 1981. An opinion provided by the Chair of the IUCN Reintroduction Specialist Group concluded that, due to the large numbers of observations the Swedish releases could be considered a reinforcement to an extant population, rather than a reintroduction. This assessment, however, did not take into account any other factors and thus the conclusion of this critical review is somewhat different, in that even if the first releases were made in Swedish Lapland whilst there were still genuinely wild birds in the area, the naturalness of this remnant population was destroyed by the introduction of birds of impure

genetic make-up and with the introduction a human-modified migration route. The Swedish population cannot be considered a part of the original wild Fennoscandian population.

The previous existence of a Western flyway

Claims have also been made by the stakeholders of the Swedish (and proposed German) release project(s) regarding the existence of a western migration route or Atlantic Flyway previously used by Lesser White-fronted Geese in order to misrepresent the fact that the migratory route currently used by the Swedish population is in fact human-induced. A review commissioned to the British Trust for Ornithology (BTO) concluded that there was little evidence that such a route existed before the Swedish releases began, and that records of Lesser White-fronted Geese in Western Europe used as an argument for the existence of such a route were of vagrants caught up with other species.

Claims that there have previously been regular wintering and/or staging areas in Northwestern Europe (Germany, the Netherlands and the United Kingdom) are also not supported by hard evidence. Rather, the species is considered a vagrant in these countries. This fact is also supported by fossil and archeological evidence, which reveals that Lesser White-fronted Geese were not consumed by humans in Western Europe in medieval times, even though there are many finds of other goose species being consumed then.

The international status and acceptance of the Swedish population

As has become clear during the ongoing revision process of the AEWA International Single Species Action Plan for the Lesser White-fronted Goose, the proponents of the Swedish release project and (some) of the range states hosting the Swedish population wish to increase the international recognition and acceptance of their population and thus also ensure that it receives the same conservation priority as the original wild populations. The majority of the range states which host the original wild Fennoscandian population as well as the stakeholders involved in its conservation, view the Swedish population as a severe threat to the further existence of the Fennoscandian population and wish to avoid at all costs that the two populations meet and mix in the future.

Conclusions and recommendations

The main conclusions and recommendations of this critical review are as follows:

- **Releasing Lesser White-fronted Geese is not an appropriate or necessary conservation action** to address the threats still faced by the original wild Fennoscandian population at this time.

- To the contrary, **the continued releases in Sweden constitute a significant additional burden and threat to the Fennoscandian population**. As documented in detail throughout this review, the available evidence indicates that the ongoing release project is jeopardizing the continued existence of the Lesser White-fronted Goose as a wild bird breeding in Fennoscandia and as a staging and wintering species throughout its traditional migratory routes in Europe. The possible consequences of the Fennoscandian birds coming into contact with the released birds constitute a serious threat to the population and include, but are not limited to, a possible alteration in their natural behaviour, changes in the sites and habitats they use as well as genetic introgression and reduced viability. The mere potential of this threat **constitutes an unacceptable risk** and the **precautionary principle** urgently needs to be taken into account.

- **The best way to safeguard the existing original wild population of Fennoscandian Lesser White-fronted Geese** and to ensure that it attains a more favourable conservation status **is to continue and enhance the conservation regime currently in place in all areas where the original population occurs** (i.e. at the breeding, staging and wintering sites).

- It is therefore **urgently recommended that <u>all current and planned releases of Lesser White-fronted Geese in Europe are halted immediately</u>, in an effort to mitigate the potential negative effects on the original wild Fennoscandian population**. If the releases are stopped now, then the majority, and perhaps all, of the released Lesser White-fronted Geese in Sweden would gradually disappear as the mortality of the released birds is high and the return rate to the natal area is low (as highlighted in this review). **By stopping the releases of birds immediately, the risk of the wild population coming into contact with the released birds would be greatly reduced**, and perhaps even eliminated.

- With regard to the **pending revision of the AEWA International Single Species Action Plan** for the Conservation of the Lesser White-fronted Goose**, any proposed changes which would alter the current status or conservation priority of the Swedish population, and thereby support the continued releases of birds or even a further increase or escalation of the release activities must be avoided**. Considering the increased potential threat to the wild Fennoscandian population posed by the continued releases, it would constitute a major contradiction to sanction actions aiming to increase the Swedish population whilst simultaneously setting goals and targets for the conservation of the Fennoscandian population. A revised International Action Plan that is not clear in addressing the genetic and ecological threats posed by the Swedish population would be a direct obstacle to the international conservation of the Fennoscandian population.

- **The focus of any revised International Action Plan must clearly remain on the conservation of the original wild populations of the species**.

- The **options recommended** by the Fennoscandian Lesser White-fronted Goose project **on how to move forward with the revision of the AEWA International Single Species Action Plan** are:

1) The revised Action Plan includes all populations of Lesser White-fronted Geese within the Western Palearctic, **but addresses the genetic and ecological issues posed by the Swedish population** (as well as by any other releases of Lesser White-fronted Geese) **as a potential threat** to the Fennoscandian population as outlined in the current Action Plan.

2) The focus of the revised Action Plan **is limited to cover only the original, naturally occurring Lesser White-fronted Goose populations**, i.e. the Swedish population is excluded from the scope of the Plan.

   A third possible option, if no consensus for either of the two scenarios above can be found, is of course to maintain the Single Species Action Plan adopted in 2008 as the internationally agreed framework for conservation action for the Lesser White-fronted Goose within the Western Palearctic.

   It should also be noted, however, that although the Swedish population is included in the scope of the current Action Plan, the Swedish National Action Plan as well as the Swedish authorities and other stakeholders along the flyway do not follow the internationally agreed activities set out therein. As such, there seems to be little merit in continuing with any Plan

that includes the Swedish population as there are no guarantees that Sweden and/or the stakeholders concerned will in fact follow a new Action Plan which has not been modified specifically to meet their goals.

Following the continuous conservation efforts across the migratory routes of the original wild Fennoscandian Lesser White-fronted Goose population, we are slowly starting to see a positive trend. As the **Fennoscandian population is currently increasing at an annual rate of 15%, there is a good chance that the species may naturally recolonise some of the former breeding areas** in Sweden and Finland, which would reflect the desired scenario included in both the Norwegian and the Finnish National Action Plans for the Lesser White-fronted Goose. We would very much welcome a collaboration amongst all Fennoscandian range states to work towards this goal, eventually bringing back the original wild population to many of its former breeding areas.

Last but not least, the international conservation community must find a way to move past these ongoing disputes which have been seriously counterproductive for the conservation work for the wild populations during the past 20 years and to focus all available resources on the conservation of the remaining original wild populations.

As the increase since 2010 in the Fennoscandian population shows, it is not yet too late!

CONTENTS

1. BACKGROUND

Plans and projects for the reintroduction of the Lesser White-fronted Goose *Anser erythropus* have been the subject of intense debate for many years, and the ongoing debates have been considered detrimental to the international conservation efforts for safeguarding the original wild populations of the species. The Fennoscandian Lesser White-fronted Goose conservation project, run jointly by NOF-BirdLife Norway and WWF Finland since the early 1990s, has taken, and continues to take, a critical stand towards such (re)introduction projects for a number of reasons. These reasons are partly summarised by Lee et al. (2012) who state that: "*While translocation techniques are improving continuously and, for some species, have clearly represented the difference between survival and extinction in the short-term, translocation projects are still associated with numerous problems and consequently still have a low success rate. Problems that are significant include (1) difficulty in establishing self-sustaining captive populations, (2) poor success in release attempts, (3) high costs, (4) introgression of alien DNA, (5) pre-emption of other conservation measures, (6) disease outbreaks, and (7) maintaining administrative continuity*".

The most frequently discussed problems regarding reintroductions of the Lesser White-fronted Goose have been related to genetic disturbance (i.e. the genetic composition of the stocks used, and planned to be used, for reintroduction) and to the modification of natural flyways by humans. There are also other reasons to take a critical stand towards the current reintroduction programmes and to be aware of the negative impacts, in particular the impact that the Swedish reintroduced population potentially could have on the original wild Fennoscandian population, if/when they come into contact. The problems related to the Swedish reintroduction project were raised at a very early stage during the process to develop and international Action Plan for the species, and the project was criticised from the very beginning. In 1998, the International Council for Bird Preservation (ICBP), the organisation which grew into the BirdLife International partnership expressed concerns about the effect of inducing another migration route by using Barnacle Geese *Branta leucopsis* as foster parents for the released Lesser White-fronted Geese (see letter from ICBP-Denmark, dated 23.12.1988, Appendix A). Most, if not all, of the concerns raised by ICBP have since proven themselves to be genuine problems, such as the concerns about what might happen regarding genetic composition issues (Ruokonen et al. 2000, 2004, 2007). Recent attempts by the Swedish Association for Hunting and Wildlife Management and the Swedish Environmental Protection Agency (SEPA) to ignore the problems and omit facts in their National Action Plan (see further discussion about this in **chapter 8.7**), as well as attempts to marginalise the scale of criticism (Liljebäck et al. 2014) do not solve any of the problems related to the Swedish reintroduced population. On the contrary, the ongoing activities in Sweden will further jeopardise not only the conservation work on the original wild populations, but will create new human-induced problems for birds breeding in Sweden and and its neighbouring countries.

We understand and appreciate that many stakeholders have a genuine interest in the conservation of the Lesser White-fronted Goose. However, it is vital that any such reintroduction or release projects are critically reviewed before commencement. It is in particular vital ro assess where such measures will possibly cross the line of contributing to the conservation of a species and instead become harmful. When efforts turn out to be counterproductive, and in this case both detrimental to international conservation actions and to the wild populations of the species, it is important to stop and reevaluate the strategies pursued. The means are not an excuse for reaching the goals, and sometimes there are no easy solutions to the problems. The idea to side-stepping the problem instead of doing something to resolve it, such as was the case when modifying the migration route in order to lower the adult mortality rate, is definitely not a good solution. The human mediated migration route takes the birds primarily to the Netherlands. There is a real threat that this route might also be adopted by the remaining original wild breeding birds in Fennoscandia which winter

farther south and east in Europe. If the original wild Fennoscandian Lesser White-fronted Geese that traditionally have staged in Finland, Estonia, Hungary as well as other countries, and wintered in Greece, were to mix with the Swedish population and follow the Swedish population on the human-mediated flyway to the Netherlands, thus disappearing from their natural staging and wintering sites, it would be a serious biodiversity loss for the countries that host, and have the conservation responsibility for these magnificent birds throughout much of their annual cycle. Larsson (1993) evaluated the Swedish reintroduction project which began in 1980 (von Essen 1991). He warned that there was a considerable risk that the most effective long-term conservation actions for the species were not being implemented, and that the reintroduction project would take the focus away from these actions. This is indeed what has happened, and in recent years, this has escalated to a dilemma which is difficult to resolve. Another serious and problematic issue is that the Swedish governmental authorities and stakeholders base their arguments and decisions on publications that are either flawed or erroneuos. Three of these publications (Kampe-Persson 2008, Mooij & Heinicke 2008, Mooji et al. 2008) have been the focus of an independent expert review undertaken by the British Trust for Ornithology (BTO) (see **chapter 8.1**), which also scrutinised two additional papers with the same fundamental problems (Mooij 2010, Kampe-Persson 2010). These and several other publications are also scrutinised here (see for example **chapter 8.3**). Such publications have further led to an unclear understanding of what is the true nature of the breeding, migration and wintering biology of the Lesser White-fronted Goose. The claims in the publications of the stakeholders that support continued releases of captive bred Lesser White-fronted Geese, about the existence of a traditional migration route from Fennoscandia to Western Europe, and that part of the Swedish breeding population used to winter in the Netherlands and Great Britain prior to the reintroduction projects, are not supported by concrete evidence. Rather, the species has long been a rare vagrant in these two, and neighbouring countries.

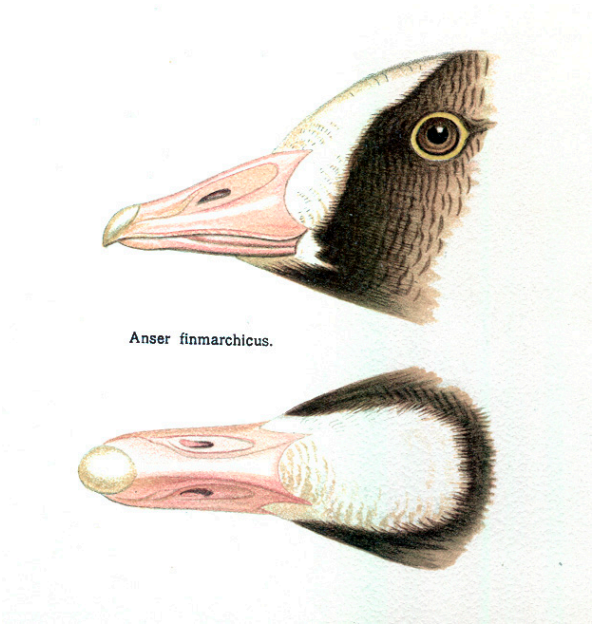
In this current report, we present details on the various release projects, as well as evidence documenting how these reintroduction projects have already, and are in future likely to (if allowed to continue), jeopardise the conservation efforts made towards safeguarding the Fennoscandian population of Lesser White-fronted Geese, and also now these activities are negatively influencing the conservation work for both the western and eastern populations of this species. Unfortunately, it is our perception that the stakeholders of continued reintroduction activities have presented biased and misleading information to support their project.

Internationally, the conservation work for the original wild populations of Lesser White-fronted Geese follow the priorities as agreed in the International Single Species Action Plan (ISSAP) for the Lesser White-fronted Goose that was first published in 1996 by the Council of Europe (Madsen 1996). An updated ISSAP was compiled by BirdLife International and adopted by the African-Eurasian Waterbird Agreement (AEWA) in 2008 (Jones et al. 2008), with an implementation period covering the years 2008-2013. The possible threats that the Swedish free-flying reintroduced population might impose to the wild Fennoscandian Lesser White-fronted Goose population were taken into account in both these action plans, although many compromises towards the Swedish population were made during the 2008 negotiation ISSAP process. The plan was based on the conclusions of the international “Workshop on Protection of Lesser White-fronted Goose” held in Lammi, Finland, from 31st March to 2nd April 2005. However, due to disagreements around the reintroduction issues the whole process stagnated. Then, after an AEWA Secretariat negotiation mission in January 2007, an agreement on how to proceed with the work was reached in November 2007, and the ISSAP was adopted by the 4th Meeting of the AEWA Parties in September 2008. A process to update this ISSAP was initiated in 2012 during the 2nd Meeting of the AEWA Lesser White-fronted Goose International Working Group, at Lake Kerkini, in Greece. Regrettably, the process has again been held up due to the strategy adopted by the Swedish Environmental Protection Agency, which now claims that the Swedish reintroduced population is a wild population that is part of the Fennoscandian population,

and demanding that it should be given the same conservation priority as the true wild populations, thereby effectively blocking progress in updating the ISSAP. As of October 2016, the AEWA ISSAP is still under revision, and two drafts have been circulated to the range states and a third draft has been circulated to the Committee for Captive Breeding, Reintroduction and Supplementation of Lesser White-fronted Geese in Fennoscandia (**chapter 6.4**). It is unfortunate that Sweden has ignored their international obligations and continued the controversial release activities, despite having adopted the ISSAP for the species, thereby ignoring the mutually agreed Action Plan and the recommended conservation actions that were adopted by the 22 pricipal range states for the species within the Western palearctic.

Information about the current Swedish release programme, the whereabouts of the released individuals, and information on how many birds are estimated to have survived following these releases is difficult to obtain. Although some information is available in some of the reports produced by the Swedish Lesser White-fronted Goose project (*Projekt Fjällgås*), comprehensive information about these geese is largely lacking. In order to obtain information used in this critical review report, we have relied on information from various national bird recording committees (national rarities committees), and from a network of international contacts, as well as information published on various websites. One problem with web-based information is that much of it is only publically available for a limited period of time, before either being updated or even deleted completely. For movements of Swedish Lesser White-fronted Geese recorded in Norway (colour-ringed and satellite-tagged individuals) we have had to rely on older information in the form of screen-grabs.

This critical review of Lesser White-fronted Goose reintroduction projects addresses issues pertaining to both former attempts to release Lesser White-fronted Geese in Fennoscandia, as well as the current Swedish project where first releases were made in 2010. The review addresses many topics ranging from historical distribution and population size, to past and present reintroduction projects, and to the current situation regarding the ecological and genetical problems with the existing free-flying reintroduced population in Sweden and their possible impact on the wild Fennoscandian population of Lesser White-fronted Goose. As mentioned above, the review has drawn upon information from a wealth of publications and internal documents, as well as from information from dedicated field workers.



الأوز الأغر الصغير - Arabic
Ծվվան Սագ - Armenian
小白额雁 - Chinese
Νανόχηνα - Greek

The Lesser White-fronted Goose has many names, and most of them describe its diminutive size or its call. In one of the Sami languages spoken in northern Fennoscandia the name is Gálbbenjunneçuonjis, which means “calf-nose goose”. This describes the resemblance with the white face of new-born reindeer calves. This illustration of a Lesser White-fronted Goose head is from Alpheraky (1905) at the time when the scientific name was *Anser finmarchicus*. The name comes from the northernmost region in Norway where the Lesser White-fronted Goose used to be a common breeder during summer in the mountains.

2. REINTRODUCTION AND TERMINOLOGY

2.1 Definitions

Terminology relating to translocation, reintroduction and supplementation has been used inconsistently in the past, thereby resulting in some confusion. Terms such as "exotic", "alien" and "non-native" describe the origin of the species concerned, whereas "feral", "introduced" and "reestablished" describe the processes by which establishment in the wild has occurred (Holmes & Simons 1996, Holmes & Stroud 1995). Translocation as a tool that has been scrutinised during the last two decades, as an ever-increasing number of translocation projects worldwide have aimed at re-establishing extinct or threatened populations. To improve conservation work, the International Union for Conservation of Nature (IUCN) developed a set of guidelines in 1998, i.e. the "IUCN guidelines for re-introductions". In 2012, AEWA commissioned the Wildfowl and Wetlands Trust (WWT) to create a set of guidelines specially to address the issue of translocating waterbirds for the purpose of re-establishing or reinforcing a species in its historic range. The commissioned work brings additional focus on conservation introductions and risk analyses as a tool for determining whether or not a translocation should go ahead (Lee et al. 2012). These guidelines were adopted by the AEWA Meeting of the Parties (MOP5) in 2012, and all AEWA Parties are recommended to follow them.

Throughout this report, the following terms and definitions are used:

2.1.1 Translocation

Translocation is the human-facilitated deliberate and mediated movement of wild individuals or populations from one part of their range to another.

There are several types of **translocation**: introduction, reintroduction, reinforcement/supplementation and restocking:

Introduction is the deliberate or accidental translocation of a species into the wild in areas where it does not occur naturally (outside it's historically known range). Introduction of non-native species occurs for a variety of reasons (see below for definitions of a non-native taxon). Examples include economic gain (Sitka Spruce *Picea abies*), improvement of hunting and fishing (Canada Goose *Branta canadensis*), ornamentation of roads (*Rhododendron spp.*) or maintenance (Sweet Chestnut *Castanea sativa*). In the past, negative effects of translocation introductions of non-native species to ecosystems far outweighed the benefits of them.

Reintroduction is an attempt to establish a species in an area which was once part of its historical range, but from which it has been extirpated or become extinct. Re-establishment is a synonym, but implies that the reintroduction has been successful. Reintroduction is used as a wildlife management tool for the restoration of an original habitat when it has become altered of a species which has become extinct due to overcollecting, overharvesting, human persecution, or habitat deterioration.

Reinforcement/supplementation[1] is the release of an organism into an area of its native range where it still occurs in order to supplement/build up the existing population. Groome et al. 2006 in

[1] The Oxford English dictionary defines **reinforcement** as "Make stronger by adding more men or material; increase the size, thickness of something so that it supports more weight" and **supplementation** as "Added later to improve or complete, e.g. a dictionary".

Principles of Conservation Biology defines supplementation as "Addition of individuals to an existing population of conspecifics."

Restocking is the translocation of an organism into the wild into an area where it is already present. Restocking is considered a conservation strategy where populations have dropped below critical levels and population recovery is questionable due to slow reproductive rates, high mortality or inbreeding. The International Union for Conservation of Nature (IUCN) recommends that restocking only occur when the causes of population decline have been removed, the area has the capacity to sustain the desired population, and individuals are of the same race as the population into which they are released but not from genetically impoverished or cloned stock.

Since there is no standardised term to describe any programme that involves the release of an organism into its historic range either for reintroduction or supplementation, Lee et al. (2010) in their feasibility study used the term "reintroduction/supplementation" for this purpose.

For further discussions around this terminology and issues, see for example IUCN (1998), IUCN/SSC (2013), Armstrong & Seddon (2008) and Lee et al. (2012).

Conservation introductions: the intentional movement and release of an organism outside its historic range. There are two types:

- **Assisted colonisation**: the intentional movement and release of an organism outside its historic range when protection from current or likely future threats in the historic range is deemed less feasible than at other sites.

- **Ecological replacement**: the intentional transport and release outside its historic range of an organism to perform a specific ecological function lost through extinction of other taxa.

Of the various types of translocations, the assisted colonisation and ecological replacement are the most controversial with ecological and ethical arguments underpinning the criticism of them (Ricciardi & Simberloff 2009, Sandler 2009, Williams et al. 1988). It is generally understood that historical range boundaries are associated with ecological factors that promote survival of viable populations, and therefore that locations outside historical ranges are less suitable. Identifying the necessary ecological conditions and habitats outside the historic range would be virtually impossible. Other arguments against releases outside the historic range are that assisted colonisation exacerbates the invasive species problem, and the release of threatened or endangered fauna may have unintended impacts on target systems (Davidson & Simkanin 2008, Huang 2008, Ricciardi & Simberloff 2009).

2.1.2 Naturalised

"**Naturalised"** is an all-encompassing term for wild self-sustaining populations of such species ("exotic", "alien" and "non-native"), describing the outcome of the process. The term "naturalised" can be accompanied by a qualifier explaining the origin of the species concerned to produce the following categories:

- **Naturalised feral**: a domesticated species established in the wild. Note that mere keeping in captivity does not necessarily constitute domestication. The species must undergo some change in genotype, phenotype or behaviour in captivity.

- **Naturalised introduction**: established species which would not occur without introduction by man.

- **Naturalised re-establishment**: a successful re-establishment of a species in areas of former occurrence. Note that "re-established" is favoured over "reintroduced". The latter is often used to describe species which have been re-established in an area of former natural occurrence, following extinction.

- **Naturalised establishment**: establishment of a species which occurs but does not breed naturally in a given area e.g. a vagrant, passage migrant or winter visitor. Note that these terms are meaningless without some geographical reference.

Owen et al. (2006) defined a non-native taxon as "a species, sub-species or discrete geographical population that would not occur in an area without interference by man". This includes:

- A taxon introduced to a region where it normally only occurred outside the reproductive season.
- A taxon introduced entirely outside of its previous known range.
- A taxon imported and taken into captivity at a location outside of its normal range.
- Domesticated taxa that have established in the wild, including domestic-type strains that have arisen by hybridisation between wild and domesticated individuals.

A prerequisite of a naturalised population is that it is self-sustaining (Sol et al. 2005).

2.1.3 Population definitions

The following terms are used to describe natural groups of individuals in ecological studies according to Wells et al. (1995):

Metapopulation	A set of spatially disjunct populations, among which there is some immigration.
Population	A group of conspecific individuals that is demographically, genetically, or spatially disjunct from other groups of individuals.
Aggregation	A spatially clustered group of individuals.
Deme	A group of individuals more genetically similar to each other than to other individuals, usually with some degree of spatial isolation as well.
Local population	A group of individuals within an investigator-delimited area smaller than the geographic range of the species and often within a population (as defined above). A local population could be a disjunct population as well.
Subpopulation	An arbitrary spatially delimited subset of individuals from within a population (as defined above).

AEWA (2005), document MOP3.12, reviewed the practice and principles of defining waterbird populations and concluded:

"*A waterbird biogeographical population is a population of a species or a sub-species that is either geographically discrete from other populations at all times of the year, or at some times of the year only, or is a specified part of a continuous distribution so defined for the purposes of conservation management*".

2.1.4 Wild versus captive

A clear distinction between captive and wild organisms does not seem to exist, despite the fact that all captive animals have a wild origin, and released captive animals sooner or later adjust to a life in the wild when released. Some discrepancy exists such as when captive bred animals are released into non-native areas and are thereby still treated as of captive origin.

The aquarium industry has a set of short-term naming conventions when wild-caught fish have been taken from the wild in order to be sold into the aquarium trade. These fish are taken directly from their natural habitat, for example lakes, rivers and seas and these wild-caught fish are referred to as F0 fish. F1 fish are captive bred offspring of wild caught fish, while F2 fish are captive bred offspring of those etc. Captive bred fish have been bred in captivity. It is, however, possible that their parents were wild caught, or that they have wild caught fish somewhere in their ancestry.

Similarly, the exotic pet industry distinguishes between wild-caught, first generation captive breed and captive breed thereafter. A typical example would be:

Captive bred: An exotic pet that comes from a breeder rather than the wild.
Captive born: An exotic pet born in captivity from wild-caught parents.
Captive hatched: An exotic pet hatched in captivity from wild-caught parents.
Captive farmed: Exotic pets raised in captivity in their country of origin.
Wild caught: An exotic pet taken from the wild.
Long term captive: An exotic pet that has been in captivity for three month or more that has been taken from the wild.

However, these naming conventions are related to the transfer of an animal from the wild to captive conditions and thereafter kept there.

According to the Oxford English Dictionary, wild is defined in the case of an animal or plant as "*living or growing in the natural environment; not domesticated or cultivated*".

2.1.5 What is an alien species?

The term alien species is used in preference to the term introduced species since the term introduced is associated with deliberate actions, whereas alien is considered to be more neutral. The most problematical alien species are often termed as either invasive or invading species. A synonym to alien species is non-native species.

The definition of alien species according to the International Union for Conservation of Nature (IUCN) own definition is as follows: "*Alien species" (non-native, non-indigenous, foreign, exotic) means a species, subspecies, or lower taxon occurring outside of its natural range (past or present) and dispersal potential (i.e. outside the range it occupies naturally or could not occupy without direct or indirect introduction or care by humans) and includes any part, gametes or propagule of such species that might survive and subsequently reproduce*.

2.2 Delimitation of Lesser White-fronted Goose populations

Three geographic groups of wild populations of Lesser White-fronted Goose are recognised. In addition to these is the reintroduced Swedish population comprising released birds with a human-mediated migration route, but only the first three are recognised in published literature as wild/naturally occurring. The following naming and description of breeding delimitation was adopted for the current AEWA International Single Species Action Plan for the Lesser White-fronted Goose (Jones et al. 2008, **Figure 1**):

- **Fennoscandian population**, breeding in Norway, Finland and the Kola Peninsula of NW Russia.
- **Western main population**, breeding in northern Russia to the west of the Taymyr Peninsula.
- **Eastern main population**, breeding from the Taymyr Peninsula eastwards and wintering in China.
- ***Swedish population***, reintroduced by the release of captive-bred birds within the former range of the Fennoscandian population in Sweden and by the establishment of a human-mediated flyway to wintering grounds in the Netherlands.

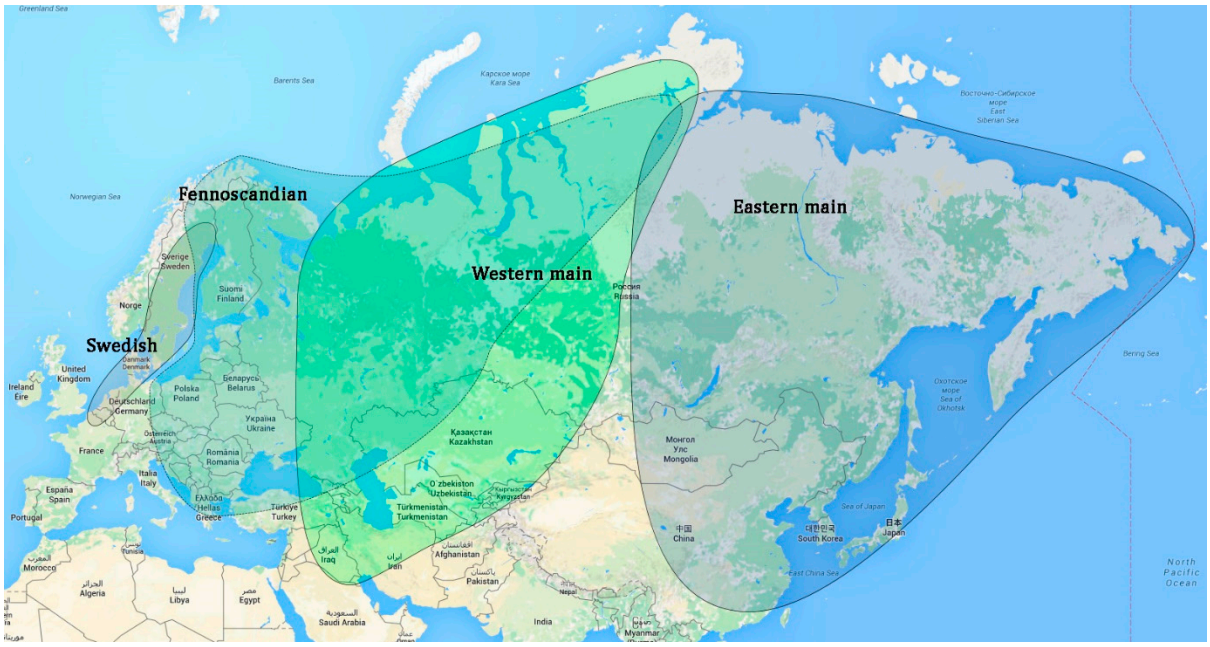


Figure 1. Population delimitation of the Lesser White-fronted Goose.

The naming of the three wild populations stem back in time to the late 1970s and early 1980s when research focused on birds breeding, or formerly bred, in Norway, Sweden and Finland. At the time, the term Fennoscandian was developed for the remaining small population breeding mainly in Lapland in northern Sweden, Norway and Finland (Norderhaug & Norderhaug 1980, 1982, 1984). During the 1990s, when research was conducted on the genetics of the species, it was shown that there was a clear phylogeographic structuring fitting known biogeographic and migratory divisions (Ruokonen et al. 2004). In addition to identifying the Fennoscandian population as a distinct management unit, the phylogeographic divide in the Taymyr Peninsula area led to a need for separating these two major populations breeding in Russia, with migration routes either taking them south-west to the Caucasus/Middle East or south-east to China. Informal discussions during international meetings and conferences settled with the above given names and these were subsequently published in both international (Jones et al. 2008) and National Single Species Action Plans for the species (Norwegian Directorate for Nature Management 2011).

In published literature relating to the reintroduction issue, various new naming regimes regarding the different populations have been used or proposed. For instance, Lee et al. (2011) suggested using an untraditional naming of populations: "*(i) Norwegian population: population breeding in northern Norway and wintering in Greece and possibly Turkey; thought to use traditional Lesser White-fronted Goose migratory routes. (ii) Swedish population: population breeding in Swedish Lapland and wintering in the Netherlands; uses non-traditional migratory routes. These terms are in line with the outcomes of the first meeting of the RECAP committee. The term "Fennoscandian population" is used more broadly to refer to birds breeding in Fennoscandia (Norwegian population, Swedish population, and the unknown number of birds breeding on the Kola Peninsula) or the historic population breeding widely across Fennoscandia in the early 20th century."*

The publications produced by the stakeholders supporting continued Lesser White-fronted Goose releases also use their own naming conventions. In recent years they have presented the Swedish reintroduced population as "The southern Fennoscandian Lesser White-fronted Goose population" and described the population as one of two sub-populations of the wild Fennoscandian population. The result of this is that uninitiated managers and policy makers are confused. The internationally accepted names are based on breeding distribution of the different populations, but they might as well have been named based on their wintering distributions, for example "Greek", "Middle East" and "South-East Asian". The latter is in common use for the eastern most population migrating to China. For the reintroduced Swedish population, the equivalent term would then be "Dutch". As shown later in the present report (**Chapter 3.3**), the Fennoscandian population spends 31 % of the year in Norway (breeding period) and 44 % in Greece (wintering).

The stakeholders of continued release activities have therefore increasingly argued that the Swedish population should be treated as part of the Fennoscandian population both in the revised ISSAP and in other international fora (e.g Conservation of Arctic Flora and Fauna - CAFF). However, as will be shown throughout the present report, there is no evidence that the reintroduced population in Sweden represent traces from the original wild breeding population in Sweden, and it should therefore still be treated as an entirely separate entity. This is also important in the light of the documented Swedish population's deviation from the wild Fennoscandian population in genetic composition, migration route, behaviour and adaptation. As more research focuses on the potential negative effects of reintroduction and translocation projects as for example the ongoing studies currently carried out on the mass releases of Mallards *Anas platyrhynchos* for hunting purposes in Europe (Söderqvist et al. 2014, Söderqvist 2015, Champagnon et al. 2016), it is even more important to separate this population from the other naturally occurring ones.

Looking more closely at the exact global breeding distribution, the original wild Lesser White-fronted Goose populations breed in six more or less discrete geographical areas (see e.g Morozov & Syroechkovski 2002, **Figure 2**):

- **Fennoscandia** (northern parts) including the Kola Peninsula; 25 – 30 pairs (not including the Swedish population).
- **Tundra areas between the White Sea and the Ural Mountains** (Malozemelskaya- and Bolshezemelskaya tundras, and the Ural Mountains); 250 – 400 pairs.
- **Yamal Peninsula** (southern parts); 350 – 500 pairs.
- **Taymyr Peninsula** (southern parts); 1,000 – 1,500 pairs.
- **Putorana Mountains** (south of Taymyr Peninsula); 150 pairs.
- **North-eastern parts of Siberia** (Indigirka, Abyiskaya lowlands in Yukatia); 1,050 – 1,850 pairs.

Figure 2. Global distribution of breeding areas of the Lesser White-fronted Goose.

3. NATURAL MIGRATION ROUTES AND POPULATION DEVELOPMENT

3.1 Fennoscandian population migration routes

Ekman (1922) in his seminal work 'Djurvärldens utbredningshistoria på Skandinaviska halvön [Distributional history of animals on the Scandinavian peninsular]' wrote that (translated): "*the two breeding goose species, the Bean Goose and the Lesser White-fronted Goose, have totally different migration routes. The Bean Goose migrates in large numbers across Sweden and, as is well-known, being enthusiastically hunted. The Lesser White-fronted Goose on the other hand, migrates rarely through these areas, so seldom, that it can be with great certainty be claimed that the migration passes over non-Scandinavian areas. In northern and eastern Finland, it is a common migrant both in spring and autumn. The Lesser White-fronted Goose is with certainty a north-eastern immigrant and as is with other goose species, it migrates with adult and young birds together. It is here possible to think that the birds, generation after generation, could retain their ancient migration routes (the species immigration routes). This conservative adherent to old habits could be explained in such that the routes are learned by the young through the adult's guidance*".

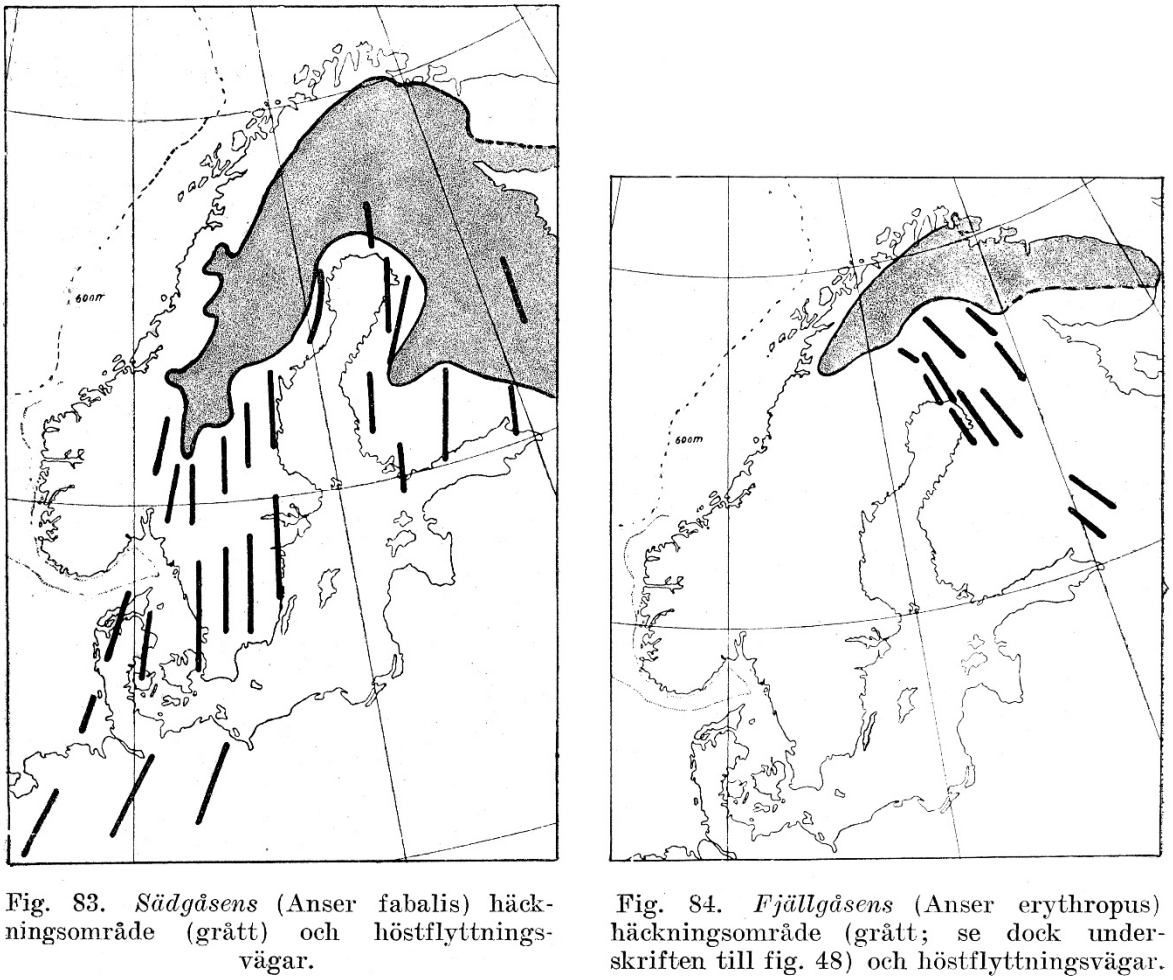


Fig. 83. *Sädgåsens* (Anser fabalis) häckningsområde (grått) och höstflyttningsvägar.

Fig. 84. *Fjällgåsens* (Anser erythropus) häckningsområde (grått; se dock underskriften till fig. 48) och höstflyttningsvägar.

Figure 3. Breeding areas (grey hatching) and autumn migration routes for the Bean Goose (left) and Lesser White-fronted Goose (right) in Fennoscanda according to Ekman (1922).

Similarly, Berg (1937) wrote (translated): "*The Lesser White-fronted Goose is regarded immigrated from east and northeast after the last glacial period, and it migrates regularly back in autumn along the routes it arrived. Rarely has it been encountered during migration in southern Sweden.*"

> Da det er så mange av dem og da de er trekkfugler som ellers ikke kommer oss det ringeste til nytte, har jeg aldri hatt de minste anfektelser for å drive jakt på fjellgås om våren.
>
> [Because there are so many of them and since they are migrants and otherwise of no use to us, I have never had any scruples of hunting Lesser White-fronted Goose during spring.]
>
> *Håkon Evjenth, 1927*

In 1980, Norderhaug & Norderhaug published their review report on the status of the Lesser White-fronted Goose in Scandinavia. The review was undertaken with the help from numerous researchers in Finland, Sweden and Norway, as well as an extensive literature search. They concluded, in the same way as Merikallio (1920), Munsterhjelm (1913, 1916) and Hortling (1929), that the main spring migration route follows the western Finnish coast and crosses the mainland in a north-westerly direction and follows various river valleys to the breeding locations. In addition, a more easterly route through Finland was formerly important based on numerous inland observations of migrating birds. In Sweden there are direct observations of an eastward origin. Haglund (1938) wrote that the first Lesser White-fronted geese in spring arrive in the delta of the Umeä river in the last week of April. Thereafter, numbers increase and peak in mid May when 200 birds could be seen in one flock, and that they were more common than the Bean Goose. At the time it was believed to be likely that these Lesser White-fronted Geese came from Finland and over the Holmöerna islands, and this hypothesis was confirmed by observations of flocks of Lesser White-fronted Geese of 6 and 12 individuals respectively, observed migrating NNE at Holögadd on 11th and 15th May 1936.

Regarding autumn migration, Norderhaug & Norderhaug (1980, 1984) wrote that "*the autumn migration seems to be following more or less the same route as in spring. Unfortunately, the number of published autumn migration records are low*". This is not surprising knowing the migratory system as mapped by use of satellite transmitters since 1994 when the first Lesser White-fronted Goose was tagged in Finnish Lapland. In Norway, 17 wild Lesser White-fronted Geese (in the years 1995 to 2011) have been tracked (Lorentsen et al. 1998, Aarvak & Øien 2003, own unpublished data). A typical pattern is that the birds use larger areas and more variable habitats in autumn than in spring. The Valdak Marshes have been known as a spring staging (and spring hunting) area at least since the 1950s, but it was not until 1994 that the significance of the area as an autumn staging site for Lesser White-fronted Geese was realised.

In spring, the geese concentrate in the thawed salt marshes along the fjords and are therefore easy to see (and hunt), while in autumn they utilise a larger spectrum of food, of which crowberries *Empetrum nigrum* are very important, as it is also for other goose species such as the Cackling Goose *Branta hutchinsii* (Hupp et al. 2013). Crowberries are easily available almost everywhere and have, in contrast to most other berries at northerly latitudes, a steady annual yield (Wallenius 1999), and with wide distribution and good abundance the geese utilise much larger areas in autumn and are therefore also much more difficult to find. Another important factor in the reduced observation frequency in autumn is the variable amount of the population that either do not breed at all or which fail early that undertake a long-distance migration eastward, to moulting sites in Russia (Aarvak & Øien 2003). For the years 1994-2014 on average 50% of the birds seen in spring migrate during early summer to moult elsewhere, and are subsequently not seen at the Valdak Marshes in autumn. The easternmost known moulting area for Fennoscandian breeders is on the Taymyr Peninsula in Russia (Aarvak & Øien 2003, BirdLife Norway unpublished data). This area was also known previously as Rogacheva (1992) wrote: "*Much of the misinformation concerning the breeding distribution of the species can probably be attributed to the fact that the species often moults in northern tundra beyond its breeding range. Considerable concentrations of moulting Lesser White-fronted Geese were noted by V.V. Leonovich in the arctic tundra in the Tareya River Basin, 300-400 km north of the*

nearest breeding grounds of the species (Krechmar 1966); such concentrations were also noted near Lake Taimyr at the sources of the Nizhnyaya River (Sdobnikov 1959)".

There are only a few recoveries of ringed Lesser White-fronted Geese from Fennoscandia before 1980, but the two recoveries that exist of birds ringed in Lapland, Sweden, suggest that the populations at the time also had a similar system with moult migration to Russia and that they were wintering in Greece or surrounding areas (Fransson & Petterson 2001). The earlier interpretation of these two recoveries (one in winter from 7th February 1956 in Macedonia, Greece, and one in autumn on 1st September 1957 in Manych area, Stavropol, Russia, between the Caspian and Black Seas) was that the birds were on autumn migration to wintering sites in the Middle East and Asia Minor. However, present knowledge suggests that the Russian recovery might equally likely be a bird who was actually moving from moulting sites in Russia, travelling through Kazakhstan and was on its way to the winter quarters in Greece or Turkey. So, it was travelling westwards rather than eastwards as was original assumption based on the time of the year these birds were shot (Fransson & Petterson 2001). The moult migration from Fennoscandia to the Taymyr Peninsula was not known at that time (BirdLife Norway unpublished data).

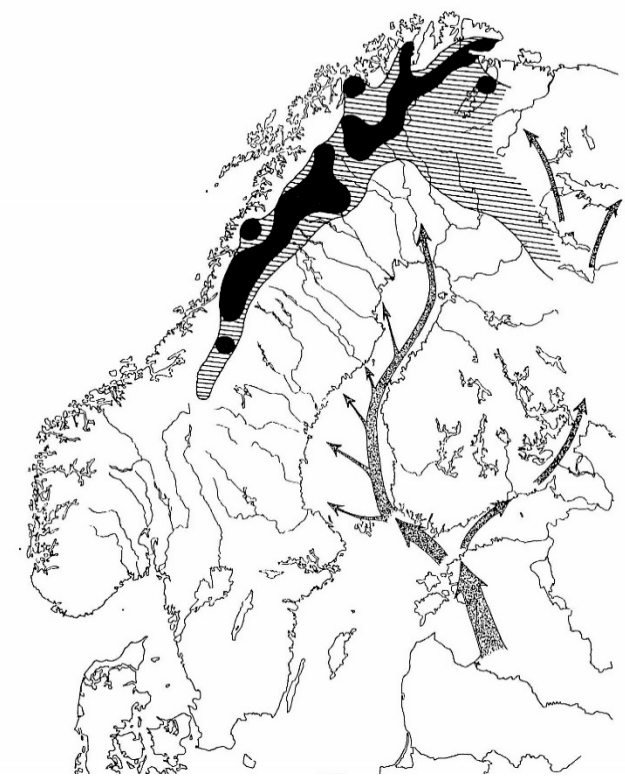


Figure 4. Spring migration route of the Lesser White-fronted Goose (arrows). After Norderhaug & Norderhaug 1984. Past distribution is shown with horizontal hatching and present (early 1980s) as black shading.

By use of satellite transmitters and colour-rings on Lesser White-fronted Geese from the Fennoscandian population since 1994, basic knowledge about the elaborate migratory system has been gathered (Lorentsen et al. 1998, Aarvak & Øien 2003, Morozov & Aarvak 2004, BirdLife Norway unpublished data).

In autumn, after completing the moult, successful breeding pairs return to the same staging area as used pre-breeding in spring. There, at the Valdak Marshes in Finnmark County, Norway, about 80% of the population gathers each year (Aarvak et al. 2009). They spend about three weeks at Valdak before migrating eastwards to the Kanin Peninsula, north-west Russia, in early September. From there the main migration route divides into two, of which the main route is towards the south-west, to staging areas north of the Onega and Ladoga lakes in Russia, then to Eastern Germany/Western Poland, then Hortobágy in Hungary and further to Northern Greece before eventually ending up in the wintering area at the Evros Delta on the border area of Greece and Turkey (Lorentsen et al. 1998, Aarvak & Øien 2003**, Figure 5**). The other migration route, leads south-eastwards from the Kanin Peninsula, crossing the Ural Mountains to staging sites in the lower Ob River Valley (Lorentsen et al. 1998), and further south to the Kostanay Region in northern Kazakhstan (Karvonen & Markkola 1997, Aarvak & Øien 2003). Non-breeders and failed breeders follow a similar migration route southward

from the northern Ob-valley after having left the breeding areas in Norway in late June and migrated estwards to moulting sites in northern Russia (some of them as far east as the Taymyr Peninsula). From Kazakhstan, the Fennoscandian birds turn south-west crossing north of the Caspian and Black seas before also ending up in north-eastern Greece. The Ob valley route south to Kazakhstan, is also followed by the Russian Western main population, though these continue further south to wintering grounds in Azerbaijan, Iran and Iraq (Morozov & Aarvak 2004).

As mentioned above, the sub-adults, failed- and non-breeders undertake a long distance moult migration in mid-June, eastwards from the breeding areas to moulting sites, which stretch from the Kanin Peninsula, Kolgujev Island, and all the way to the Taymyr Peninsula in Russia (Aarvak & Øien 2003), and these birds end up in the same wintering areas in Greece and Turkey as successful breeders and their offspring (BirdLife Norway unpublished data, **Figure 5**). This difference in migration routes between breeders and non-breeders is important since the mortality rate on the eastern routes is much higher due to exposure to excessive hunting pressure and illegal killing.

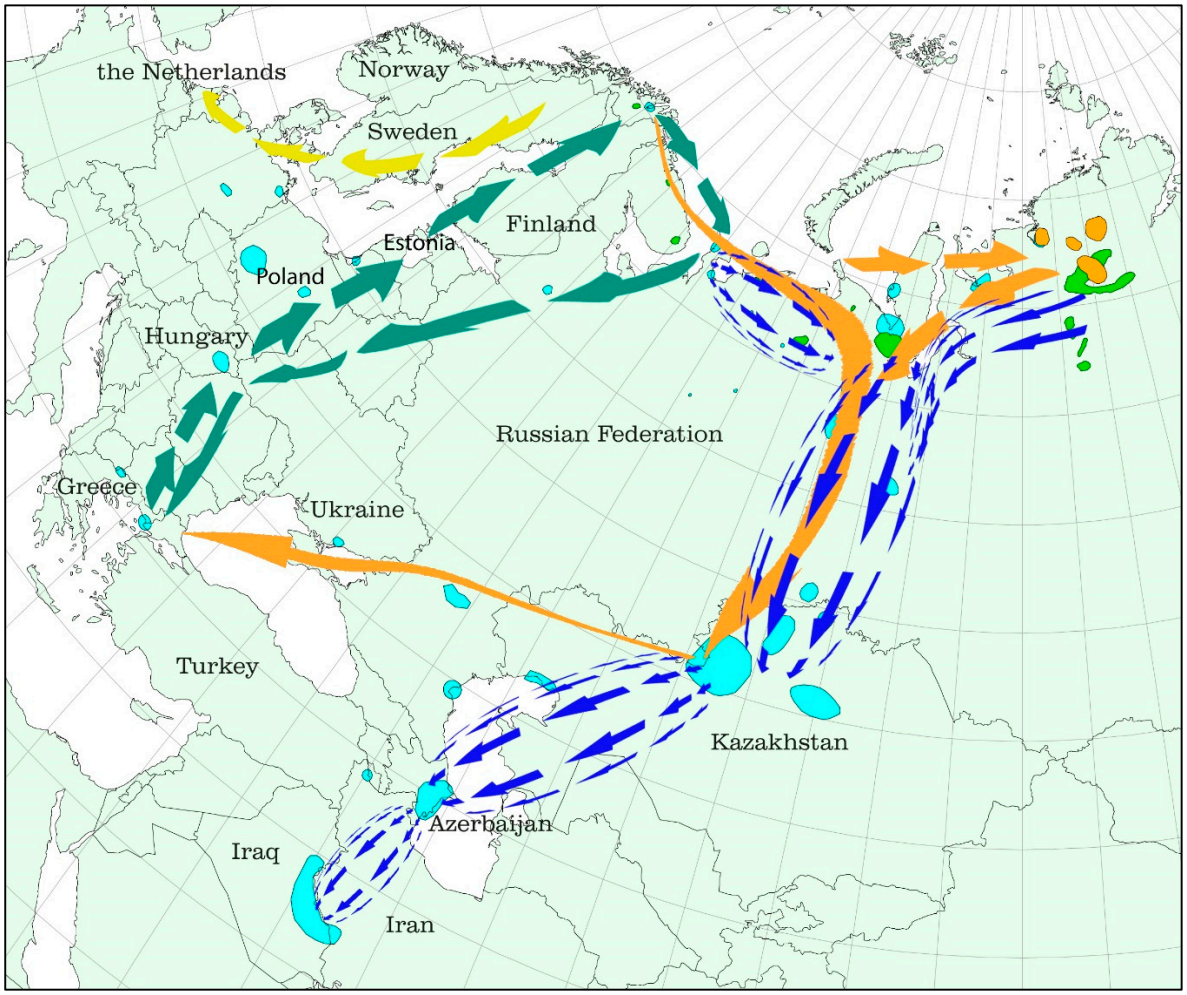


Figure 5. Migration system for the Lesser White-fronted Goose in the Western Palearctic. Light blue shading = important staging sites and wintering sites, dark green = breeding areas, orange = moulting sites. Fennoscandian population: Green arrows = migration route for successful breeders, orange arrows = moult migration route. Swedish reintroduceed population: yellow arrows show the main route southwards. Russian Western main population: blue arrows show main routes southwards (after Lorentsen et al. 1998, Aarvak & Øien 2003, Morozov & Aarvak 2004, BirdLife Norway unpublished data).

3.2 Possible existence of a western migration route, an "Atlantic flyway"

Even at the time when the Lesser White-fronted Geese in the Fennoscandian population were numerous and where several accounts describe the Lesser White-fronted Goose as being a common breeder in the uplands (von Wright 1873, Collett 1921, Ekman 1922, Ryd 2007, Munsterhjelm 1913), and when 80 000-120 000 of them were seen during migration in Hungary (Sterbetz 1982), there were no records of significant flocks of Lesser White-fronted Geese in the Netherlands and Great Britain, which is contrary to the claim by the reintroduction stakeholders (Kampe-Persson 2008, Mooij et al. 2008, Mooij 2010, Kampe-Persson 2010). Following concerns about the three aforementioned publications being biased, an independent review by Marchant & Musgrove (2011) was commissioned by AEWA (see section 8.1), which concluded that "*all records in western Denmark, western Germany, Spain and other west European countries can be accounted for by vagrancy and by escapes*".

The Netherlands and Great Britain have never been part of a regular wintering area for any wild breeding population of Lesser White-fronted Goose. On the contrary, all historical, as well as new ornithological accounts, from these countries describe the species as a rare vagrant (van den Berg & Bosman 1999, Brill 1970, Owen et al. 1986, Parkin & Knox 2010). If any of these countries were formerly part of the normal wintering area of a Lesser White-fronted Goose population, we would at least expect regular occurrence of family-sized groups or small flocks. Of the 130 records in Great Britain, there are 98 records from before 1980, of which only eight consist of two individuals and there is only one record of more than two birds (six individuals seen at Slimbridge, England in March 1956). The remainder of records (91%) are of single birds. The fact that the majority of records are of single individuals cannot constitute evidence of regular wintering, and these records do not *per se* indicate the presence of a population (single individuals cannot breed without a partner). Additionally, data from the British Trust for Ornithology (BTO) in recent years conforms to this pattern of vagrancy, with very few single bird observations believed to be of wild origin. The majority of observations during the last couple of decades involve birds of feral / captive origin (see Parkin & Knox 2010).

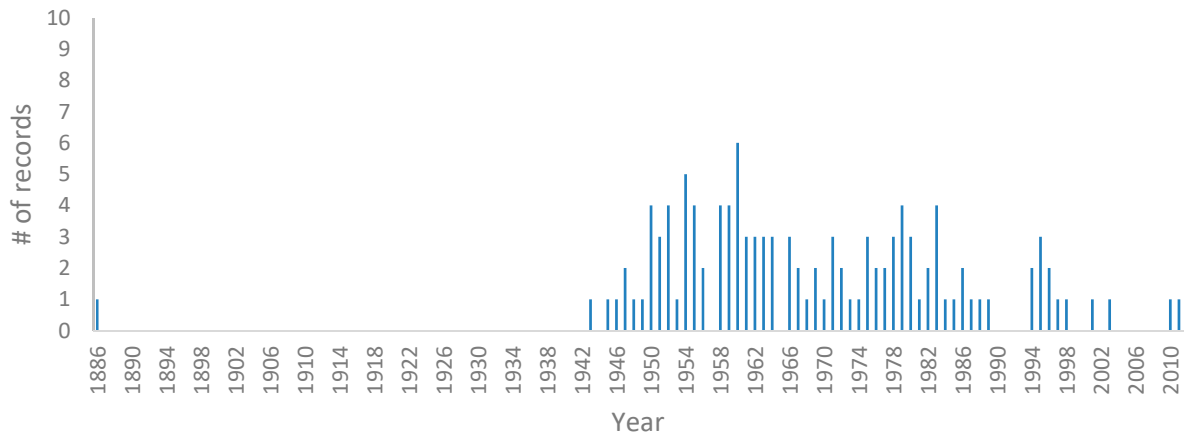


Figure 6. Annual numbers of accepted records of wild Lesser White-fronted Geese held by the British Birds Rarities Committee 1986-2011 (data from BBRC).

Similarly, in the Netherlands, there are no observations of flocks as large as an average goose family of 5 birds (an adult pair plus an average brood during winter of 3 goslings, Lee et al. 2010) before 1980. The species was regarded as rather rare in the Netherlands in the 19th Century, and in the period 1900-1968 there were only 41 records (van den Berg & Bosman 1999). These were in total 16

individuals (14 collected and 2 observed in the field) in the period 1908-1949, and 25 individuals (10 collected or trapped and 15 observed in the field) in the period 1950-1968, all from the period September to March. Since 1969, the species was recorded almost every winter, with increasing numbers especially since 1980 when the Swedish reintroduction project modified the migration route of the released birds to use wintering areas in the Netherlands. Since then it became impossible to distinguish between these introduced birds from Sweden and vagrants from Russia, and the Dutch rarity committee (CDNA) decided not to consider or record the species from 1st January 1990 onwards. Koffijberg et al. (2005) showed how numbers reported in the Netherlands matched up to 99% of the estimated size of the Swedish reintroduced population in the preceding autumn, while more recent data (years 2009-2015, Koffijberg & van der Winden 2013, Kees Koffijberg pers. comm.) shows that an average of 97.2% (range 88.9%-120%) of the numbers in Sweden in autumn are found in the Netherlands during winter. The discrepancy probably arises from a smaller number of ferals and/or vagrant birds of Russian origin following the migration of Greater White-fronted Geese. The latter is a typical pattern observed in Hungary and described in more detail below.

The claim that the Netherlands has been a traditional wintering area for parts of the wild Fennoscandian Lesser White-fronted Goose population originally breeding in Sweden is incorrect. In the 1930s, flocks of approx. 150 Lesser White-fronted Geese could be seen in Ångermanland, Västerbotten and Norrbotten in Sweden. In the 1950s, flocks of 50 Lesser White-fronted Geese could still be seen in Sweden in Västerbotten and Norrbotten (SOF 1990). There were no observations of large (or even small) flocks in the Netherlands in the 1930s and 1950s, despite this being one of the smaller countries in the world with a dense human population, a rich ornithological history and a high number of active birdwatchers. Brill (1970) categorised the species as an irregular visitor to the Netherlands, and it was similarly classified as a scarce winter visitor by van den Berg & Bosman (1999). It is worth mentioning that in former times the Friesian goose catchers, using nets, caught live geese, and that the common species were killed and sold to poulterers, and the rare ones like the Lesser White-fronted Goose (known as 'goudeachje' =golden-eye) were sold to waterfowl collections (http://www.science.uva.nl/ZMA/index.htm, downloaded 15.01.2015). Furthermore, the almost total absence of skins of the species in the zoological collections in the Netherlands clearly indicates that a regular wintering population of Lesser White-fronted Geese was non-existent. Also one of the founders of the reintroduction project in the late 1970s in Sweden, von Essen (1982) wrote: "*In spite of the fact that the natural migration route of the Anser erythropus from Scandinavia goes in a southeastern direction we have decided to try the Branta leucopsis as foster-parents.*" Clearly, the founders of the first reintroduction attempts in Sweden were aware that Lesser White-fronted Geese traditionally flew in another direction than to Western Europe.

To set the small number of records of vagrant Lesser White-fronted Geese in perspective: the Fennoscandian population utilises the Hortobágy area in Hungary exclusively during spring and autumn migration (as confirmed by annual resightings of colour-rings), but in addition vagrant Lesser White-fronted Geese originating from the Western main population in Russia are recorded at many sites in the company of Greater White-fronted Geese (see observation data at http://piskulka.net). In 2015, 168 observations / records of Lesser White-fronetd Geese were reported in Hungary. Of these, 74% were of Russian origin (125 records) and 6.5% of Fennoscandian origin (11 records). Alltogether 31 records could not be classified with certainty. The average group sizes were 2.7 (118 records) and 58.7 individuals for Russian and Fennoscandian birds respectively. The average for birds of Russian origin is overestimated as many of the records are given as sums of individuals that are found within the large flocks of Greater White-fronted Geese that reach up to 20,000 individuals. The Fennoscandian birds pass through quickly during spring and autumn migration, while birds of Russian origin stay throughout winter. Out of the 125 records of birds of Russian origin, 68% (85 records) were found within much larger flocks of other species. The main carrier species was Greater White-

fronted Geese with 97.5% of the records. Lesser White-fronted Geese were found within flocks of other species of goose flocks only twice, once with Red-breasted Geese and once with Greylag Geese.

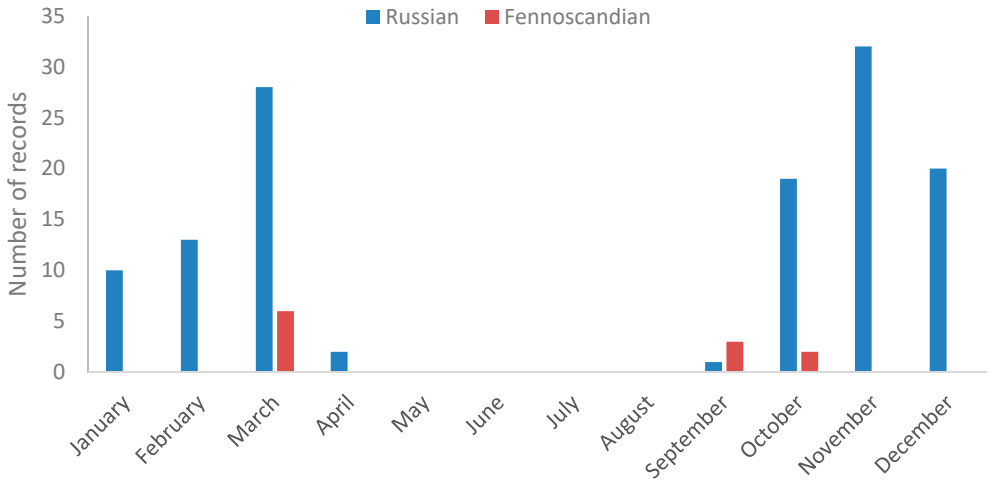


Figure 7. Monthly distribution of records of Lesser White-fronted Geese in Hungary in 2015, with 11 and 125 records of Fennoscandian and Russian origin respectively. The origin is determined based on colour ringed indivdiuals as well as the carrier species they acccompany (data from http://piskulka.net).

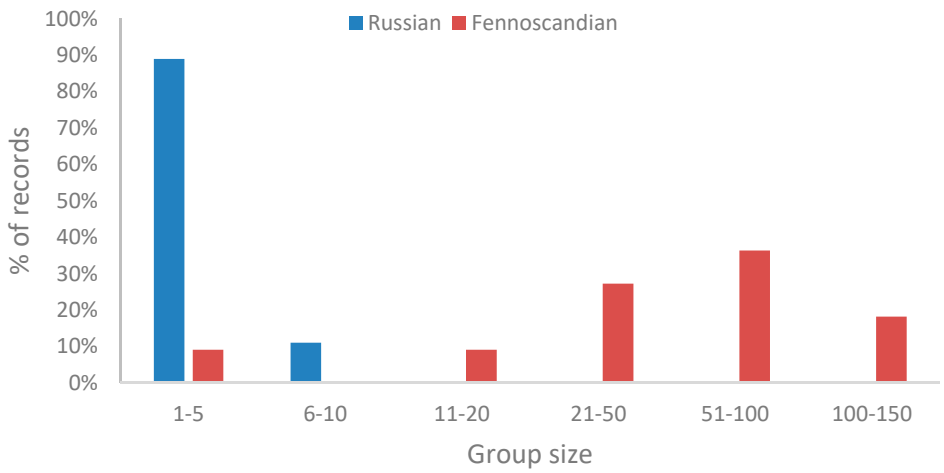


Figure 8. Distribution of group size of Lesser White-fronted Geese of Russian origin (blue bars, n=118) and Fennoscandian origin (red bars, n=11) observed in Hungary in 2015 (data from http://piskulka.net).

Figure 9. All observations of Lesser White-fronted Goose in Hungary in 2015. Winter observations are shown in light blue, while autumn observations are shown in red. The Hortobagy area is marked with stipled circle (data from http://piskulka.net).

In the review of articles claiming the existence of a traditional migration route to Western Europe, Marchant & Musgrove (2011) concluded that "*There is little evidence that such a migration route existed before the Swedish project began, although it might have done so, dying out before European ornithology had developed sufficiently to record it*". This is an understandable reservation from the authors considering the material they scrutinised. This reservation has, however, been interpreted by the stakeholders of continued releases as it is as likely that there has been an original migration route from Fennoscandia to western Europe rather than the opposite. Yet the reservation by the authors can in fact be refuted, as fossil records reveal no finds of Lesser White-fronted Goose in Western Europe. On the contrary, all known existing fossil records of Lesser White-fronted Geese are from the Mediterranean (Italy and Egypt) as well as central Europe, a pattern fitting the species' current distribution. Based on the work of Tyrberg (1998), Ruokonen (2001) analysed the records of a total of 91 fossils of Lesser White-fronted Goose, Greater White-fronted Goose, Bean Goose and Pink-footed Goose during the last two stages of the late Pleistocene (IS3 60,000 – 24,000 BP and IS2 20,000-10,000 BP) and first isotope stage of Holocene (10,000 BP-present). Tyrberg concluded that the Pink-footed Goose is only found in Western Europe with the exception of one fossil location found in Italy during Dryas III, the last cold period before the onset of Holocene, which was harsh, especially in western Europe. Comparatively, Lesser White-fronted Goose fossils are not found in Western Europe, which is in agreement with their present day distribution in Europe during the non-breeding season (Ruokonen 2001).

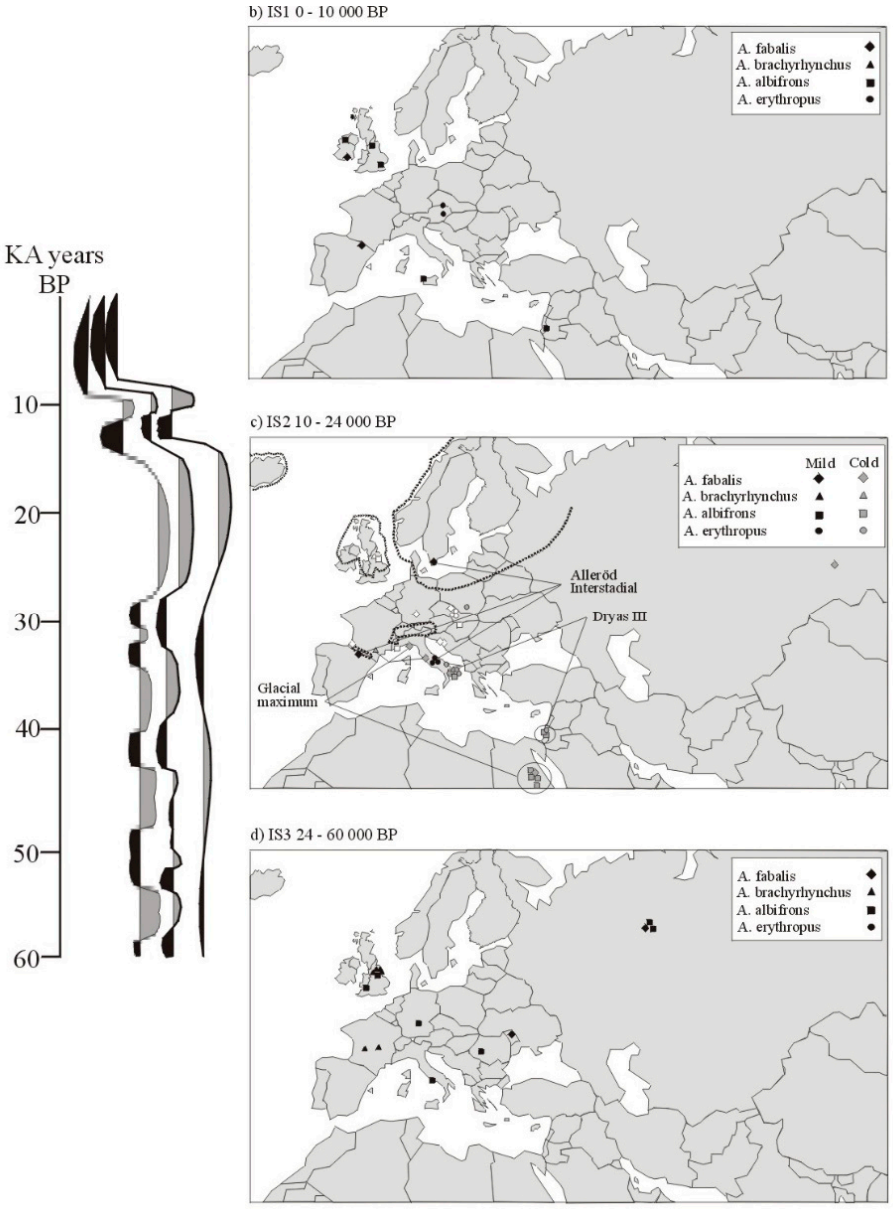


Figure 10. Fossil records of Lesser White-fronted Goose, Greater White-fronted Goose, Pink-footed Goose and Bean Goose from appr. 10,000 -24,000 BP based on 76 records (after Ruokonen 2001).

Research into more recent history does not provide any evidence of a western distribution as exemplified by the work of Albarella & Thomas (2002), who reviewed the use and consumption of wild birds in medieval England. A survey of the occurrence of wild birds from 153 sites of Anglo-Saxon origin found evidence of domestic Greylag Geese from 10 sites in the 6th-early 11th centuries, and regularly thereafter up to the 16th-17th centuries (early post-medieval). Wild Greylag Geese and Barnacle Geese were also common, while Pink-footed Goose, Greater White-fronted Goose and Brent Goose were found at one site each. There are no records of Lesser White-fronted Goose. In 1991-1993 large scale excavations were carried out in Friesland in the Netherlands (Zeiler 2014). The artificial dwelling mound, situated in a former tidal salt marsh area, contained 3,429 bird remains from the Roman period (AD 175-300/500) up to the Ottonian period (850-900/950) in the early Middle Ages. Here the most common species were Greylag Goose (n=60) and Brent Goose (n=20), while Greater White-fronted Goose (n=2) and Bean Goose (n=4) were found in smaller numbers.

3.3 Fennoscandian population development

The Fennoscandian Lesser White-fronted Goose population has been monitored in detail in Norway since 1990 and in Finland since 1985, where all birds have been identified individually based upon their unique black belly-markings (Øien et al. 1996). For identification between years and migration and survival analyses, 68 individuals have been colour-ringed in Norway since 1995. In addition, a few birds have been ringed in Finnish Lapland. The Fennoscandian population has been the focus of five EU-LIFE conservation projects since 1997, of which the latest is due to finish during 2016-2017. Besides these, national research and monitoring projects have been running for several decades in Norway, Finland, Estonia, Hungary and Greece and, through their collaboration in the current EU-LIFE project from 2011 (LIFE10 NAT/GR/000638), an extensive network of field workers have been set up in the Western Palearctic, covering more than 17 countries within the distribution range of the Fennoscandian population. The collaborative work has led to a good understanding of the population dynamics and the factors affecting trends in numbers, mortality and reproduction.

Observations of Lesser White-fronted Geese from the Fennoscandian population are now continuously added to the databases of http://piskulka.net in addition to the many national bird observation databases. The observation coverage for the Fennoscandian population throughout the year is good, and the periods of the year when their whereabouts are unknown are well documented.

Maximum weekly numbers throughout the year for the six most important countries for the Fennoscandian population in the years 2011-2015 (**Figure 11**) shows that they disappear for a short period during midwinter, then again when migrating northwards from Hortobágy in Hungary in spring. To understand the data, it is important to be aware that during spring migration northwards the goose flocks split up into smaller groups or pairs, so the maximum weekly numbers drop since they travel more independently in this period.

Based on an average maximum weekly numbers for the years 2011-2015, the Lesser White-fronted Geese stay in Norway for 30.9 % of the year (breeding season) and 43.6 % of the year in Greece (wintering). Corresponding percentages during migration periods (staging) are Finland 5.5 %, Estonia 5.5 % and Hungary 14.5 %.

During summer, approximately 75% of the pairs breed in a core breeding area, but in order to reduce disturbance they are not the target to any specific research after the early breeding survey in early June is finished (these data are not presented here). In autumn, the birds again show strong flocking behaviour and migrate in one or two large groups, and this is well reflected in the maximum weekly numbers recorded. After the last observation date in northern Norway, they migrate to western Russia where there are no field observers, but they probably stay at the known staging site on the Kanin Peninsula until they again show up in Hungary 1-2 weeks after they left Norway. From Hungary all the birds migrate to Lake Kerkini in Greece were they usually stay until the New Year. Afterwards, they move a short distance to the Evros Delta. Here parts of the flock can leave for several weeks for a hitherto unknown area, dubbed the “mystery site”. Count coverage is more limited in the Evros Delta because of more difficult access and poor visibility for some of the preferred feeding habitats.

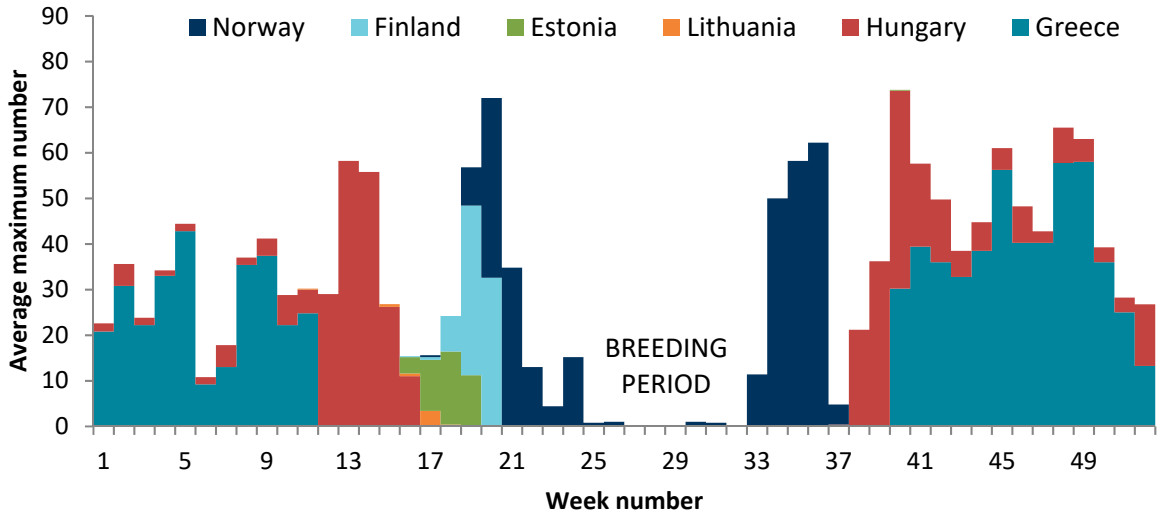


Figure 11. Average weekly maximum number of Lesser White-fronted Geese throughout the annual cycle in the years 2011-2015. Data from http://piskulka.net.

The best long-term monitoring data is from the spring and autumn staging site in the Porsangen Fjord (which includes the Valdak Marshes) in Finnmark, Norway, where on average 80% of the population is present during spring staging (Aarvak et al. 2009). Here, the population was decreasing by 4.5% annually until 2010, after when it started recovering with an annual increase of more than 14% per year.

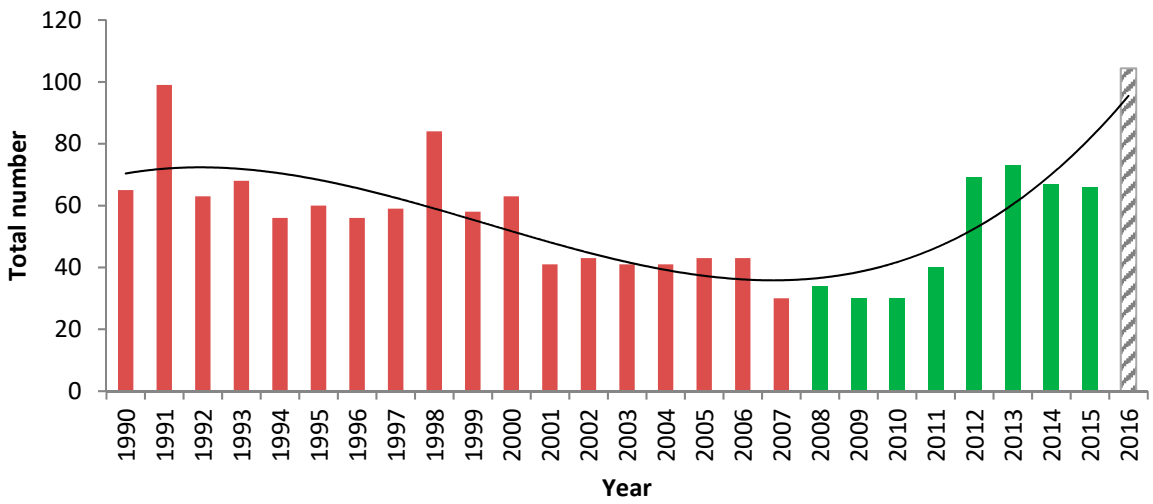


Figure 12. Total numbers of Lesser White-fronted Geese during spring staging in Porsangen Fjord, Finnmark Norway during the years 1990-2015. A preliminary estimate of 104 individuals for 2016 is added (video analyses for spring 2016 still pending).

As the population dynamics of the original wild Fennoscandian Lesser White-fronted Goose population are not the focus of the present report we will not present specific details on mortality, production and the factors regulating them, but note that culling of Red Foxes in the core breeding area in Norway (started in 2008, with effective implementation from 2009) is a key to the changing

trend in population development. The purpose of the culling is to counteract loss of egg clutches but most importantly to delay possible loss of clutches or broods to avoid the adult birds undertaking the long moult migration to Russia where they are exposed to heavy hunting pressure during the summer. Later, during the autumn migration along the eastern route through Russia, Kazakhstan and Ukraine, they are subjected to an even higher hunting pressure despite being totally protected. Because of the underlying reasons for the culling, we do not expect that a similar culling activity of Red Foxes in the release breeding area of the Swedish population will have a similar large positive effect, since it is the adult mortality on migration that is being affected and not the survival and production within the breeding areas per se. To further understand the mechanisms and effects of climate changes to the future survival of the Fennoscandian population, BirdLife Norway joined in 2016 the Norwegian research program "Sustainable management of renewable resources in a changing environment: an integrated approach across ecosystems" (SUSTAIN). This is in order to analyse and model the effects of climate change and culling of Red Foxes in the breeding areas on the population development of the Fennoscandian Lesser White-fronted Goose. Our research data will be incorporated into one of six case studies. The SUSTAIN project involves three of the strongest scientific groups within ecology and evolution in Norway who join efforts to study the combined impacts of environmental change and harvesting across marine, freshwater and terrestrial ecosystems. The research groups are the Centre for Ecological and Evolutionary Synthesis (CEES), Dept. of Biosciences, University of Oslo (UiO), Centre for Biodiversity Dynamics, Norwegian University of Science and Technology (NTNU) in Trondheim, and the Department of Arctic and Marine Biology, University of Tromsø, (UiT).

SUSTAIN

In 2014, the Fennoscandian population size in late spring/early summer was estimated at 70-90 individuals, of which 15-20 were breeding pairs (BirdLife Norway unpublished data), a slight increase from the estimate of 60-80 individuals given by Fox et al. (2010). The population is predicted to be significantly larger in 2016 as an effect of the good production in 2015 (**Figure 12**). In mid-February 2016, at least 144 birds were wintering in Greece (http://piskulka.net) and in early May, 104 individuals were observed at staging sites near Oulu, Finland. This is the highest spring count in Finland since 1964! During spring staging i late May 2016 in The Porsangen Fjord, 28 potential breeding pairs were identified.

Since the 19th Century, when the Fennoscandian Lesser White-fronted Goose population was at its peak with a gross estimate of at least 10,000 individuals, the numbers have fallen drastically during the 1940s and 1950s, and the decline continued and brought the population to the brink of extinction in early 2000s (**Figure 13**). This was accompanied by a severe decrease and fragmentation of the breeding areas, and the Fennoscandian population was occupying less than 1% of its former range in early 2000s. Following the positive change in numbers during the last 5-6 years, Lesser White-fronted Geese have started to reoccupy several of the former breeding areas in the counties of Finnmark and Troms in Norway and possibly also areas in northern Finland close to the border with Finnmark (BirdLife Norway unpublished data).

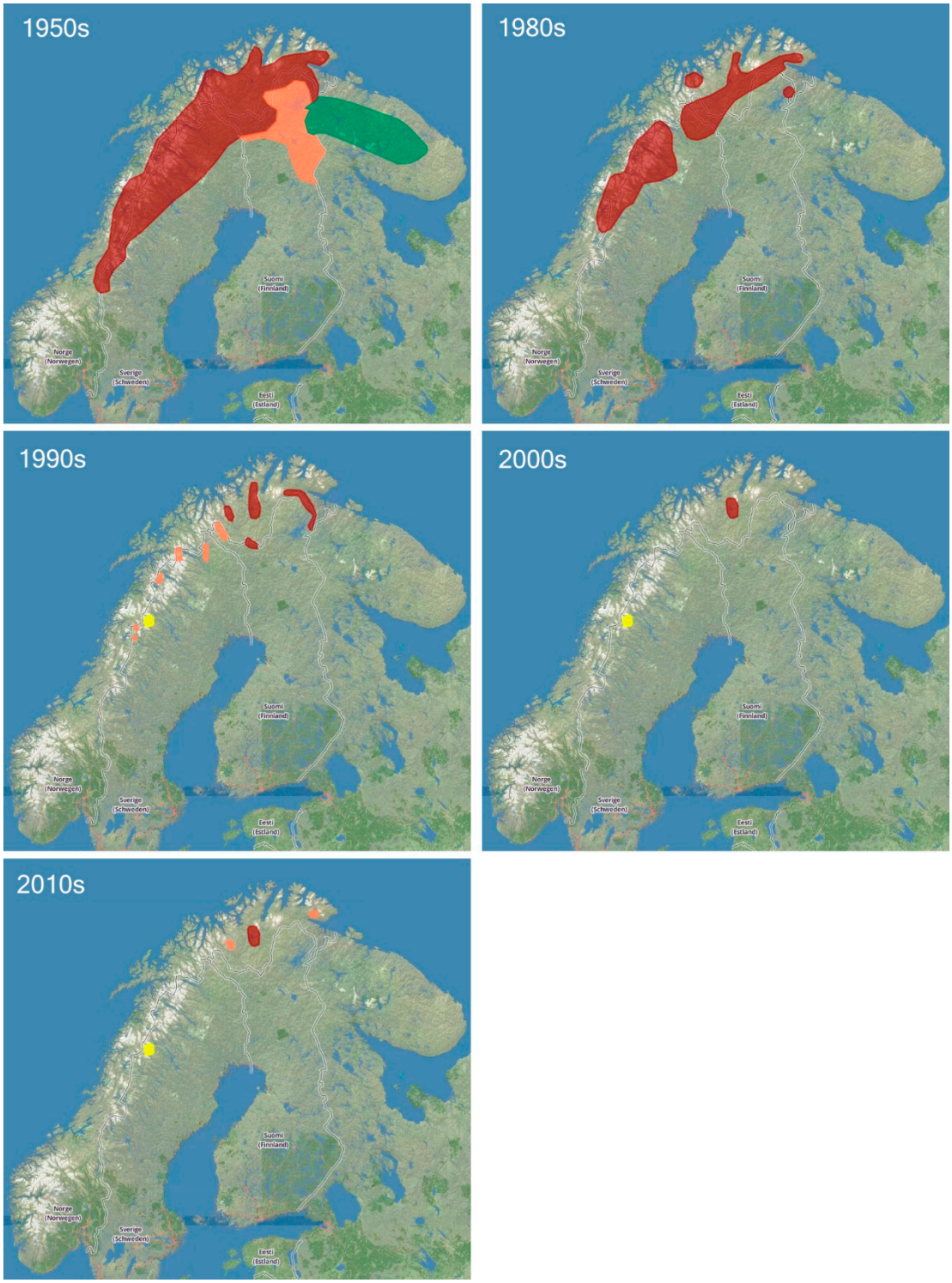


Figure 13. Changes in breeding distribution of Lesser White-fronted Geese in Fennoscandia from the 1950s until 2015 (red = regular breeding, green= probable breeding area, orange = sporadic breeding, yellow = Swedish population reintroduction area). In 2016 an additional recolonised area was located in Finnmark County, Norway.

3.4 Migratory behaviour

3.4.1 Cultural/social learning versus inherent (genetical) knowledge

Migratory behaviour can be genetically or culturally determined. In cultural transmission, the young learn by following their parents, or other group member's behaviour. Consequently, species with this system are expected to have a social lifestyle, long life spans, and (in higher vertebrates) extended parental care. Classic examples include schooling fish species such as herring (cf. Huse at al. 2002), geese, swans, and mammals such as antelopes, Wildebeest *Connochaetes* sp., and Sperm Whales *Physeter macrrocephalus*. For Sperm Whales, cultural inheritance has been shown to drive fitness asymmetries where it influences both clan membership and foraging strategies, with differential feeding success among clans (Whitehead & Rendell 2004).

Genetically determined migration is typically associated with threshold photoperiods or preferred directions, and involves species where there are no parents accompanying the young, peers or elders, due to short lifespan, high mortality, or separation of age classes or generations. Genetic transmission is typical in passerine bird species (Berthold et al. 1992, Alerstam 1990), all insect migrants and sea turtles (cf. Fuxjager et al. 2014). The knowledge that swans, geese and cranes learn the migration routes and which sites to use by accompanying their parents (culturally determined) has been used to re-establish populations in areas from which former populations had been eliminated. Ellis et al. (2003) describes 15 experiments from 1993 to 2002 where they used ultra-light or micro-light aircraft to accompany species such as Canada Goose *Branta canadensis*, Sandhill Crane *Grus canadensis* and Trumpeter Swan *Cygnus buccinator* in the United States. The Swedish reintroduction project that used Barnacle Geese as foster parents to manipulate the migration route to a safer wintering area (von Essen 1991) has become a classical textbook example of how effective this cultural learning is for young geese (Milner-Gulland et al. 2011, Cabot 2009). The fact that geese learn the routes from their parents has probably been known for a long time (cf. Ekman 1922), and this is not surprising considering how long geese have been used for various purposes by man (Kear 1990, Shrubb 2013). In the Light-bellied Brent Goose *Branta bernicla hrota*, it was shown a kin structure where most offspring chose staging and wintering sites in adulthood that were identical or very near to those of their parents, but with no evidence of genetic differentiation (Harrison et al. 2010). This represents a mechanism whereby behaviour learned from parents could generate reproductive isolation through allopatry (Harrison et al. 2010).

Experiments by Chernetsov et al. (2003) proved that young White Storks *Ciconia ciconia* who undertake their first autumn migration without the aid of parents or other adults do not know where to travel, and that they do not possess a genetically inherited compass telling them in which direction to go. The study used satellite transmitters to follow the migratory orientation of juvenile White Storks from the population in the Kaliningrad Region (Russia) during their first autumn migration. Two series of experiments were performed. The first involved several groups of first-year storks raised in an aviary, kept there until all free-living conspecifics had left the area, and then released. These birds had to select their migratory route on the basis of the inherited directional information they possessed, without any chance of being guided by experienced conspecifics. The second experiment used several groups of juveniles displaced from the Kaliningrad Region to the Volga area and to Western Siberia. Both areas lie outside the breeding range of the White Stork, so the displaced birds also had to rely on their innate migratory programme. Results from the differently designed experiments did not match, nor did they match with the results of earlier experiments on the delayed departure of juvenile White Storks. The authors suggest that naïve White Storks (and perhaps other soaring migrants) rely on social interactions when selecting their autumn migratory route to a much greater extent than do passerine long-distance migrants (Chernetsov et al. 2003).

Similarly, Mueller et al. (2013) found evidence of long-term social learning, but no effect of genetic relatedness on migratory performance in Whooping Cranes *Grus americana*.

For other species such as Herring Gulls *Larus argentatus* and Lesser Black-backed Gulls *L. fuscus* it has been shown through cross-fostering experiments that genetic influences override social ones in determining whether to migrate or not. Young migratory Lesser Black-backed Gulls became imprinted and fostered by resident Herring Gulls and vice versa (Harris 1970). Both species behaved as their species normally do, and did not pick up the migratory, or lack of, migratory behaviour of their foster parents. In addition, another important lesson from these experiments was the effect of imprinting (Harris 1970): "*Despite wide ecological and behavioural overlaps, interbreeding between L. argentatus and L. fuscus is exceedingly rare. However, as a result of cross-fostering experiments, 31 and 40 mixed pairs were found on Skokholm in 1968 and 1969 respectively. Although some of the birds involved were unringed it is probable that all the adults in mixed pairs had been cross-fostered. Other cross-fostered birds were found mated with their own species and it appears that the sex of the imprinted birds was important. Female gulls will usually only mate with males of their own species, or in the case of the cross-fostered birds, with males of their foster species. Males will mate with either species. Evidence is given that suggests that the colour of the mantle and wings is important in species recognition at long range, and the colour of eye-ring and join of the mandibles for recognition at short range. The role of voice is uncertain but general behaviour is probably unimportant*."

3.4.2 Imprinting and adoption

Individual birds immediately become associated upon the species they first become associated with, and this behaviour is known as imprinting (Spalding 1872). Many studies, such as the classical behavioural experiments performed by ethologists such as Konrad Lorenz (1903-1989), have taken advantage of the bonding process immediately after birds hatch out of the egg, where young become imprinted on the first living being they see, regardless as to whether or not this is their own parent(s), or indeed their own species. As an example, Lorenz's captive Greylag Geese became imprinted upon their human foster parents.

Choudhury et al. (1993) carried out studies on a wild population of Barnacle Geese breeding in the Svalbard archipelago to determine the frequency and timing of adoption within the same species. This revealed that adoption was most likely to occur in the early development stages of goslings, shortly after hatching, although adoption was also recorded in geese at later stages when goslings were up to 12 weeks old. Adoption shortly after hatching probably occurs whilst parents and offspring are still unfamiliar and are not yet able to recognise one another, but this did not explain adoptions at later stages.

In a study of a Barnacle Goose population in the Baltic, Larsson et al. (1995) found that there appeared to be little benefit in adopting young. In adult birds, there were no significant differences in either body mass, adult survival or reproductive success in subsequent seasons. Post-fledgling survival in young geese was not significantly different in birds that were adopted as opposed to birds in families with or without adopted goslings. A study on adoption in Snow Geese *Chen caerulescens* found that an adopted gosling was as likely to survive to fledging as the other (original) members of the brood (Williams 1994). Nilsson & Kampe-Persson (2003) found, however, that there were significant advantages in adopting geese, with goslings in larger families of Greylag Geese having improved survival and were more likely to reach recruitment age (which is three years after fledging in Greylag Geese) than goslings reared in smaller families. Furthermore, goslings in families had a distinct advantage over lone goslings in gaining access to better quality foods, and that they are attacked proportionately less often and for shorter periods than lone goslings. They were also able to

feed undisturbed for longer periods, thus being in better body condition and have increased fitness and survival (Black & Owen 1984, 1989a, 1989b). There are also likely to be benefits to the host family in the form of an extra group member to help look out for predators, and larger broods appear to have faster growth rates compared to smaller broods (Cooch et al. 1991, Black & Owen 1987).

The above examples suggest that there are advantages in being adopted, and that goslings that have become separated from their parents are unlikely to survive without becoming adopted. There are undoubtedly advantages for a lost gosling to join another family, not least because parental protection is likely to play a significant role in offspring survival (Black & Owen 1987). Adoption is more likely at an early age in life (up to about two weeks of age) but there are examples where adoption has occurred at later stages in life (see reference to Choudhury et al. 1993).

An obvious prerequisite for adoption is that there are other families of geese in the area so that adoption may be possible. In the case of the released population of Lesser White-fronted Geese in Sweden, their production of young has been low (amongst other reasons due to high predation rates on adult birds) and the chances of young that are released actually becoming adopted are very small as there are very few pairs with broods of goslings. In this respect, releases of young raised in captivity into the Swedish mountains are unlikely to result in birds becoming adopted by adult birds from the Swedish Lesser White-fronted Goose population. As a result, these goslings cannot be expected to follow the same route as the other geese (which themselves follow a human-induced and unnatural migration route, see elsewhere in this report).

3.4.3 Family and social life

Geese are social animals and interact both with members of their own family as well as other conspecifics. Young geese remain within the family unit until they are chased by their parents or leave on their own accord. The length of time that geese remain in the family varies but is normally for several months, at least until prior to the next breeding season. In some species, however, young birds may continue to associate with their parents for several seasons (e.g. Warren et al. 1993). Raveling et al. (2000) found that prolonged parental care was beneficial to Canada Geese, resulting both in better survival as well as having better reproductive success in their first year of breeding than for young birds that were not in family associations. Black & Owen (1987) showed that young in families had enhanced social status. Lack (1968) showed that survival and subsequent reproductive success was enhanced in birds within a family structure.

Young geese are known to learn which food plants that are most profitable from their parents, and indulge in food-sharing (Black & Owen 1989a, Turcotte & Bédard 1989). Food-sharing bouts may occur up until the young are ten months old. However, the frequency of such bouts decline as goslings become older (Black & Owen 1989a).

In the case of the Lesser White-fronted Geese released in Sweden without any parents or foster parents (i.e. birds released in the current programme from 2010 onwards) then these feed in habitats that are very unlike that of the wild Fennoscandian birds (see **chapter 5.6.2**). These birds feed in agricultural habitats and in park grasslands, whereas the wild Fennoscandian Lesser White-fronted Goose population feed on coastal marshes and steppe-like habitats. A shift towards agricultural and other man made habitats may lead to a conflict between geese and human interests, if the population were to increase. The problem would be exasperated if the birds released in Sweden breed successfully (which they do) and thereby teach their offspring to feed in the same habitats as the parent birds.

4. HISTORY OF CAPTIVE BREEDING AND RELEASES OF LESSER WHITE-FRONTED GOOSE IN EUROPE

Captivation and domestication of geese has a long tradition. The Egyptian Goose *Alopochen aegyptiacus* was caught, kept in captivity and possibly domesticated in Egypt in the 3rd millennium BC. The common domestic goose, nowadays found across the world, derives from the Greylag Goose *Anser anser*, probably of the *rubrirostris* subspecies (Albarella 2005). Several time-lines for the domestication processs have been suggested, though the general consensus is that the European domestic goose was domesticated approximately 3,000-5,000 years ago, most likely in the vicinity of the eastern Mediterranean region (Heikkinen et al. 2015, Bruford et al. 2003). The Chinese domesticated geese are derived from another species, the Swan Goose *Anser cygnoides* (Bruford et al. 2003). Well-documented records of domestic geese date back to the first half of the 8th century, as in Homer's "Oddyssey". By Roman times, goose husbandry had become well established. Geese were, however, not only used for food, but were also kept for religious purposes and for pleasure as was evident in the 1st century BC (Albarella 2005). In mediaeval England during wartime, goose feathers for fletching arrows were in great demand. In February 1417, six feathers from every goose in 20 southern counties were ordered sent to the Tower (in London) by 14th March, and, on 1st December 1418, sheriffs were ordered to supply 1,190,000 goose feathers by Michaelmas. Such orders were issued annually to replace stocks (Hardy 1992 referred in Shrubb 2013).

As detailed above, having geese in captivity has a long history. Although we have not made a specific extensive search of literature for records of Lesser White-fronted Geese held in captivity, we know they have been held in captivity at least since the mid-1850s. Irby (1861) mentions seeing Lesser White-fronted Geese in the Zoological Gardens, Regent's Park in London, England sometime after 1859. He was familiar with the species after having previously shot two birds in India. Finn (1909, 1915) describes how four wild-caught birds where obtained from a Calcutta bazaar in 1898 and sent to the Calcutta Zoo, India. Horsbrugh (1910) describes a hybrid Lesser White-fronted Goose x Brent Goose in the waterfowl collection of Stephen's Green in Dublin, Ireland, and Quintin (1919) describes the probable first captive breeding of Lesser White-fronted Goose in Britain in 1918. Quintin acquired his three adult birds in July 1914. At Slimbridge on the Severn estuary (England), they acquired their first Lesser White-fronted Goose in 1946 (The Severn Wildfowl Trust 1948). The Severn Wildfowl Trust, later became the Wildfowl Trust, and again changed its name to the current one of The Wildfowl and Wetlands Trust (WWT). At that time, the Lesser White-fronted Goose was considered an extreme rarity in Britain with only three records of single birds prior to 1946 (British Birds Rarities Committee (BBRC), Davies & Scott 1946).

The total number of captive Lesser White-fronted Geese currently registered worldwide with the International Species Information System (ISIS 2013) as of October 2013 was 272 individuals in 46 collections, with 37 of these collections being in Europe (with a total of 233 individuals). These numbers are likely to represent much less than half of the true number of captive Lesser White-fronted Geese, as many private breeders and other collections are not registered with ISIS. In Sweden both "Nordens Ark" (65 individuals) and The Skåne Zoo Foundation (Stiftelsen Skånes Djurpark) (1 individual) were registered, while similarly in Finland, Ahtari Zoo, Helsinki Zoo and Ranua Wildlife Park were registered with 3, 4 and 2 individuals respectively in 2013. Clearly, most of the stakeholders of continued releases of Lesser White-fronted Geese in Fennoscandia that keep Lesser White-fronted Goose stocks do not have their breeding stocks registered with the International organisation for zoos, aquariums and related conservation organisations.

Significant captive breeding stocks of Lesser White-fronted Goose were built up in Sweden and Finland to supply the reintroduction/supplementation programs that released birds in Fennoscandia between 1981 and 1999. These breeding stocks were mainly housed at the Öster-Malma Hunting and

Wildlife Management School in Nyköping, Sweden; the "Nordens Ark Foundation" in Western Sweden; a private farm on the isle of Hailuoto on the west coast of Finland; and Hämeenkoski Farm in southern Finland.

While a small proportion of the birds (seven individuals) which founded the Öster-Malma breeding stock were wild-caught in Fennoscandia and therefore of known wild origin, the majority of birds introduced into these breeding stocks were from existing captive collections of unknown wild origin and with a long history of captive-breeding (Tegelström et al. 2001).

After a temporary halt of releases in Sweden after 1999 following the detection of alien genes in the original captive stock, a new captive stock was established at the zoo of the foundation known as "Nordens Ark", Sweden in cooperation with the Swedish Association for Hunting and Wildlife Management (Svenska Jägareförbundet) and they also rebuilt the captive stock at Öster Malma. These stocks were founded by using wild-caught birds from the Western Main population. Juvenile Lesser White-fronted Geese were captured on the Russian tundra and moved to Moscow Zoo where they underwent a veterinary examination before being sent to "Nordens Ark". A total of 59 Russian Lesser White-fronted Geese were imported into Sweden between 2006 and 2013 (Liljebäck et al. 2013).

By 2015, a total of 740 captive-bred Lesser White-fronted Geese have been released in Fennoscandia through official release programs. This comes in addition to an unknown, but perhaps substantial, number of illegally released and escaped Lesser White-fronted Geese from a number of sources throughout Europe.

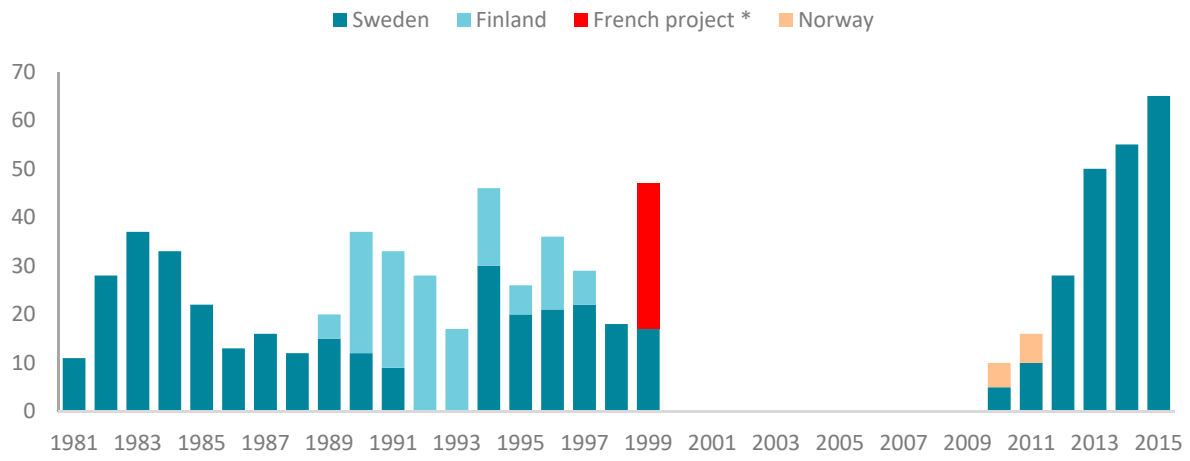


Figure 14. Number of released captive-bred Lesser White-fronted Geese in Fennoscandia in the period 1981-2015. In addition, there is an unknown number of illegally released and escaped Lesser White-fronted Geese throughout Europe. *=raised in Belgium, released in Central Sweden.

4.1 Reintroduction in Sweden using Barnacle Goose foster parents (1981-1999)

A project was intitiated in 1976 for a release programme for Lesser White-fronted Geese in Sweden. The project group consisted of Bertil Haglund, Eric Fabricius, Finn Sandberg and Lambart von Essen, and the latter was chosen as project leader.

The release site in Norrbotten County was selected as being where Swanberg (1936, 1946) found that the Lesser White-fronted Goose was a common breeder in the 1930s and 1940s. According to locals, only some few single birds had been seen in recent years. Later it was reported that a single brood with four goslings had been seen by a Dutch ornithologist in 1979 in the northern part of the area (von Essen 1993a, 1996b).

The first releases into the wild took place in 1981 (von Essen 1986, 1993a, 1996b). The breeding stock was built up during 1977-1979 mainly with birds and eggs originating from wildfowl collections in the Netherlands, England and West Germany (von Essen 1982). During the period 1981 to 1999, 348 captive-bred Lesser White-fronted Geese were released in Swedish Lapland, mainly in the Svaipa area, Arjeplog municipality in Norrbotten County, although in 1994, 30 of them were released at "another site". Most of these latter geese disappeared (von Essen 1999c).

Barnacle Geese were used as foster parents to alter the migration route of the geese to supposed safer and better wintering areas in the Netherlands (von Essen 1986, 1999c). The method was based on the knowledge that geese are imprinted on the location where they learn to fly and that they learn the routes by following their parents. The project team were obviously aware that goslings are imprinted on the birds which rear them (von Essen 1999c, Fabricius 1983), and thus the released Lesser White-fronted Geese would follow their foster parents to wintering grounds in the Netherlands. The birds used this artificially established migration route, which avoided countries with unsustainably high hunting pressure. A total of 66 young fledged from breeding attempts in the release area between 1981 and 1999 (Tegelström et al. 2001). The number of fledglings reared between 1999 and 2007 ranged from 13 to 20 annually, with a total for the eight-year period of 136 fledglings from 51 broods (Tegelström et al. 2001). See **chapter 5** for a detailed description of the population development and the possible negative effects of the project.

The exact origin of birds used in this first introduction project are poorly documented or indeed lacking, although Tegelström et al. (2001) writes that seven of the individuals which founded the Öster-Malma breeding stock were wild-caught. The details and catching data on these seven wild-caught individuals have not been traced in any publications currently known to us, but as they were caught after protection in Sweden in 1964, records of this must exists at least in the archives of the Environmental Authorities.

In 1991, blood samples were collected from 23 Lesser White-fronted Geese in Öster Malma for analyses of relationships between individuals (Tegelström & von Essen 1996). However, these birds originated from at least five different sources / farms as follows: Uvnäs-Eriksberg, Sweden (7 of the sampled individuals), Boda, Sweden (5 individuals), Öster-Malma, Sweden (2 individuals), unknown source in Germany (1 individual) and from Slimbridge, England (5 individuals). The same authors also note that all of the birds from sources in Sweden might have originated from a Dutch wildfowl farm. Additionally, following import to Sweden, individuals have been moved between groups/farms (Tegelström & von Essen 1996). In 1993, the number of captive breeding pairs was further increased with imports of birds from several farms, although the numbers of geese involved are unknown. These birds came from "Nordens Ark" in Sweden, from Rängs Farm in Sweden, and from an unknown source in Denmark.

The releases were halted after 1999 when a study of the genetics of the Finnish captive stock showed that four out of the 15 individuals sampled carried mitochondrial DNA (mtDNA) typical for Greater White-fronted Goose *Anser a. albifrons* (Ruokonen et al. 2000). Among the 15 individuals studied, three had originated directly from Öster-Malma in Sweden, and one of the Öster-Malma individuals had the mtDNA characteristic for the Greater White-fronted Goose (Tegelström et al. 2001, Ruokonen et al. 2000, Andersson et al. 2004).

A more thorough study involving a total of 128 captive Lesser White-fronted Geese held in Swedish farms, 91 wild Greater White-fronted Geese sampled in the Netherlands, Sweden, Ireland, Bulgaria, Kazakhstan and Russia, and 110 wild Lesser White-fronted Geese, showed that a total of 17 individuals (16%) of the captive Lesser White-fronted Geese had mtDNA typical for the Greater White-fronted Goose, while four (3%) of the captive birds (originating from a Belgian farm) were found to carry a mtDNA haplotype related to the Greylag Goose *A. anser* (Ruokonen et al. 2007). None of the wild Lesser White-fronted Geese or Greater White-fronted Geese were found to carry a mtDNA haplotype typical for the other species nor mtDNA halotypes typical for Greylag Goose. The two species were monophyletic with respect to mtDNA (Ruokonen et al. 2007).

A Lesser White-fronted Goose (front and side views) with colour-ring combination as used by the Swedish reintroduction project in the 1981-1999 releases. Illustration by Jari Kostet.

4.2 Restocking in Finland (1987-1997)

In winter 1985-1986, a captive breeding stock was established on the isle of Hailuoto on the western coast of Finland, and since 1989 also at Hämeenkoski in southern Finland (Markkola et al. 1999). The first four adults came from Öster-Malma in Sweden, while another 11 birds came from a private farm in Sweden (which later became Eriksberg Viltpark). Several further imports were made of birds originating from captive populations in the UK, the Netherlands, Germany, Denmark and Belgium. Between 1989 and 1997, 143 captive-bred Lesser White-fronted Geese were released in Finnish Lapland, but high mortality rates were detected and no known breeding attempts were made by the released birds (Tolvanen & Markkola 1997, Markkola et al. 1999).

This restocking project did not aim to modify the migration routes of the Lesser White-fronted Goose as was the case with releases in Sweden. With no guidance from adults, the birds mainly flew south along the coast, and it was thought that they followed Bean Geese on migration to winter in western Europe, rather than to follow routes used by wild Lesser White-fronted Geese. Released Lesser White-fronted Geese have been observed in October and winter in southern Sweden, Denmark, the Netherlands, Belgium, Great Britain and even in Spain (Markkola et al. 1999). One of the main problems experienced by this restocking attempt, in addition to the birds following the wrong migration route, was high mortality that was attributed to behaviour. The birds were much too tame and many of them were consequently killed in a variety of manners. During the first winter, mortality rate was as high as 70-80%. The released birds were observed in yards, and one individual landed in a kennel and was killed by dogs. The releases were abandoned in 1998 after an international conference on conservation of Lesser White-fronted Goose in Helsinki in 1998 concluded that the release project did not work as anticipated. However, Lesser White-fronted Geese have continued to be bred in captivity in Finland since then.

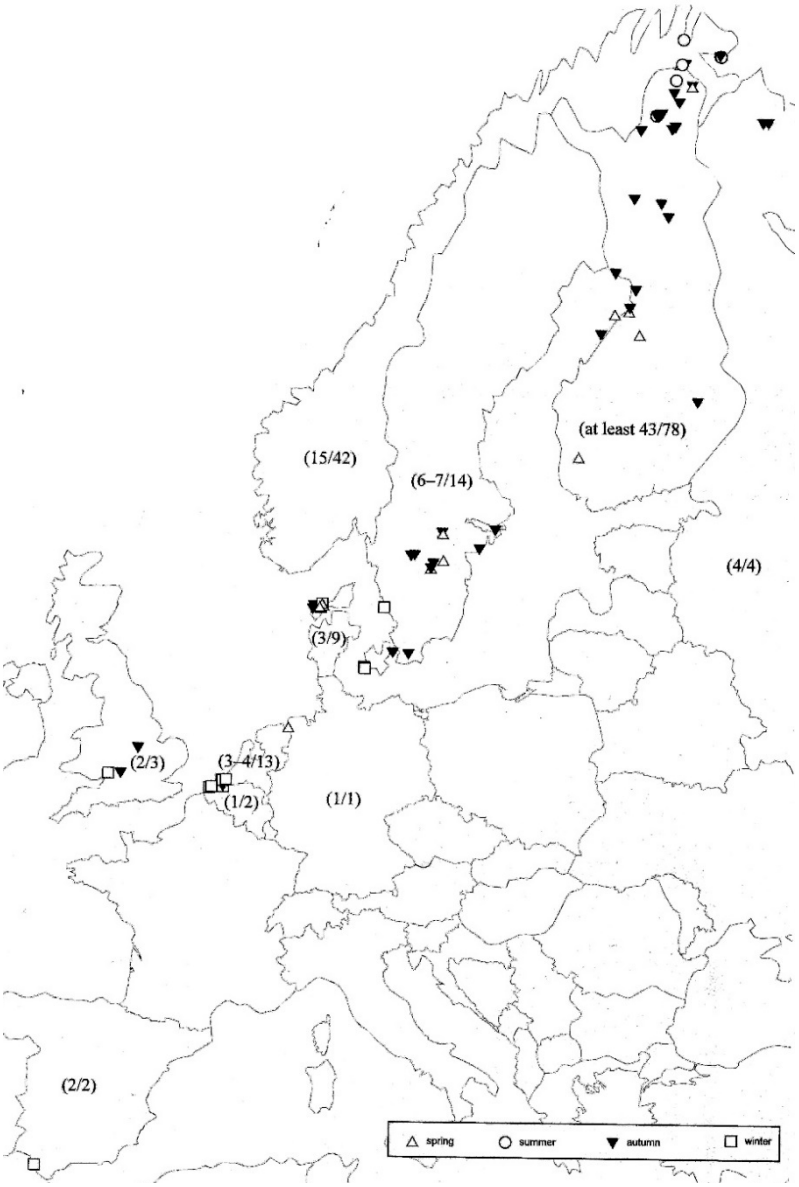


Figure 15. Spatial distribution of resightings and recoveries of released Lesser White-fronted Geese from the Finnish restocking project in 1989-1997. The numbers show the totals of different individuals / number of observations in each country (after Markkola et al. 1999).

Finnmarken NESTESISTE-SIDA Onsdag 26. september 1990 23

Atten nye agronomer

Fungerende rektor Berit Martinsen (bildet) ved Finnmark Landbruksskole i Tana kan i disse dager ønske atten etablerte jordbrukere, femten kvinner og tre menn, lykke til med sin agronomutdanning ved skolen.

De atten gjennomgår en desentralisert agronomutdanning. I løpet av en periode på to år vil de fullføre kurset. Skolens lærere skal stå for undervisningen. Elevene har tredagers samlinger i Tana hver måned. Mellom samlingene i Tana vil det bli holdt lokale fagsamlinger rundt i fylket.

Martinsen kan fortelle at det har vært stor interesse for kurset. Skolen håper dette er en utvikling som går i retning av å tilføre det etablerte jordbruket nødvendig fagkompetanse.

Fylkeslandbrukskontorets prosjekt «Særlige tiltak for jordbruket i Finnmark» har tatt initiativ til kurset.

Brevvenn i Ghana?

Finnmarken har fått et nytt høflig brev fra Ghana. Det kommer også fra Takoradi i den vestlige delen av landet. Denne gangen er det Clement på 21 år som ønsker seg en brevvenn. Om det er finnmarkingene som nå har blitt så populære i Ghana, vet vi ikke, men brevene finner i alle fall veien helt fram til oss i Vadsø. Riktignok med en heller sparsom adressering.

Clement studerer og skal bli sivilingeniør. Han liker å reise, å lese og å lage mat. De som vil, kan skrive til Clement på engelsk. Hans adrese er:

Clement Segborwoiso
Takoradi Polytechnic
P.O. Box 256
Takoradi
Western Region-Ghana

Halvville eller halvtamme gjess

Om dette er halvtamme villgjess eller halvville tamgjess, skal vi ikke sverge på. Vi skal heller ikke begi oss på å bedømme hvilken gjessart det dreier seg om. Det vi med sikkerhet kan si at det er staselige fugler og at de er ringmerket et eller annet sted i Finland.

Det er Harald Johnsen fra Båteng som har tatt bilder av fuglene. Han kom på fire, fem meters hold før gjessene hev seg på vingene. Hver av fuglene hadde nummerert «halsbånd» og ring i den ene foten. Fugleeksperter blant våre lesere kan sikkert gi oss og andre fugleinteresserte opplysninger om hvilken gjessart disse fuglene tilhører. Nebbet hos disse fuglene er etter fargefoto rødgult. Kan det være grågås, eller kanskje sædgås – eller ingen av delene.

Figure 16. Several Lesser White-fronted Geese from the Finnish restocking project showed up in Båteng, Finnmark, Norway, and the observation was published in the regional newspaper "Finnmarken" on 26th September 1990. They were unusual tame and this is illustrated by the first sentence: "If these are half-wild or half-tame we can't swear to it". The observer came on a distance of 4-5 meters before they flew off.

4.3 Pilot project on reintroduction by use of ultra-light aircraft in Sweden (1999)

In 1999, 30 Lesser White-fronted Geese of mostly Belgian captive origin were transported from France to central Sweden. The goslings were hatched and imprinted upon two humans (Christian Moullec and his wife Paola) in France. The Moullecs then travelled with the goslings and two ultra-light aircraft to Öster-Malma in Sweden in the beginning of July (von Essen 1999b). There, the geese learned to fly with the ultra-light aircraft. On 1st September they flew stepwise along the Baltic Sea coast south to a nature reserve along the River Rhine in Germany. The French project wanted to release the birds in Swedish Lapland, but the leaders of the Swedish reintroduction project opposed this, since they were worried it would disturb their own project that had shown some small improvements at the time (von Essen 1999b). Only 12 of these 30 birds returned to Öster-Malma, where they were recaptured and entered into the farming stock (Andersson 2001), so the majority remained free-flying. Some of them were subsequently observed in southern Sweden (Andersson 2001) and coastal areas of Finland (occasionally also in Denmark and Germany) mainly together with Barnacle Geese. No breeding by these birds has been reported. A television film crew from *Media Video Compagnie* followed the project and made a film for French television.

4.4 Illegal releases of broods in Finland with Barnacle Goose foster parents

In summer 2004, three Lesser White-fronted Goose goslings were released together with their Barnacle Goose foster parents in northern Finland, despite the moratorium on releases in Finland. The male was satellite-tagged (Jones et al. 2008). One of the young Lesser White-fronted Geese was observed among Barnacle Geese in the Netherlands in December 2004, though not in the company of its foster parents, nor with reintroduced Swedish birds. The illegal release was filed but in a subsequent district court trial in 2005 those responsible for the releases were not sentenced, because it was concluded that the "scale of the activity" was so small, i.e. the risk of establishing an alien population was considered to be negligible.

Similar to the 2004 release, one brood of Lesser White-fronted Goose goslings was released in northern Finland in summer 2009 along with Barnacle Goose foster parents. The whereabouts of these birds are unknown. The 2009 release was, as in 2004, taken to the district court. The court concluded that the captive Lesser White-fronted Goose stock is regarded, as is also the case for Barnacle Goose in Finnish Lapland, as an alien species, and the perpetrator of the release was fined on the grounds of a nature conservation violation.

A third release took place in 2013. A family consisting of Barnacle and Lesser White-fronted Geese were apparently illegally released, as such a group was observed on the lake by Näkkälä village, Enontekiö municipality, Finland, in August 2013 (Tuomo Ollila, Metsähallitus pers. comm.).

There are also observations of hybrid Barnacle Goose x Lesser White-fronted Goose in South-western Finland (BirdLife Suomi-Finland 2016), but it is not known if these originate from the Swedish reintroduction project or from the Finnish releases.

The details of the three court cases are given in **chapter 4.13**.

4.5 Pilot project on supplementation in Norway (2010-2011)

In Norway, a pilot project was initiated in 2008 to see if supplementation of the wild population could help it to recover from a critically low level. A feasibility study (Lee et al. 2010) was commissioned to Wildfowl & Wetlands Trust (WWT), and a preparatory workshop was held in Trondheim, Norway between WWT, the Norwegian Directorate for Nature Management (currently the Norwegian Environment Agency), NOF-BirdLife Norway and the AEWA Secretariat in May 2009. The feasibility analysis was extensive, and made recommendations for which key issues and risks should be factored into the decision making. If a decision were to be made to implement a supplementation programme, the programme should aim to release birds with utmost urgency while the existing part of Fennoscandian Lesser White-fronted Goose population breeding in Norway was large enough to support a supplementation, and any supplementation should be conducted in conjunction with wider conservation measures. A set of short-term steps were identified. In addition, the feasibility study identified several short-term steps if a decision should be made <u>not</u> to implement a supplementation programme.

During the autumns 2010 and 2011, a total of 11 goslings were released at the Valdak Marshes in the Porsangen Fjord same period as wild successful breeding birds were staging in the area. The released birds came from the zoo "Nordens Ark" in Sweden, were they had built up a new stock of Lesser White-fronted Geese originating from the breeding areas in the Polar Urals in Russia (see **chapter 4.6**). The release site was chosen in the hope that the released goslings would join the wild flock and follow them on the migration to the wintering areas in Greece. All goslings were fitted with black

neck-bands with individual codes. Two of the four goslings in 2010 were released with satellite transmitters. One gosling had a 30-gram ARGOS/GPS solar-powered transmitter mounted as a backpack, while the other had a 5-gram Argos transmitter mounted on the neck-band. In 2011, five of the six goslings were released with 5-gram Argos transmitters attached to the neck-band (Øien & Aarvak 2010, Aarvak & Øien 2011). The expectancy of any of the birds returning was low as all the goslings were believed to be males, and in geese in general it is the male that is the dispersing sex. The captive breeding stock at "Nordens Ark" struggled with a highly skewed sex ratio with an overwhelming number of males produced. Of the six goslings in the brood sent with parents to Finnmark in 2011, only one gosling was sexed as female and the Swedish "Project Fjällgås" demanded its return. It was subsequently returned together with the mother only, as the accompanying adult male died suddenly in the holding pen (see **chapter 4.12** on spread of diseases). After releases from the pen both in 2010 and in 2011, the young were observed at the marshes daily, sometimes alone, sometimes in association with Greylag Geese, and on a few occasions together with the wild Lesser White-fronted Goose staging in the area.

Four juvenile Lesser White-fronted Geese together with two adult birds, in the holding pen at Valdak Marshes in 2010. The birds have just arrived and are not yet processed for release with neck-bands. Photo: Tomas Aarvak

Table 1. Details of the Lesser White-fronted Geese with black neck-bands (white characters) released in Porsanger, Norway in 2010 and 2011. All birds released were fledged goslings (i.e. 1st calendar-year birds).

Ring nb.	Status	Neck band	Date release	Sex	Date biometry	Wing max	Head+bill	Weight	PTT id.	Resighted abroad?
CA21163	Released Porsanger	A06	26.08.2010	M	21.08	356	82.3	1300	43913	
CA21164	Released Porsanger	A16	26.08.2010	F*	21.08	365	83.6	1440		
CA21165	Released Porsanger	A17	26.08.2010	M	21.08	368	84.0	1460		
CA21166	Released Porsanger	A18	26.08.2010	M	21.08	373	87.7	1330	43884	yes
CA21167	*Returned Nordens Ark*	*(A20)*		F	21.08	357	81.8	1260		
CA21175	Released Porsanger	A19	22.08.2011	M	11.08	337	82.6	1030	60761	
CA21176	Released Porsanger	A21	22.08.2011	M	11.08	361	86.0	1160	60762	yes
CA21177	Released Porsanger	A22	22.08.2011	M	11.08	333	77.6	1030	60768	
CA21178	Released Porsanger	A23	22.08.2011	M	11.08	337	78.9	1060	60772	
CA21179	Released Porsanger	A24	22.08.2011	M	11.08	346	86.3	1100	60773	
CA21180	Released Porsanger	A25	22.08.2011	M	11.08	358	84.5	1160		yes

* this individual was at first sexed as male.

Only one of the released birds (black neck-band A16) returned to the release site in the Porsangen Fjord the following year, but it was despatched on 23rd May 2012 by the Norwegian State Nature Inspectorate since it did not follow the wild Fennoscandian Lesser White-fronted Geese, but rather wintered in the Netherlands and Belgium. The choice of this route was undesirable, as the individual could come into contact with birds from the Swedish release project, or with feral birds and bring individuals or groups with an altered genetic make-up into the wild Fennoscandian population. Additionally, amongst many arguments for and against, it was considered extremely important not to destroy the natural migration route of wild Lesser White-fronted Geese that migrate through Russia, Hungary etc., to the wintering areas in Greece. This is important for the species, and also for the nature conservation in Hungary and Greece, as these countries could risk losing the species within their national borders.

Of the 11 birds released, two individuals generated many resightings (A21 & A25), especially in the Netherlands (see **Figure 19**, **Figure 20**).

The releases in Norway were abandoned in 2012 when it was concluded that thereleased Lesser White-fronted Geese did not follow the natural migration routes, but presumably followed Greylag Geese from the Porsangen Fjord to Belgium and the Netherlands. Greylag Geese from northern Norway, especially from central and eastern Finnmark, migrate through the Bothnian Bay southwards along the Baltic Sea, crossing southern Sweden before ending up wintering in the Netherlands. The Lesser White-fronted Geese equipped with satellite transmitters and neck-bands followed either the east coast of Sweden (n=1) or the west coast of Finland (n=5). In Finland, one of the individuals was recorded staging in a city park together with Barnacle Geese. Some continued further to Spain (Arne Follestad pers. comm.). Although the carrier species in this case was not confirmed, an explanation could be that they just follow any of all the many geese migrating south to winter in the most important areas in the Netherlands. The number of geese in the Netherlands peaks at 1.8 million geese during winter and this amounts to approximately 50% of all wintering geese in Europe (Koffijberg et al. 2010, Fox et al. 2010). Based on resightings in the Netherlands of neck-banded Lesser White-fronted Geese from the Finnish and Norwegian releases, Koffijberg & van Winden (2013) wrote in the summary about migration of Lesser White-fronted Goose: "*this confirms that birds from several sites in Northern Fennoscandia might migrate to the Netherlands in winter*". This statement is incorrect if it is related to wild breeding birds and not farmed ones. However, they

correctly conclude in the discussion: "*On the other hand, none of the earlier colour-ringed individuals, or satellite-tracked birds from Norway (native breeding birds) was ever observed in the Netherlands. Thus, the difference in dispersal might just be a result of the origin of the birds*". Migration studies by use of satellite transmitters and resightings of colour-ringed birds from the wild breeding birds in northern Norway and Finland clearly show that they have never wintered nor migrated through Western Europe, but rather that they utilise sites in Eastern Europe on the way to the wintering areas in Greece (see **chapter 3.1** and **3.2**). This is not surprising given the species preference for steppe and puzta habitats, which do not exist in Western Europe.

The negative lessons learned from these two release projects in Finland and in Norway have regrettably not been taken into account in Sweden. Neither has the fact that published sources from the early 1980s stated that goslings learn where to migrate from their parents (von Essen 1982). Advice from the early 1980s has clearly been ignored. Without the guidance by parents we can only speculate as to what determines the choices made by geese when the summer ends and it is time for the migration to the wintering areas.

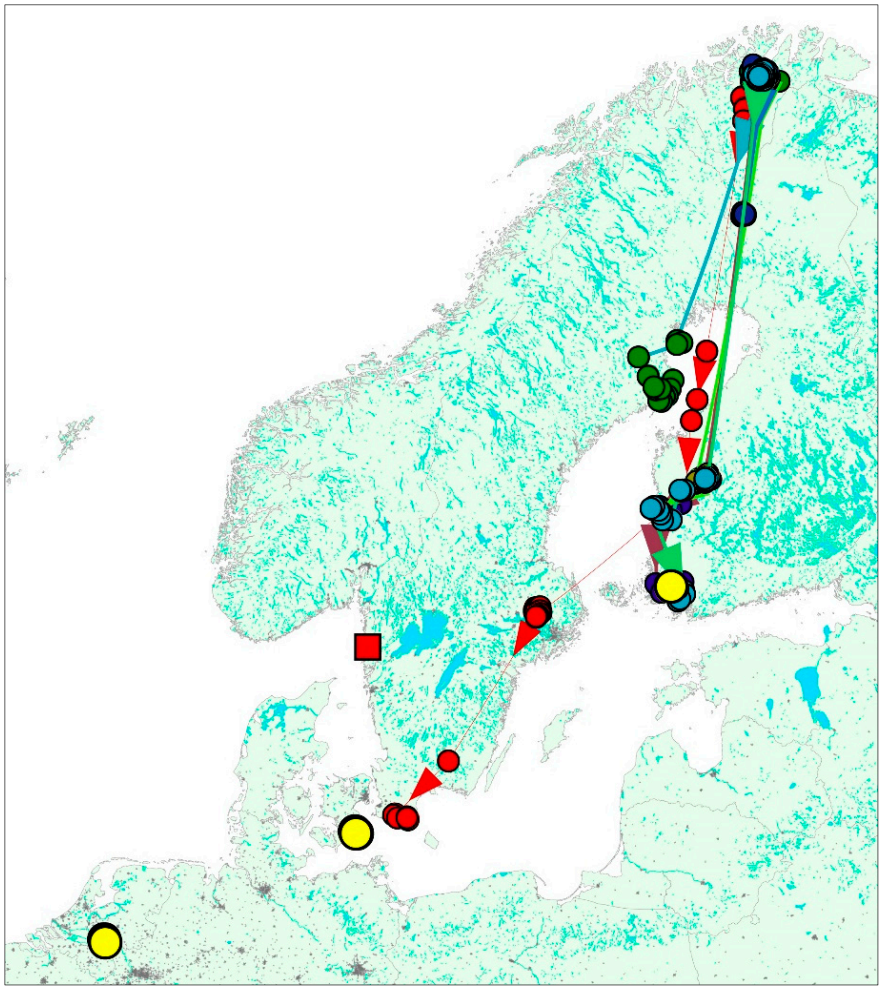


Figure 17. Migration routes of the captive bred Lesser White-fronted Geese that were released with satellite transmitters in the Porsangen Fjord area, Norway, in 2010 and 2011. The red dots represent the individual released in the autumn 2010. Other colours represent different individuals released in the autumn 2011. The autumn observation on Ruissalo, SW Finland, in October 2010, and in Denmark and in the Netherlands during the winter 2011-2012 are indicated by yellow dots. The location of the zoo at "Nordens Ark" where the released birds were reared is indicated by a red square.

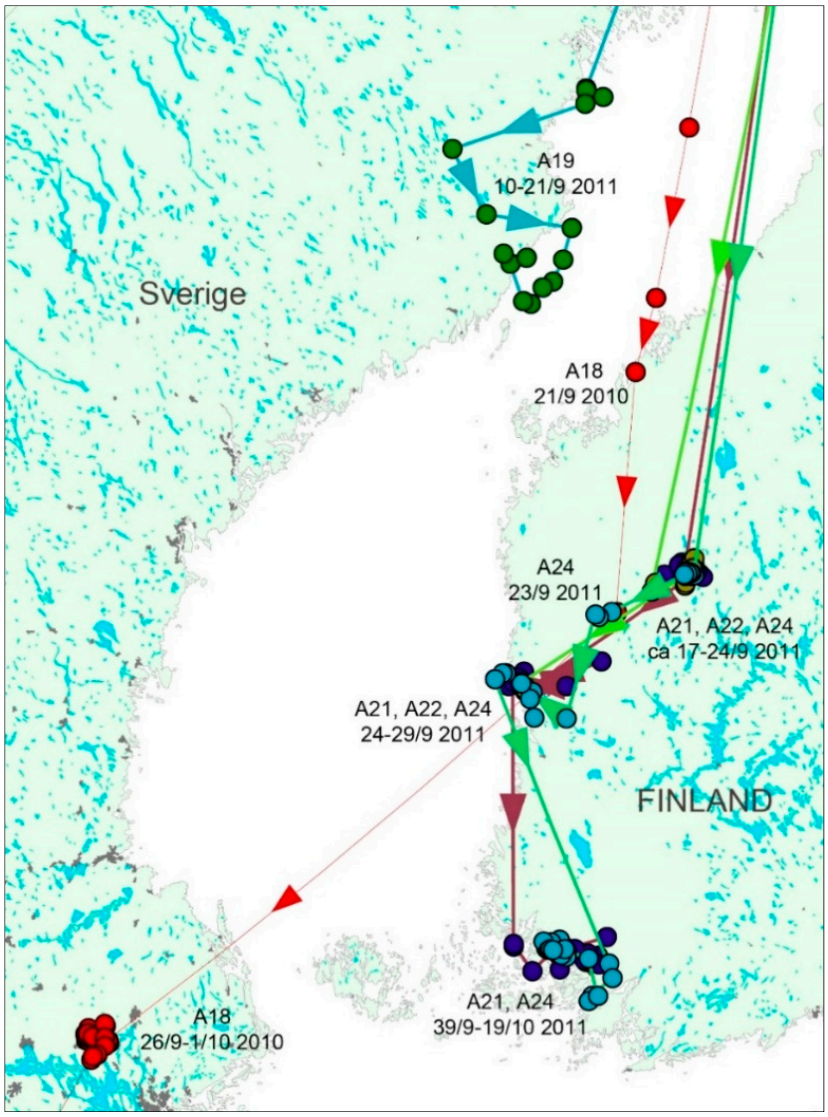


Figure 18. Migration and local movements in the Gulf of Bothnia by captive bred Lesser White-fronted Geese that were released with satellite transmitters in the Porsangen Fjord area, Norway, in 2010 and 2011. The red dots represent the individual released in autumn 2010 (neck-band A18). Other colours represent different individuals released in the autumn 2011 (neck-bands A19, A21, A22, A23 and A24).

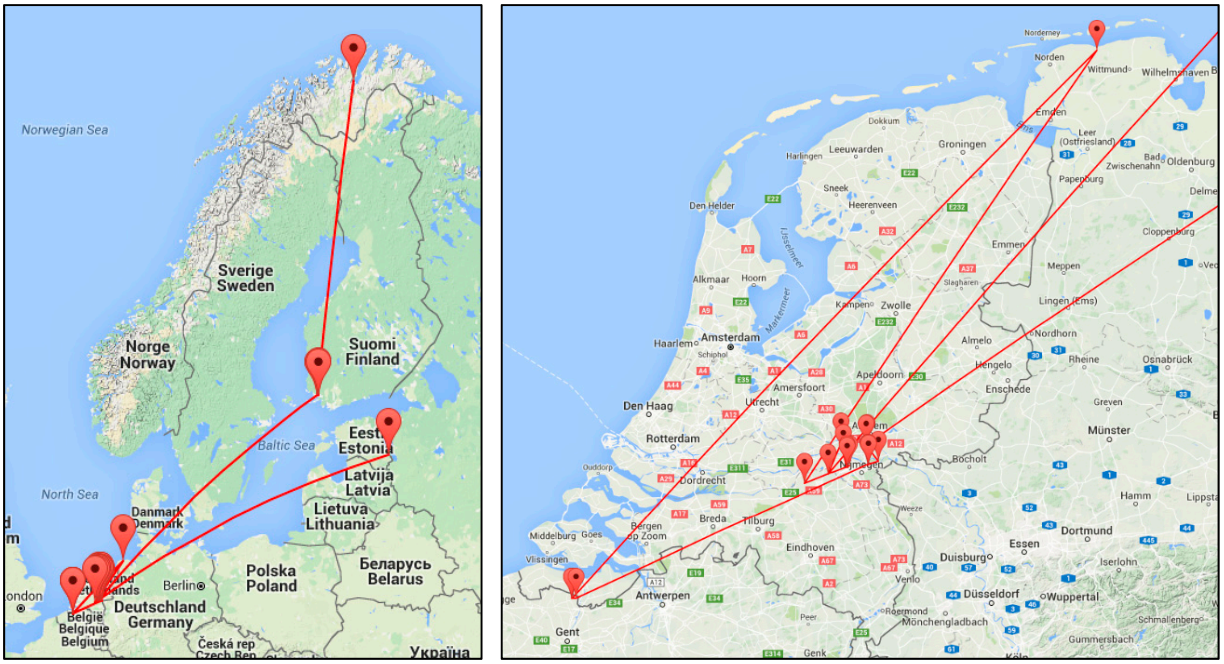


Figure 19. Resightings of Lesser White-fronted Goose with neckband A21 (n=23 records, data from http://geese.org and http://ringmerking.no). The red lines merely connect the sequence of observations and do not indicate the migration route. This bird seemed to have joined Russian Greater White-fronted Geese as it was regularly seen within larger flocks of these during winter. The bird had a 5 gram satellite transmitter attached to the neck-band, but this transmitter was lost after 68 days. The goose was last seen 9th May 2013 in Estonia.

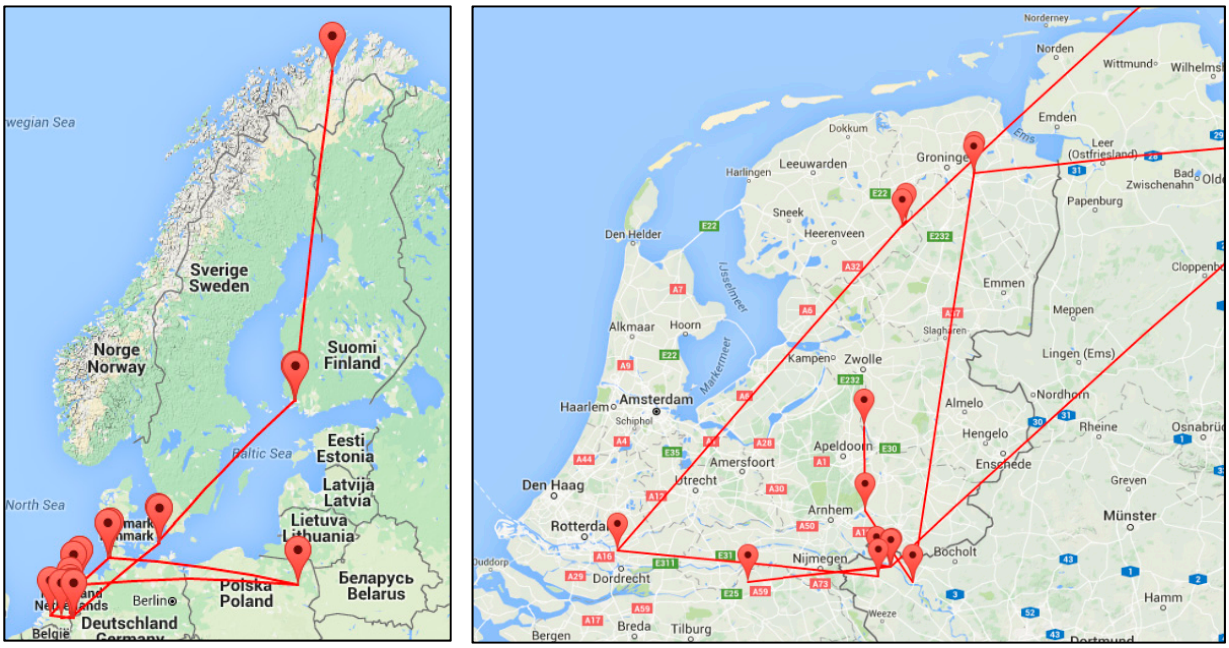


Figure 20. Resightings of Lesser White-fronted Goose with neckband A25 (n=29 records, data from http://geese.org and http://ringmerking.no). The red lines connect the sequence of observations and do not indicate the migration route. It was seen with A21 in a flock of Barnacle Geese during the first autumn migration. During winter, it has been seen together with Greylag Geese, but also more recently together with Greater White-fronted Geese. It is believed to follow Greater White-fronted Geese during migration to summer in Russia.

4.6 Current release project in Sweden (2010-present)

The current release project in Sweden is run by *Projekt Fjällgås*, which is a collaboration between the Swedish Association for Hunting and Wildlife Management (Svenska Jägerförbundet) and the zoo foundation "Nordens Ark".

After genetic studies in 1999 revealed that individuals in the captive breeding stock used for the Finnish and Swedish release projects were carrying DNA of other goose species, notably Greater White-fronted Goose and Greylag Goose, and pending additional genetic studies, a moratorium on the release of the birds was introduced in Sweden. The genetic findings initiated an intensive debate about the value of the present captive-bred stock and the possible consequences of the existence of an unknown number of released birds carrying Greater White-fronted Goose genes in Sweden. Negotiations were initiated with Russian scientists and authorities in late 2003, aimed at transferring young wild Lesser White-fronted Geese caught in northern Russia west of the Ural Mountains to Sweden. *Projekt Fjällgås*/SEPA subsequently established a cooperation with the Russian Goose, Swan and Duck Study Group and with Moscow Zoo. The first eight young birds were captured in 2005 in the Polar Urals, transferred to Moscow Zoo, and then imported to Sweden.

Since 2010, *Projekt Fjällgås* have released Lesser White-fronted Geese reared in captivity into the mountainous region around Arjeplog in Swedish Lapland (Andersson & Holmqvist 2011, Liljebäck et al. 2012, 2013, 2014). The numbers released have varied, and have ranged between 5 and 86 individuals annually. Since 2013, birds have also been released in the local park in the town of Hudiksvall, 550 km to the south of the release sites in the mountains. The town of Hudiksvall is situated on the east coast of Sweden, at 61°N. The habitat in and around Hudiksvall is very different to the mountain sites, and the birds are released within a public park with grass lawns. Hudiksvall is used as both a staging and a moulting site for a variable number of individuals from the Swedish reintroduced Lesser White-fronted Goose population. In total, 299 Lesser White-fronted Geese have been released in Sweden in the period 2010-2016 (**Figure 21**).

Unlike the releases undertaken in 1981-1999 in Sweden where they used Barnacle Geese as foster parents and where the goslings and adults stayed together from the summer, over the winter and until the next spring when the Barnacle Geese would return to their breeding site at Öster-Malma, the current project has released goslings or one-year old geese without parents. We only have access to detailed age distribution data for the years 2010-2012 and 2014, and the proportion has been 69% goslings and 31% yearlings.

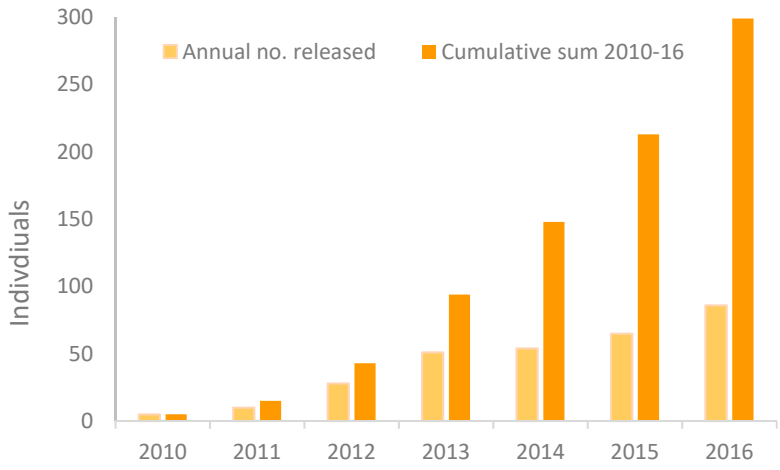


Figure 21. Annual numbers of Lesser White-fronted Geese released in Sweden in the period 2010-2016 (light orange columns) and the cumulative number of birds released in the same period (dark orange columns).

4.7 Imprinting on micro-light aircraft – Operation Lesser Whitefront, Germany (2001-present)

This pilot project is based on modifying the migration route of Lesser White-fronted Geese by imprinting newly-hatched goslings on a micro-light aircraft and training them to follow the aircraft on the ground, on water and in the air.

This project was founded in 2001 with the aim to contribute to saving the declining population of Lesser White-fronted Goose in Fennoscandia. Themain action is to imprint Lesser White-fronted Geese upon micro-light aircraft and lead the birds from northern Sweden (Lapland/Västerbotten) along the Swedish Baltic coast, through Denmark, to the Lower Rhine area in Germany. The target area for the reintroduction is Vindelfjällen nature reserve in Västerbotten, and was chosen because of its optimal location in relation to the re-introduction area used by *Projekt Fjällgås*. According to the project "*It is likely that birds introduced by this pilot project sooner or later will mix with birds already migration between Sweden and the Netherlands. As all birds used in this project will be genetically checked, a dilution of unwanted genes already existing in Sweden could take place*" (Scholze 2005). From Vindelfjällen the geese will be led by micro-light aircraft to the Umeälven delta, and then southwards. Due to the restricted range of the micro-light aircraft, the geese will learn staging sites situated 200-225 km apart all the way to the Danish border. From Denmark to the Bislicher Insel in Germany mainly sites in crop fields and grasslands will be used. The project plans to avoid areas protected by national conservation legislation as stop-overs in Sweden and Denmark, but not so in Germany were the project states that relevant authorities are ready to give special permission for landing in such areas with the geese (Scholze 2005).

The project has, as of October 2016, not been able to fly with any geese, though permission from the Swedish Environmental Protection Agency (SEPA) was granted as early as 2005 (letter Dnr 402-3587-05 Nv) with permission to use a maximum of 25 geese per year. The permission was given despite many critical statements from different authorities and organisations, both within Sweden (Länsstyrelsen i Norrbotten, Länsstyrelsen i Västernorrlands län, Länsstyrelsen i Örebro län, Sveriges Ornitologiska Förening, Svenska Naturskyddsföreningen & Norrbottens Ornitologiska Förening) and from abroad. The permission was re-issued in 2010 following only a limited inquiry in Sweden by telephone beforehand (Dnr 429-2910-10 Nv). The first postponement of the project came due to the outbreak of avian influensa in a number of European countries in winter 2005-2006. A further delay arose due to the already proven problems with the genetic make-up of the captive breeding stocks of Lesser White-fronted Geese and the free-flying reintroduced population in Sweden. Based on the results of a negotiation mission of the AEWA secretariat and the subsequent appointment of the Lesser White-fronted Goose RECAP Committee (Committee for captive breeding, re-introduction and supplementation of Lesser White-fronted Geese in Fennoscandia) in 2007, the German Ministry of Environment, Nature Conservation and Nuclear Safety (BMU) requested Aktion Zwerggans and the Allianz Umweltstiftung (the foreseen main financial supporter of the project) to postpone the first flight of the pilot project. The request was made for a three-year postponement until there would be enough offspring of western Russian origin available in the new Swedish captive breeding stock, which would remedy the genetic problems encountered.

The partners of this project include amongst others Aktion Zwerggans (*Operation Lesser White-front*), the German Aero Club, the Biological Station in the District of Wesel (BSKW), Institute of Biodiversity – Network e.V., Zoological Garden Cottbus, the Friends of the Lesser White-Fronted Goose (a Finnish organisation which runs the breeding farm at Hämeenkoski) and Lyksele Zoo (in Sweden).

As is the case with other release projects, this project is also prone to a number of potentially negative effects:

- It is unclear why a new wintering area should be established.
- There is no environmental/ecological impact assessment of the establishment of a new migration route.
- There is no impact assessment of mixing two populations with different migration routes.
- Establishing a new migration route is not in line with modern conservation biology since it avoids problems instead of solving them, and the ecological effects are unknown.
- It diverts the conservation efforts away from the original wild populations.

Using micro-light aircraft creates a migration route with many new stopover sites with distances of approximately 200-225 km apart, which is fundamentally different to the migration strategy of wild Lesser White-fronted Geese where stopover sites are situated 800-1,300 km apart (Aarvak & Øien 2003, Morozov & Aarvak 2004). This also creates another serious issue for which environmental authorities, especially within the European Union (EU) have to deal with, as they are obliged to establish protected areas where significant numbers of this highly threatened species occur (see also **chapter 4.13**. on the Dutch State of Council ruling). A flight with micro-light aircraft from Vindelfjällen to the south tip of Sweden is approximately 1,400 km, and would involve a minimum of seven stopover sites. The project has mapped the route from Umeå to Denmark and has identified 30 locations along the route which could be used for stop-over and emergency landings.

Another risk is the possibility of Lesser White-fronted Geese (or any other goose species for that matter) which are habituated towards micro- or ultra-light aircraft, then there is that serious risk at they will not respond as other geese by fleeing from aircraft. Rather, such individuals may even be attracted to aircraft, thereby creating a serious aviation hazard. Geese are large-bodied birds, and they can do considerable damage to aeroplanes. The project “Operation Lesser White-front”, is modifying their own aircraft with propeller cages to avoid injuries to the imprinted geese (Scholze 2005).

4.8 Hybridisation between *A. erythropus* and *A. albifrons* in zoos

Nagy (1950) used four hybrids specimens of Lesser White-front x Greater White-fronted Geese (*Anser erythropus* x *A. albifrons*) from a local zoo to describe how wild hybrids would look (**Figure 22**). His intention was to help observers to distinguish between various species and races on the one hand, and various hybrids on the other hand. The hybrids were raised at the Blücherhof estate in Mecklenburg, Germany, and were later available as skins in the Museum Alexander Koenig (=König) in Bonn (provided by Director Dr. von Jordans and Assistant Dr. Mannheims). By 2015 only two of the four *A. erythropus x A. albifrons* specimens seen by Nagy were still present in the collection, of which the two individuals described by Nagy (1950) on pages 260-261 (male, 20th October 1912) and on page 262 (female, 13th March 1915). However, there is an additional hybrid from Blücherhof that was apparently not studied by Nagy. Hence, in total the museum now has three adult/subadult specimens of hybrid origin (bred in captivity at Blücherhof) plus two hybrid pulli specimens (Dr. Till Töpfer, Curator, pers. comm.).

This shows that hybridisation between these two species occurred in captivity long before the onset of the reintroduction project in Sweden. It therefore provides more support for the later analysis which showed a captive origin of the introgression problem in the Finnish and Swedish captive stocks (Tegelström et al. 2001, Ruokonen et al. 2000, 2007), and then evidently also for the Swedish free-flying reintroduced population which stems from captive-bred birds.

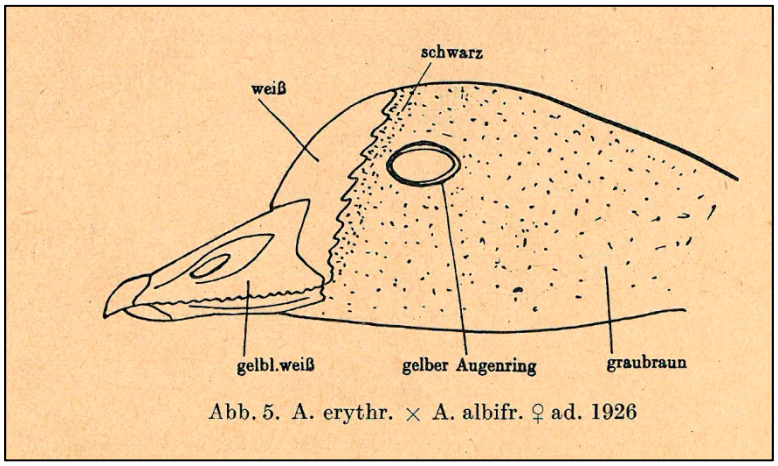


Figure 22. Illustration of the head of a captive-bred hybrid *A. erythropus* x *A. albifrons* from Museum Alexander Koenig. After Nagy (1950).

4.9 Hybridisation between Lesser White-fronted Goose and Greater White-fronted Goose in the wild

Hybridisation of Lesser White-fronted Goose with other goose species is expected to occur in the wild, but is mainly found in Western Europe in relation to breeding/release projects and in pairs with alien species such as Cackling Goose *Branta hutchinsii* and Canada Goose outside the normal breeding range/habitats. Geese that have been bred in captivity are also more prone to hybridise than their wild conspecifics (Randler 2000). As far as we can tell from published accounts, there are to date no records of proven hybrid offspring between Greater White-fronted Goose and Lesser White-fronted Goose, although aberrant and likely hybrids are regularly seen in Western Europe. There is one report from England of "*A male Lesser White-fronted Goose mated to a Siberian White-fronted Goose with two young, the young not distinguishable from those of Siberian White-fronts, were seen at Slimbridge Gloucestershire 6-7 March 1956*" (Scott & Boyd 1956, Kampe-Persson & Lerner 2007). However, this is not on the list of accepted records by the British Birds Rarities

Committee. Based upon the location of the observation in Britain, they could well be from any of the many stocks of locally bred birds from waterfowl collections as there is no tradition of pinioning geese (or other wildfowl) when the species is registered as naturally occurring in the country. Pinioning is normally only used on non-native wildfowl (Wildfowl & Wetlands Trust 2016).

McCarthy (2006) lists a number of hybrid combinations with the Lesser White-fronted Goose, but all of these either refer to hybridisation in a farm/zoo environment, or are of suspected/likely hybrids based on intermediate phenotypic expression as for instance the apparent hybrid reported by Shackleton (1956) in England in 1956.

In a detailed study on hybrid geese in Sweden, Kampe-Persson & Lerner (2007) describe records of hybridisation of Lesser White-fronted Goose with Canada Goose, Cackling Goose, Barnacle Goose and Greater White-fronted Goose. In addition, there is are also a record of a first-generation hybrid between a male Cackling Goose x Lesser White-fronted Goose hybrid attempting to breed together with a female Barnacle Goose, but no eggs hatched. Also, a male hybrid Barnacle Goose x Lesser White-fronted Goose bred unsuccessfully with a Canada Goose as none of six eggs hatched (Kampe-Persson & Lerner 2007). However, in 2010 a female hybrid Barnacle Goose x Lesser White-fronted Goose bred successfully with a male Barnacle Goose (see **chapter 5.6.3**). The hybridisation with Cackling Goose is thought to originate from the breeding of geese at Eriksberg (Nilsson 1983). The large number of hybrids with Barnacle Goose stem from the reintroduction and use of Barnacle Geese as foster parents.

Kampe-Persson & Lerner (2007) list all available records of possible hybrids between Lesser White-fronted Goose x Greater White-fronted Goose in Sweden up until 2007. This includes one hybrid pair in 1991, two individuals in 2005, three individuals in 2006, one in 2001 and a new individual in 2004. In addition, two possible Lesser White-fronted Goose x Greater White-fronted Goose hybrids were reported in 2006. None of these are possible to validate in the Swedish Reporting System as this hybrid combination is even not listed under valid taxa that can be reported (possible hybrid taxa that can be selected in the Swedish Reporting System are *Anser erythropus* x *Anser canagica* and *Anser erythropus* x *Branta leucopsis*). Of the purported hybrids, only two are published in ornithological journals with photographic documentation, and based upon identification characters both seem to be intermediate and candidates for being classified as “likely hybrids” (cf. Lerner 2005).

The article by Nijman et al. (2010) is discussed in detail elsewhere in this report (**chapter 8.3**), but here we would mention that the conclusion in that article of an estimated hybridisation rate of 4% is unrealistic, and this ought to have alarmed the authors that something with their analyses was not correct. A species with such a high rate of hybridisation would not be accepted as an own independent species.

It is noteworthy that the majority of such hybrid combinations occur within regions in Europe where zoos, breeding farms, wildfowl collections and aviaries are common, and one might even speculate if the long domestication history with man is an important factor in the high hybridisation rates found in waterfowl in particular. Recent research into the genetics of Greylag Geese for instance shows both past and ongoing hybridisation between wild Greylag Geese and domestic geese in multiple locations (Heikkinen et al. 2015).

During many field seasons in North-western Kazakhstan where hundreds of thousands Greater White-fronted Geese and more than ten thousand Lesser White-fronted Geese are staging annually during autumn migration, not a single mixed pair have been observed, nor any hybrid offspring despite intensive sampling. In 1997, 15,000 geese were identified to species, while 1,734 Lesser White-fronted Geese were accurately aged (Tolvanen & Pynnönen 1997). In 1998, 11,000 individuals

were identified to species, while 691 Lesser White-fronted Geese and 588 Greater White-fronted Geese were aged (Tolvanen et al. 1999a). In 1999, 46,740 geese were identified by random sampling, with 274 Lesser White-fronted Geese and 14,130 Greater White-fronted Geese accurately aged. As part of the methodology of estimating production, both full broods as well as age samples have been obtained in large numbers to allow for species and year discrimination analyses. Any samples where identification has not been 100% accurate have been dismissed, so only birds seen well have been included. For full details of methodology see Tolvanen et al. (1999b).

In addition, through the EU LIFE+ Nature project "Safeguarding the Lesser White-fronted Goose Fennoscandian population in key wintering and staging sites within the European flyway" (2011-2016), three identification training workshops have been carried out. In these workshops, 36 participants from 14 countries (Estonia, Lithuania, Poland, Hungary, Romania, Bulgaria, Greece, Turkey, Russia, Ukraine, Kazakhstan, Azerbaijan, Iran, Iraq) have brought with them experience and pictures (of varying quality) of these two species, to help train in identification. Several photos of aberrant Greater White-fronted Geese have been presented, of which the most typical are birds with a distinct yellow eye ring, which is not uncommon in Greater White-fronted Geese (see example photo in Tolvanen & Pynnönen 1997). Also, pose of the bird could give impression of shorter wings, as well as effects of light conditions which could give the impression of dark neck or vice versa. Overall, no presumed hybrids have ever been seen within these countries, despite intensive surveys for Lesser White-fronted Geese.

4.10 Escapees, illegal releases and feral populations

This chapter is not exhaustive in terms of documenting where and how many escapes or feral Lesser White-fronted Geese exist in Europe, but it is nonetheless substantial. The best-documented and most easily accessible material is from Great Britain, which has one of the highest density of ornithologists in the world (Parkin & Knox 2010), as well as easy accessible literature since English is one of the major world languages. Great Britain and Ireland, as well as the Netherlands and Germany, probably have the highest number of wildfowl collections, both private and public, anywhere in Europe, and much of the available literature published on feral or escaped wildfowl is easily accessible. It is, however, a more daunting task tracing records from other countries unless one has a good grasp of the relevant languages. As an example, if people from Britain or Germany should attempt to access all observations of Lesser White-fronted Geese in Norway, it would require knowledge of Norwegian language since most old records are published in the plethora of local, regional and national birding magazines (at present Norway has 16 local magazines and four national magazines/journals for wild birds alone). Even for a Norwegian it would require a large amount of detective work to locate all the relevant information within the various regions in Norway.

The oldest documented escaped Lesser White-fronted Goose we are aware of comes from Somerset in England, where a bird was shot in January 1888 (Gurney 1902). Due to the regular occurrence of birds clearly of captive origin, it has been difficult to estimate or validate the number of genuinely wild Lesser White-fronted Geese in Britain & Ireland (Parkin & Knox 2010, Cabot 2009, data from British Birds Rarities Committee (BBRC) and the British Trust for Ornithology (BTO). Only about 130 birds of probable wild origin have been recorded since the first official record of an immature shot on Fenham Flats in 1886 (Parkin & Knox 2010, BBRC). Since the majority are of feral origin, the species is included in the British Ornithologist's Union Records Committee (BOURC) category AE*, with records thought to largely represent feral birds, but with occasional wild vagrants. Breeding has been reported occasionally in the past but there are no records in recent years (Banks et al. 2008). An increasing number of records are likely to be escapes from wildfowl collections. Four birds recorded during the Wetland Bird Survey (WeBS) in winter 2005-2006 were thought to be escapes (Musgrove

et al. 2007, Cabot 2009). Apart from birds originating from the releases in Sweden (see **chapter 5.2.4**), only presumed escapes have been seen in Great Britain in recent years, for example at five sites during the winter 2009-2010 (Holt et al. 2011) and four sites in 2010-2011 (Holt et al. 2012).

In 1991, an extensive survey was carried out in Britain to produce accurate estimates for all introduced goose species and of hybrids between them. This was especially due to rapidly increasing populations of introduced Canada Goose and Greylag Goose (Delany 1992). There was a growing pressure to control population numbers, particularly of Canada Geese, from farmers whose crops were damaged and also due to damage to sites of conservation interest. Owen et al. (1986) describes the situation for the Canada Goose as "*only coordinated action can prevent this introduced species from assuming pest proportions*". A total of 29 feral/introduced Lesser White-fronted Geese were found during the nationwide survey in 1991, of which 24 were in East Anglia. The principal site was at the Otter Trust near Bungay, Suffolk, where a flock of 15 full-winged birds were kept. The site at Bungay was formerly home to a small collection of waterfowl. Two hybrid Lesser White-fronted Goose x Greater White-fronted Goose were found in the River Sure system, Norfolk (Delany 1992).

Kampe-Persson (2010) summarised data on naturalised goose populations in Europe. Besides elucidating which populations ought to be considered as naturalised, basic data were presented for 69 national populations of naturalised *Anser* and *Branta* geese. Regarding the Lesser White-fronted Goose Kampe-Persson wrote that the population breeding in Sweden is the last remnant of a formerly abundant Scandinavian population, and is a mixture of the original population and birds from the Swedish Lesser White-fronted Goose project. It is also stated that they follow one of the traditional migration routes, routes that were well separated from that of the North Fennoscandian population and refers to his own work (Kampe-Persson 2009). He concludes that the population should be described as re-inforced. No other populations or countries are mentioned, but in the summary table the total number of naturalised Lesser White-fronted Geese is given as 3 pairs / 7 individuals. The erroneous statement regarding migration routes and status of the Swedish population are discussed in detail elsewhere in the present report. However, it is important to comment that the estimate for the naturalised Lesser White-fronted Goose in Kampe-Persson (2009) is far too low. According to available data, there are annually observations of 10-30 individuals in Great Britain, 5-15 in the Netherlands, and 1-3 in Belgium, and presumable the situation is similar in France and Germany, although no data were available for these countries at the time of writing this report.

Looking at the complete datasets of records of Lesser White-fronted Geese (Waarneming.nl) for the Netherlands (9,205 records as of 07.10.2015) and Belgium (Waarnemingen.be, 724 records), there are 74 and 18 observations respectively of exotic/feral origin, of which only one record from the Netherlands is before 2002 (in 1994). The lack of records before the early 2000s is probably an effect of when the databases went online and became common usage, rather than an absence of escapees/birds of feral origin. In the Netherlands, 5 to 15 birds of feral origin are recorded annually (**Figure 23**), and also numbers during summer are quite high with as many as 10 birds during a survey in July 2005 (van der Jeugd et al. 2006), and 7 individuals in 2009 (de Boer & Voslamber 2010). It has not been proven if these individuals involve any Swedish birds that have stayed behind after winter, but Koffijberg & van Winden (2013) assess this as not likely judged by the sites where these Lesser White-fronted Geese were recorded during summer. There are also a number of breeding records in the Netherlands, also involving hybridisation, with the first in 2002 (van der Jeugd et al. 2006). An adult with four pulli was seen in 2004 and three pairs were recorded breeding in 2005. In 2008, two pure pairs plus one hybrid pair involving a Greylag Goose was recorded (Voslamber et al. 2010), while a hybrid pair of Lesser White-fronted Goose x Greylag Goose produced one gosling in 2013. The number of feral birds are probably higher as not all observers submit records of escaped waterbirds (Koffijberg & van Winden 2013).

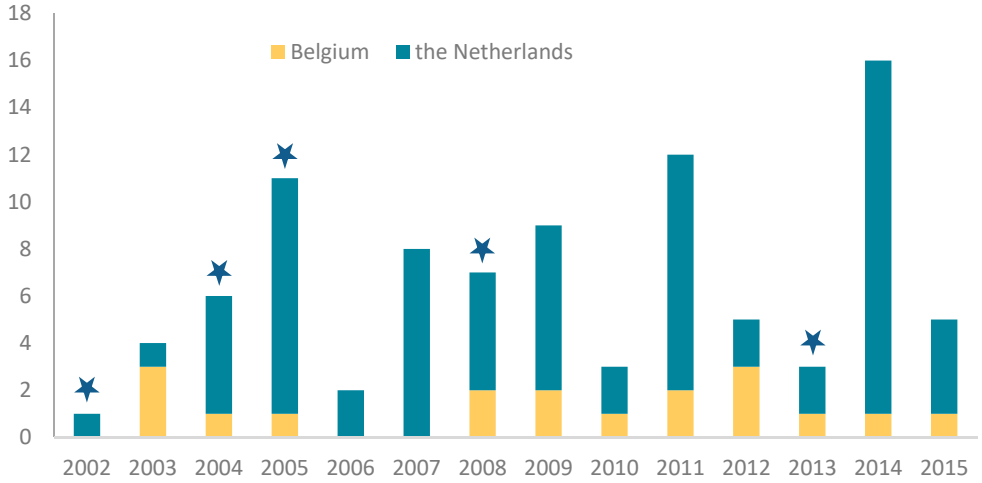


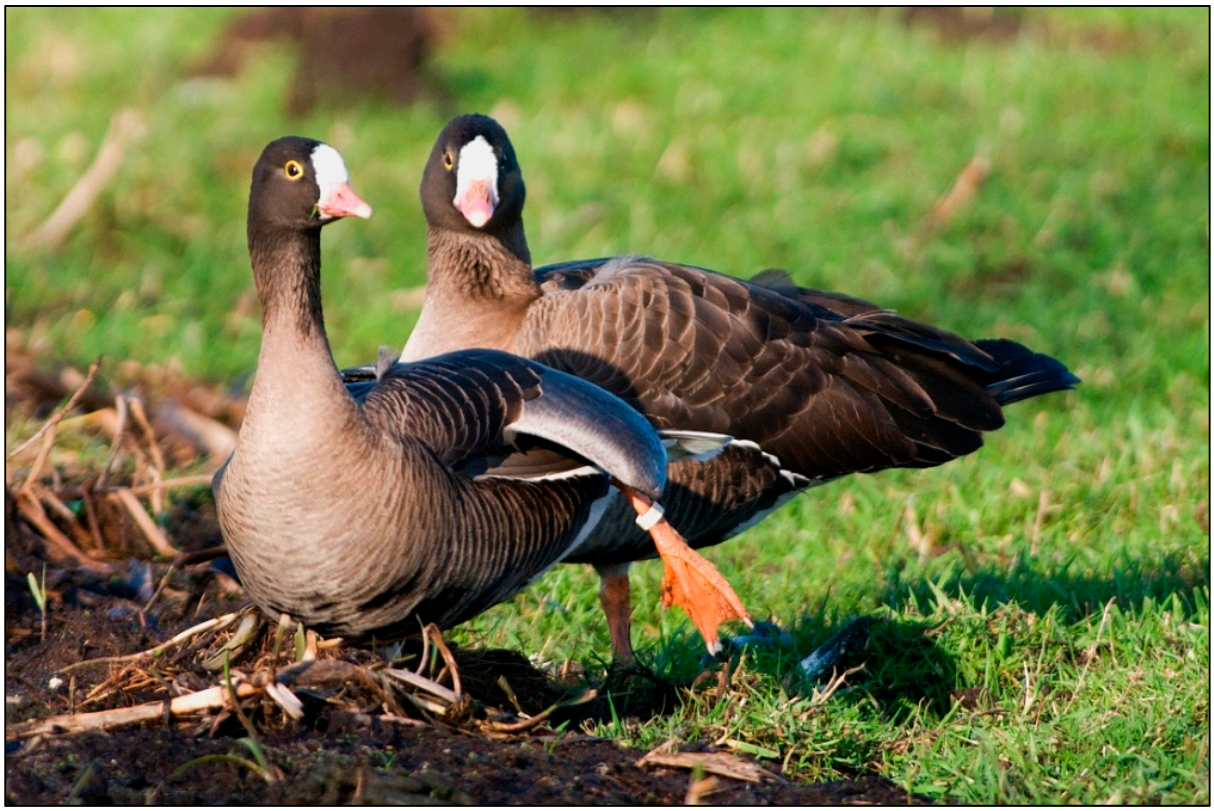
Figure 23. Maximum numbers of Lesser White-fronted Goose of feral origin in the Netherlands and Belgium 2002-2015 (source: Waarneming.nl, Waarnemingen.be). Columns marked with stars are years where Lesser White-fronted Geese were confirmed breeding in the Netherlands (van der Jeugd et al. 2006, Voslamber et al. 2010, de Boer & Voslamber 2010).

An escape from the Hämeenkoski farm in Finland in September 2013. According to the farmer, the bird escaped through a hole in the fence. It was first seen on 17th September 2013 at Teivaanranta, Lahti, Finland. Photo: Petri Kuhno.

A family of Barnacle Goose foster parents and juvenile Lesser White-fronted Goose that was illegally released at the lake by Näkkälä village, Enontekiö municipality, Finland, in August 2013. All the birds, including the Barnacle Geese, seemingly bore colour rings. A request for an investigation by the police was made by the Finnish state management organisation "Metsähallitus", though the outcome of this is unknown. Photo: Pekka Sulkava.

An escape or illegally released Lesser White-fronted Goose in Espoo, Finland, 15th June 2004, originating from Germany. This bird, with a green plastic leg ring (D 15 01 KS 725), was seen in Helsinki region annually from August 2003 and at least until June 2008, as documented on the Finnish report system for rare birds (Tarsiger.com). Photo: Matti Rekilä.

The code on the green plastic leg ring D 15 01 KS 725 yields the following information: D = Deutschland, 15 = size (15 mm), 01 = ringing year (2001), KS 725 = individual part; KS may refer to the farm/society running the farm, so the bird in question originated from some (unknown) German goose farm/zoo or wildfowl collection. Photo: Pasi Pirinen.



One of many escapes or illegally released birds in Wijngaarden, Oosteinde, the Netherlands, 17th January 2015 (http://waarneming.nl/waarneming/view/97373605). Part of the ring number is readable as “3044 03”. Photo: Hans Verheij.

Table 2. Some example records of Lesser White-fronted Goose escapes recorded by the Dutch bird reporting system at http://waarneming.nl/. The list is not complete and includes some observations between 30.03.2014-17.01.2015.

Date	Nb.	Status	Age	Activity	Locality	Observer
17.01.2015	2	Escape	unknown	present	Wijngaarden - Oosteinde [ZH]	Hans Verheij
05.01.2015	1	Escape	adult	present	Cuijk - Maasboulevard [NB]	Gert-Jan Caspers
25.12.2014	1	Escape	adult	present	Middelaar - Schiereiland [LI]	Gert-Jan Caspers
15.12.2014	1	Escape	unknown	present	Nieuwegein - Lekkanaal [UT]	Herman Bouman
07.12.2014	1	Escape	unknown	present	Nieuwegein - Lekkanaal [UT]	Herman Bouman

25.11.2014	1	Escape	adult	present	Katwijk (NB) - Maasuiterwaarden [NB]	Gert-Jan Caspers
13.11.2014	1	Escape	adult	present	Cuijk - Maasboulevard [NB]	Gert-Jan Caspers
06.11.2014	1	Escape	adult	resting	Katwijk (NB) - Maasuiterwaarden [NB]	Gert-Jan Caspers
16.10.2014	1	Escape	adult	present	Cuijk - Maasboulevard [NB]	Gert-Jan Caspers
13.10.2014	1	Escape	adult	present	Cuijk - Maasboulevard [NB]	Gert-Jan Caspers
07.10.2014	1	Escape	adult	present	Katwijk (NB) - Maasuiterwaarden [NB]	Gert-Jan Caspers
29.09.2014	1	Escape	unknown	flying NW	Mookerplas - Noord [LI]	Gert-Jan Caspers
22.09.2014	1	Escape	adult	present	Katwijk (NB) - Maasuiterwaarden [NB]	Gert-Jan Caspers
10.09.2014	1	Escape	adult	present	Middelaar - Schiereiland [LI]	Gert-Jan Caspers
08.09.2014	1	Escape	adult	present	Cuijk - Maasboulevard [NB]	Gert-Jan Caspers
29.08.2014	1	Escape	unknown	present	Nieuwegein - Lekkanaal [UT]	Herman Bouman
16.08.2014	1	Escape	adult	present	Katwijk (NB) - Maasuiterwaarden [NB]	Gert-Jan Caspers
16.08.2014	1	Escape	adult	present	Stellendam - Buitenhaven [ZH]	Albert de Jong
06.08.2014	1	Escape	unknown	present	Nieuwegein - Lekkanaal [UT]	Herman Bouman
06.06.2014	1	Escape	unknown	present	Eindhoven - Karpendonkse Plas [NB]	Wim Hallink
09.05.2014	1	Escape	unknown	present	Middelaar - Schiereiland [LI]	Gert-Jan Caspers
30.03.2014	1	Escape	unknown	present	Arcen - Straelensche Broek/Hanik [LI]	Herman Rothoff

That Europe still has a large number of escapes does not come as a surprise since farmed/captive Lesser White-fronted Goose can be traded without restrictions, as the species is not listed on any of the appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Due to the European Single Market and the absence of systematic border controls within the EU, the provisions of CITES have been implemented uniformly in all EU Member States. CITES is implemented in the EU through a set of Regulations known as the EU Wildlife Trade Regulations.

In the case of Sweden, the main national legislation relevant to the implementation of the EC Wildlife Trade Regulations is the Species Protecion Ordinance of 2007 (Artskyddsförordningen 2007:845). For the EU there is another set of directives relating to the keeping of wild animals in zoos, of which the most important is the Council Directive 1999/22/EC of 29th March 1999 (see Appendix F).

In a study of zoos in Spain, Fabregas et al. (2010) found that 14% of the evaluated enclosures were not secured against animal escaping, either due to problems associated with the physical barrier surrounding the enclosure and/or the possibility of the public releasing the animals, and that 75% of the zoos in the sample had at least one non-secured enclosure in their facilities. Given that 75% of all the Spanish zoos participated in the study, he considered that the results reflected quite accurately the situation in Spain, and that the actual number of enclosures from which animals could potentially escape was near 1,000. For the Netherlands, the situation is probably not very different judging by the slightly increasing number of Lesser White-fronted Geese recorded as of feral origin. Since 2002 an average of 6.8% of all records in the Netherlands are believed to be of feral origin, and with the recent strong decline in the population of Swedish reintroduced origin this proportion is now over 12%.

4.11 Spread of diseases

The spread of diseases due to the extensive farming and releases of geese from zoos, and the subsequent risks to the wild populations of Lesser White-fronted Geese, has to date not been properly assessed. There are several cases showing that this is not only a theoretical threat (described below), but something that should be thoroughly identified as a potential negative factor to be dealt with in the conservation work on Lesser White-fronted Goose. Altizer et al. (2011) suggested that there was some evidence to show that less-virulent strains circulate in migratory populations than in resident populations. The recent releases of hand-reared Lesser White-fronted Geese have now resulted in shorter migrations and a more sedentary population, with birds now wintering in southern Sweden. If the suggestion of Altizer et al. (2011) is correct, then there may be a risk of an increase in zoonotic pathogens in humans as a result. In addition, releases of farmed birds into the wild are one of the potential main vectors of spread of avian influenza virus, and should not be treated lightly (cf. Prosser et al. 2013). Outbreaks of highly pathogenic avian influenza (HPAI) in poultry during the last decade have resulted in a number of studies on virus ecology and interplay between avian viruses and their wild hosts, including in wild geese (Kleijn et al. 2010). The subject of diseases of geese in captivity has a long history. For example, Keymer et al. (1982) studied tuberculosis in birds in Regent's Park in London, and Hillgarth et al. (1983) looked at mortality causes of northern geese in captivity in the Wildfowl & Wetlands Trust (WWT) collections where causes such as renal malfunction, tuberculosis, amidostomiasis, pneumonia, egg peritonitis, aspergilliosis and cardiac conditions were documented under post-mortem examinations. Infectious diseases of viral aetiology present epidemic threats to goose production, of which Derzsy's disease is perhaps the most important. There is a mass of literature on the subject, and we mention here for example the study of Kozdrun et al. (2012), who recently showed the presence of parvovirus, haemorrhagic polyomavirus and circovirus in geese collected from farms in various locations in Poland.

Legislation on animal welfare, invasive species and human safety exists at international, European and national levels. The legislation is complex and it is essential to consult the actual legislation which appliesin each country as well as the appropriate authority that is responsible in each particular circumstance. The relevant authority may not necessarily be in the same government body as the CITES management or scientific authority.

The following is written in the overview from the European Comission about welfare, invasives and health Issues related to exotic animals and plants: "People involved in wildlife trade and in the keeping of live animals and plants are legally obliged to take adequate care of the specimen they possess, in order to prevent unnecessary mortality and suffering among live animals, damage to indigenous flora and fauna from the invasion of exotic species, potential health risks through the escape of dangerous and/or poisonous specimens, or the transmission of diseases from animals to animals and from animals to humans. This applies particularly to live animals and plants, and to other kind of vectors that may carry diseases or pests (e.g. meat, seeds or raw timber)". (http://ec.europa.eu/environment/cites/info_welfare_en.htm).

There are many permanent exhibitions of animals and plants worldwide, generally in the form of zoos, safari parks, aquaria, botanical gardens and orangeries, and all have to comply with wildlife trade regulations, as well as with nature conservation, animal welfare, animal transport, veterinary, phytosanitary and customs laws. In addition, the keeping of wild animals in zoos has been regulated at the EU level since 1999 through the Council Directive 1999/22/EC of 29th March 1999 relating to the keeping of wild animals in zoos (see **chapter 4.10**).

4.11.1 Mycobacteriosis in 1991

In Finland, the Hailuoto farm where Lesser White-fronted Geese were being bred in captivity had serious problems with Mycobacteriosis. An epidemic broke out during winter 1991-1992, and many birds died. In addition, one case of Mycobacteriosis was diagnosed in the Hämeenkoski farm. The Hailuoto farm was under quarantine for several years. The outbreak was studied by the Veterinary Organisation of the State and the University of Helsinki, where an examination work was made by Mika Aho, led by professor Eeva-Liisa Hintikka (Markkola et al. 1999). The spread of the disease was attempted stopped by: 1) Isolating the old birds from the young. This meant that eggs were incubated in an incubator and the goslings grew up without their parents. 2) Sterilisation of the farm by changing the upper soil layer, heating the soil with steam via pipes and alkalifying the soil (Mycobacteria prefer low pH). The outbreak was contained and no new cases were diagnosed after 1997 (Markkola et al. 1999). A PCR-based typing study of *Mycobacterium avium* isolates of the epidemic verified four *M. avium* strains as inducers of avian tuberculosis and all where distinct from the three environmental strains identified in the farm environment. The study indicated the high susceptibility to avian tuberculosis of Lesser White-fronted Geese in captivity (Kauppinen et al. 2001).

4.11.2 Embryonic death caused by bacteria in Sweden

In 1999, only 14 eggs out of 45 were fertilised at one of the Swedish farms. Analyses carried out at the Wildliife Division of the Swedish National Veterinary Institute proved bacterias as the culprit, which probably penetrated the egg shells and caused embryo deaths. The measure taken following this was improvments in hygiene (von Essen 1999a). The specific strain of bacteria involved was not published.

4.11.3 Norwegian case in 2010

One of the two adult Lesser White-fronted Geese sent from “Nordens Ark” in Sweden to Norway in 2010 together with goslings for release died in the holding pen at the Valdak Marshes within the planned release period in autumn. It was already known by the staff at “Nordens Ark” that one of the adults was sick, but they nevertheless sent them to Norway without knowing what the disease could be, nor notifying the staff in Norway. When the bird was found dead the release of geese was put on hold and the corpse sent by courier to the National Veterinary Institute in Trondheim for autopsy. A final report for the analyses was never produced, but in the preliminary note delivered on 20th August 2010 the veterinarian concluded that “*Results of the autopsy revealed changes indicating serious failure of both the liver and the spleen, which is the probable explanation for cause of death for this individual. However, we have insufficient information as to the likely causes of such injuries*”. In the accompanying e-mail the veterinarian wrote that “*we still suspect a bacterial infection, likely caused by E. coli. This would be in line with a comment from the Swedish Environment Protection Agency (SEPA) that the farm of origin earlier had problems with these bacteria*”. The veterinary institute collected samples for further analysis on bacteriology, histology, parasitology, virology and cytology, and provided these have not been disposed of, they should still be possible to analyse.

Dead adult captive Lesser White-fronted Goose in the holding pen at the Valdak Marshes in Norway in 2010. The bird came from "Nordens Ark" in Sweden to accompany the goslings to be released at the same site. Photo: Tomas Aarvak.

4.11.4 The most common goose diseases

Listed in this chapter are the most common goose diseases arranged alphabetically as described by the Food and Agricultural Organisation of the United Nations (Buckland & Guy 2002), and we include them here as a reference on goose diseases.

Aspergillosis is defined as any disease condition caused by a member of the fungal genus *Aspergillus*. In geese, as in most other classes of poultry, the organs most affected are the lungs, hence the term Pulmonary Aspergillosis. The disease can be quite severe in young goslings as they may become infected during hatching and even embryos may become infected. The source of infection can be either dirty incubator equipment and/or dirty eggs. Dirty eggs can contaminate both the setter and hatcher. In addition, it is possible for *Aspergillus* to penetrate the egg which is how embryos can become infected. Young growing goslings are also susceptible to Aspergillosis but usually not as severely although they can be infected from contaminated litter.

Coccidiosis Geese can get two distinct types of coccidiosis. The most prevalent form is renal coccidiosis caused by *Eimeria truncata*. While intestinal coccidiosis is less prevalent, it is caused primarily by *Eimeria anseris*. At least five additional species of *Eimeria* have been isolated from the intestines of geese. The level of infection and degree of economic loss associated with coccidiosis in geese is generally low, and it is not regarded as a major problem.

Cryptosporidiosis is a protozoan disease caused by parasites of the genus *Cryptosporidium* which infects both the lungs and intestines of geese. It is found worldwide wherever commercial poultry are raised and, as poultry health specialists develop appropriate tools to identify it, it is expected that more cases will be reported. This probably explains why reports from the goose industry are that its incidence seems to be on the increase.

Derzy's disease is a viral disease also known as Parvovirus disease because of the causative agent. Other names include Goose Plague, Goose Hepatitis, Goose Enteritis, Goose Influenza, Infectious Myocarditis and *Ascetic Hepatonephritis*. It is a highly contagious disease that affects young geese. The disease has been reported to exist in any part of the world where geese or Muscovy ducks *Cairina moschata* are raised since they are also susceptible to it and can transmit the disease to geese. In its acute form, the disease can result in up to 100 percent mortality rate or it can occur in a more chronic form. If birds are infected during the first week of age, very high losses can occur but if the goslings are 4-5 weeks old or older, the mortality rate will be negligible.

Duck virus enteritis (DVE) is an acute, contagious disease caused by a herpes virus that can infect ducks, geese and swans although the incidence of the disease in geese is very low. DVE can be transmitted directly, by contact between infected and susceptible birds, or indirectly, by contact with a contaminated environment. Birds that have recovered from DVE are immune to re-infection by the DVE herpes virus. It should be noted that in Australia a herpes virus has been isolated from a flock of infected geese (with a mortality rate of 97 percent) which was antigenically distinct from the duck viral enteritis herpes virus.

Erysipelas is generally an acute, sudden infection of individual geese within the flock. In both young and adult birds, it is caused by the bacterium *Erysipelothrix rhusiopathiae*. Outbreaks of this disease which are economically significant are uncommon in avian species, with the exception of turkeys, but some cases have been reported for geese. *Erysipelothrix rhusiopathiae* is somewhat unique in that it can infect over 50 animal species and can also infect humans. In the latter case, the infection usually enters through scratches or puncture wounds and is considered a safety issue for people working with infected animals. Human infections can be treated with antibiotics.

Flukes (trematodes) are flat, leaf-like parasitic organisms. Over 500 species belonging to 125 genera and 27 families are known to occur in birds. Generally, flukes are not a problem for geese, however, geese with access to natural lake or pond water may become infected. This is because most flukes have an aquatic snail (genus *Limnaea*) as an intermediate host. Dragonflies (genus *Odonata*) are the second intermediate host in many cases.

Fowl cholera, also known as *Pasteurellosis*, is a contagious disease affecting all domestic and wild birds. *Pasteurella multocida* is the causative agent, to which geese are highly susceptible and mortality can be high.

Leucopcytozoonosis is a parasitic disease of birds which affects the blood cells (especially the white blood cells) and the tissues of various internal organs (parasite multiplication occurs in the macrophages of brain, liver, heart, lungs, and spleen). It is a very uncommon disease in geese but outbreaks of economic significance have been reported. *Leucocytozoon simondi* is the causative agent in waterfowl and has been reported in 27 species of ducks and geese in North America, Europe and Vietnam.

Listeriosis is not a common disease of geese but some instances have been reported in temperate areas of the world. This is probably due to the fact that, in temperate climates, *Listeria*

monocytogenus (the causative agent) is found in both faeces and soil. Also, it is in these areas that many geese are kept on pasture and therefore are exposed to the organism.

Mycoplasma infections, also known as Pleuro-Pneumonia Like Organisms or PPLO, can cause relatively serious problems in geese. These organisms have an intermediary structure between that of bacteria and viruses. At least three species of Mycoplasma (*Mycoplasma anseris*, *Mycoplasma claucale* and Strain 1220) have been isolated in geese. In recent years the prevalence of *Mycoplasma* infections in geese in a number of areas appears to have increased. This is most notable when birds are managed under intensive conditions.

Necrotic enteritis is caused by *Clostridium perfringens* and has been reported to occur in geese although the incidence of the disease does not appear to be high. *Clostridium perfringens* can be found in soil, faeces, dust, litter and contaminated feed.

Nematodes, or roundworms as they are commonly called, constitute the most important group of helminth parasites of poultry. In geese, *Ascaridia* are generally not a problem but various species of *Capillaria* and *Heterakis* can cause problems. The most common nematode in geese is *Amidostomum anseris.*

Nephritic hemorrhagic enteritis is a disease that is currently quite prevalent in the south western region of France and is often referred to simply as NEHO. It can infect geese from 4-20 weeks of age and causes mortality rates from 30-100 percent. The causes of this disease are not well understood but it seems to be primarily poor management. An excess of protein in the feed or any sudden change in the diet of the birds can also bring it on, as can poor quality drinking water and parasite infections.

Paratyphoid, or salmonellosis, is an important disease in geese with young birds, generally under six weeks of age, being the most susceptible. In addition, the concern regarding salmonella infection in humans and the demand for salmonella-free poultry products has increased the awareness of this disease and resulted in various monitoring programmes being undertaken in many countries. Over 2,000 types of salmonella organisms have been isolated from various species of fowl worldwide. Generally, the salmonella serotypes isolated from poultry are more characteristic of the region than the species of poultry. Paratyphoid is easily spread through contact with either infected birds, their faeces or through infected equipment, particularly that used for hatching and brooding. It now appears that salmonella is spread by salmonella entering the egg both in vivo before it is laid and by penetrating the egg after it is laid. In both cases it can multiply in the egg. For this reason, the importance of collecting eggs frequently before they get dirty, and cleaning and fumigating them as soon as possible, cannot be over emphasised.

Riemerella anatipestifer infection is a contagious disease affecting domestic geese, ducks and various other birds which means that infections in geese can originate from other species.

Reticuloendotheliosis refers to a group of syndromes caused by the retroviruses of the REV group. The disease occurs in a wide variety of domestic poultry but is rare in geese. It is sometime called the Runting Disease because it is characterised by poor growth and abnormal feathering. In geese, viruses have been isolated from tumours of the spleen, liver, pancreas and intestines. No vaccine has been developed for this disease because the incidence and economic importance of the disease is very low.

Staphylococcosis All avian species are susceptible to staphylococcal infections though geese do not appear to be affected to any great degree. If and when they are infected, it is generally as a

secondary infection but even this is rare in geese. *Staphylococcus aureus* is the most common infection in birds. One of the major concerns is that staphylococcus infections can be transmitted from birds to humans. This has been observed among both slaughterhouse workers and people performing autopsies.

Streptococcosis There are a number of species of streptococcus that infect birds. However, to date, streptococcus infections in geese are very rare although *Streptococcus mutans*, a common bacterium of the human oral cavity, has been identified as a cause of septicaemia and mortality in geese.

Trichomoniasis is a protozoan disease that infects mostly mature geese in breeder flocks. The causative agent in geese is *Trichomonas anseris* while for other classes of poultry it is *Trichomonas gallinae*. These organisms are transmitted from bird to bird through the water and, to a lesser degree, through the feed.

Veneral diseases Bacteria, especially *Neisseria*, *Mycoplasma*, and *Candida albicans* have been associated with a venereal disease in ganders although it now seems that *Mycoplasma* are the primary infective agents.

4.12 Dutch Council of State ruling on designating SPA area

In the course of two court cases in March and December 2004 (Appendix D & E), the Ministry of Agriculture, Nature and Food Quality in the Netherlands, in an injunctive relief by the Dutch Council of State[2], was to treat the "De Abtskolk-De Putten" area as if it had been designated as a special protection area under the terms of Article 4 (1) of the EU Birds Directive (see Appendix G) for the Lesser White-fronted Goose. The case is interesting as the state refused to designate an SPA (Special Protected Area), on the grounds that the Lesser White-fronted Geese in the Netherlands come mainly from the reintroduction project in Sweden, meaning that they do not form part of a population naturally occurring in the wild. Additionally, the fact that they occur in the Netherlands is solely the result of the reintroduction programme altering the birds' migration route. Genetic crossbreeding with other goose species was also an argument against the naturalness of this population.

The Dutch Council ruling was strongly based on a decision by the European Court on a case known as "the Vergy case" (C 49/94, European Court Reports 1996 p. I-00299). The Vergy case decision indicated that the Birds Directive does not apply to birds born and reared in captivity, but does so to birds occurring in the wild in Europe and thus for all EU countries even if the country does not have the original habitat for that bird population but the bird population does occur there. This is exactly the way the Dutch Council applied that decision for the Swedish reintroduced population. The Dutch Council does not consider them as born and reared in captivity any more, even if they may be genetically polluted through their captive history.

In the wake of these court rulings, it is evident that there are unclear definitions as to when an individual can be defined as wild or as captive. However, the Netherlands judged the wintering Lesser White-fronted Geese as wild based upon the population occurrence and trend, independent of releases undertaken in Sweden. This gives rise to a number of principal question: When does a species change status according to legislation in Europe? When does a bird reared in captivity and

[2] The «Dutch Council of State» is their Administrative Jurisdiction Division which is the Highest Administrative Court in the Netherlands, but they also call themselves Council of State.

subsequently released into the wild change status from captive to wild? Are such birds not protected, but their offspring are? And similarly, when does a wild-caught bird change status in captivity, or are their offspring automatically assigned status as captive/captive-bred? See **chapter 2.1** on definitions for a further elaboration on these issues.

4.13 Finnish court rulings on catching and illegal releases in Finland

In Finland, there has been three court trials concerning catching and illegal releases of geese within the country.

Lapland district court *7.9.2005* (R *05/197). Release of juvenile Lesser White-fronted Geese with Barnacle Goose foster parents in Lapland. Criminal case.* Charges were rejected, as the court did not find evidence that the captive birds were from an alien population.

Supreme Administrative Court 20.2.2009 (DNo 1327/1/07). Application to catch wild Barnacle Geese in southern Finland to be used as foster parents for Lesser White-fronted Goose did not fulfil legal demands. The court stated that according to the Ministry of Environment's and AEWA's position it was not possible to release birds currently held in captivity into the wild. Barnacle Geese could establish an alien population in Lapland which is outside their natural range. The planned activity contradicted the Nature Protection Act. Following this decision, the reintroduction group was not legally able to use foster parents for introducing Lesser White-fronted Geese into the wild.

Lapland district court *8.6.2011* (R *11/398)*. Three defendants were prosecuted for releasing juvenile Lesser White-fronted Geese together with Barnacle Goose foster parents in Lapland in July 2009. All three defendants were found guilty, and one defendant was sentenced. The court took the view that the captive-bred Lesser White-fronted Geese and Barnacle Geese were alien species. The court stated that captive-bred Lesser White-fronted Geese are alien species because their genetics differ from the genetics of wild birds. Released Lesser White-fronted Geese could establish a permanent population and it is possible that they could mix with wild Lesser White-fronted Geese in northern Norway, where the population is genetically pure. Additionally, Barnacle Geese were viewed by the court as an alien species in Lapland because they are outside their breeding range and they could establish a permanent population in Lapland. The court ruled that it is illegal to release both Lesser White-fronted and Barnacle Geese into the wild. The case was later referred to the Rovaniemi court of appeal in 2012, and in 2014 the Supreme Court did not grant the defendants leave to appeal, so the decision that the releases were illegal still stands.

5. STATUS AND EVALUATION OF THE SWEDISH REINTRODUCED POPULATION

Already in the mid-1980s concerns were raised by many, including the International Council for Bird Preservation (ICBP) (APPENDIX A), about the Swedish reintroduction project because of possible negative effects of artificial rearing and manipulation of the migration route that would put the remaining wild population under further pressure. In addition, diverting resources from the protection work on the wild populations to reintroduction were considered to be counterproductive.

It is interesting to note a striking lack of comprehensive analyses and presentations of baseline data on the Swedish population, so the present chapter and data presented here are gathered from numerous published sources, of which the annual reports from *Projekt Fjällgås* have been important (Andersson 2001, 2003, Anderson & Holmqvist 2010, 2011, von Essen 1990, 1993a,b, 1994, 1995, 1996a,b, 1997a,b,c, 1999 a,b,c, Liljebäck et al. 2012, 2013), although we do not have access to all reports produced by the project. In addition, the annual bird reports by SOF/BirdLife Sweden (Hellström & Strid 2008, 2009, Lerner & Kampe-Persson 2006, Lerner 2005, Strid & Eriksson 2012, 2013, Strid & Wærn 2010, 2011, Strid 2004, 2005, 2006, 2007) are good sources of information as well as the plethora of local birding magazines (for example Bern et al. 2014, Dalin et al. 2010, Kyrk 1987). Lastly, we have used data from the Swedish Species Observation System (Artportalen.se). Despite us having on multiple occations requested complete data from Sweden, we did not receive access to data hidden automatically by the system, such as records of breeding birds during summer. Sweden is the only country that's has not supplied any data upon request, neither from the Artdatabanken nor from the Bird Ringing Office.

To ease reading of the present report we have added a map of Sweden showing the names of the provinces that are often mentioned in the text and figures. Another map showing the reintroduction area and most important sites along the human-mediated migration route to the Netherlands (**Figure 32**) is presented in **chapter 5.2.2** on page 79.

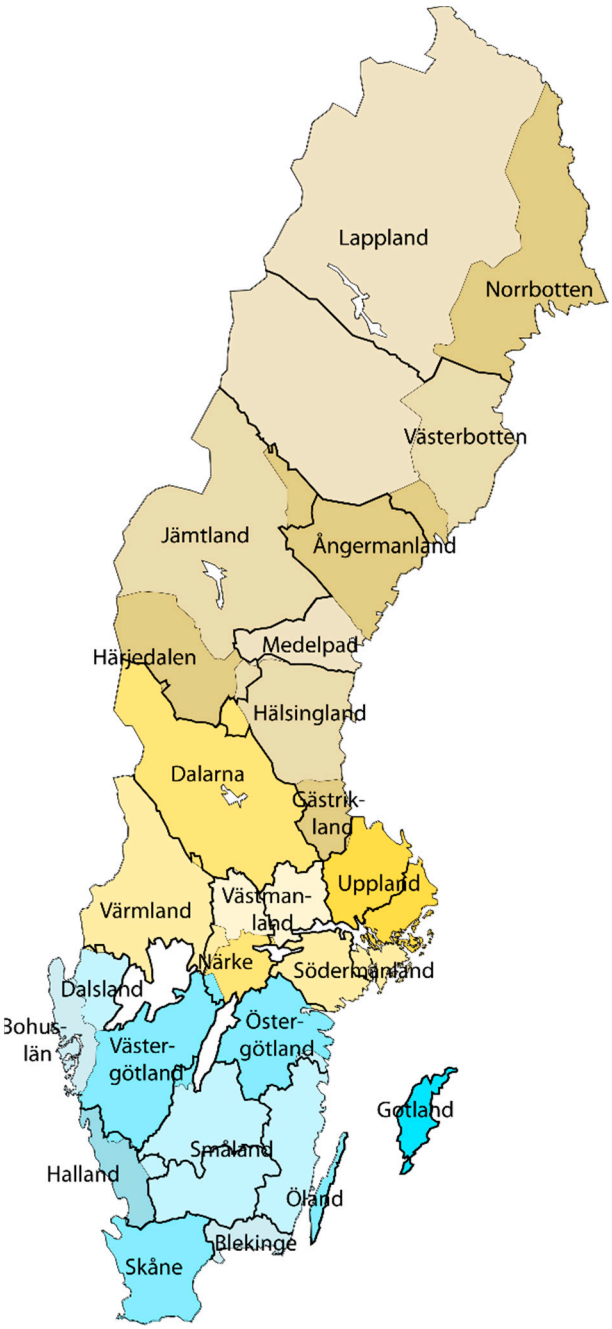


Figure 24. Map of Sweden. Bold lines represent county borders, colors represent provinces. Copyright by Sveriges Län 2007, Koyos derivative work: Cassowary [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons.

5.1 The extinct wild Fennoscandian breeding population in Sweden

In 1976 the Swedish population was estimated to be approximately 100 pairs (Ulfstrand & Högstedt 1976). In 1990, Lambart von Essen, one of the founders of the Swedish reintroduction project, estimated the remaining wild population to be 10 pairs or less (von Essen 1991). In 1998, the situation had worsened and von Essen (1999c) concluded: "*the Lesser White-fronted Goose is no longer breeding annually in Sweden outside the reintroduction area*". The situation has not changed since then and, in the latest publication about bird population sizes and distribution in Sweden, Ottosson et al. (2012) estimated the breeding population to be 15-25 pairs, but noted that these were probably only descendants from the reintroduction project run in the period 1981-1999. Ottosson et al. (2012) stated specifically that "*the original population must be treated as extinct, or at best of single pairs*".

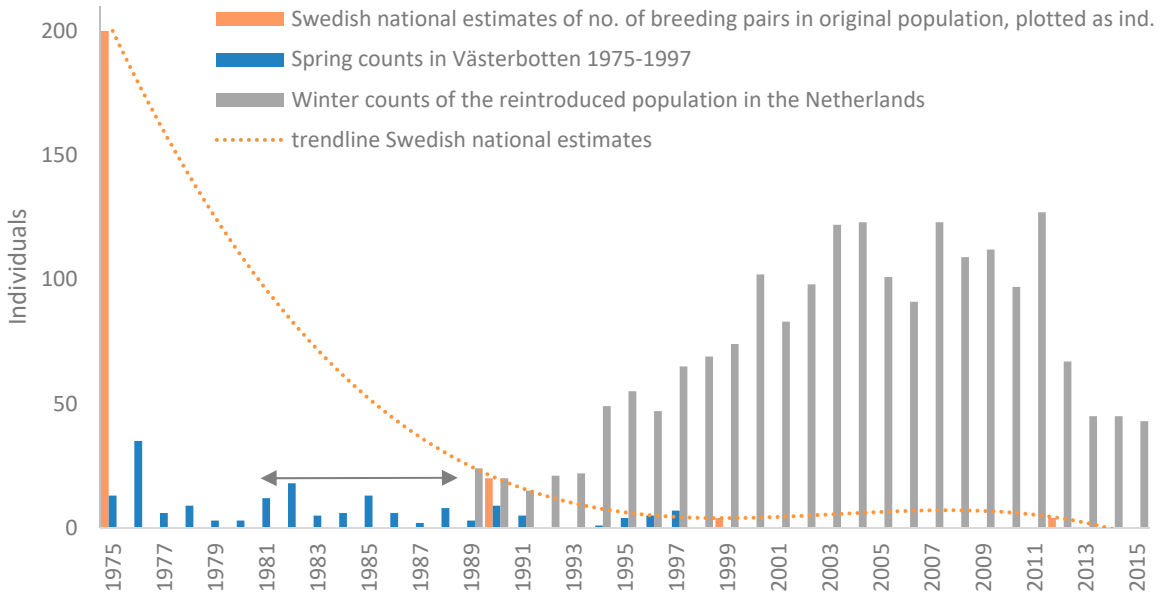


Figure 25. Population trajectories for the original wild Lesser White-fronted Goose in Sweden and the Swedish reintroduced population as assessed during winter in the Netherlands (data from Ulfstrand & Högstedt 1976, von Essen 1991, 1999c, Ottosson mfl. 2012, Olsson & Wiklund 1999). Arrows denote years 1981-1988 where estimates of the size of the reintroduced population are missing (winter counts in the Netherlands).

Counts of spring-staging Lesser White-fronted Geese in Västerbotten for the years 1975-1997 (Olsson & Wiklund 1999) clearly indicated a declining trend for the original wild population until 1980. These birds mainly used other breeding areas than where the reintroduced population was established, as the numbers did not substantially increase in the years after 1981 when releases started (see **chapter 4.1**). Olsson & Wiklund (1999) published records of colour-ringed birds from the release project up until spring 1997, when three individuals were observed in Umeälven river delta. Therefore, any population estimates after 1981, or 1982 when the released young in 1981 had acquired adult looking plumage, are unable to distinguish between Lesser White-fronted Geese from the original wild population and those stemming from the releases.

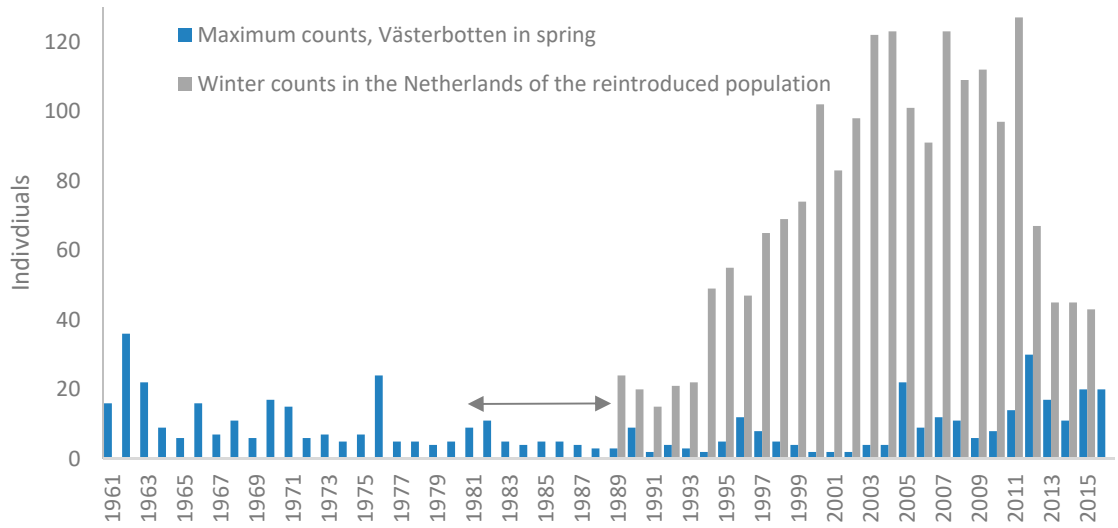


Figure 26. Maximum number of spring staging Lesser White-fronted Geese in Västerbotten county, Sweden, 1961-2016. Arrows denote years 1981-1988 where estimates of the size of the reintroduced population is missing (winter counts in the Netherlands). There is no correlation between maximum numbers during spring and winter counts in the Netherlands (R^2 = 0.005, n=23, p=0.726). Data from Västerbotten downloaded from Artportalen June 2016.

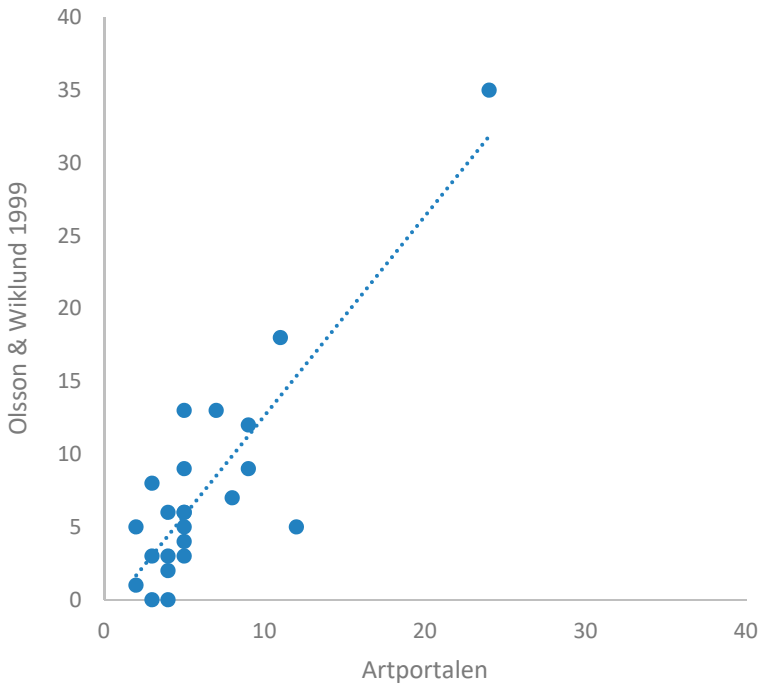


Figure 27. Correlation between maximum spring numbers of Lesser White-fronted Geese in Västerbotten for the years 1975-1997 between data given by Olsson & Wiklund (1999) and observations reported in Artportalen (R^2 = 0.743, n=27, p<0.001). Data downloaded from Artportalen June 2016.

5.2 Status of the reintroduced free-flying population in Sweden

5.2.1 Swedish population numbers

The annual size of the Swedish "free-flying" reintroduced population is traditionally estimated based upon numbers seen in autumn in Sweden and counts during the winter period in the Netherlands. The best data come from the Netherlands, where the population built up gradually until 2002, and thereafter fluctuated between 110-130 individuals between 2003-2011 (Koffijberg & van Winden 2013, **Figure 28**). Following a break of a few years, new releases started again in 2010, after which the population has since crashed, though the cause of this decline is currently unexplained. Predation by Red Fox and White-tailed Eagle *Haliaeetus albicilla* has been cited as important mortality factors in the release area (Andersson & Holmqvist 2011, Liljebäck et al. 2012, 2013). However, an increase in predation levels cannot fully explain why the population size decreasing despite continued the releases of birds since 2010.

There is, as expected, a significant positive correlation between numbers of birds released and the population development during the years 1989-1999 based upon population size estimated from counts during winter in the Netherlands (chi-square = 0.72, p = 0.012, **Figure 29**). However, after the new release regime started in 2010, there is now a significant negative relationship between release numbers and estimated population size during winter for the years 2010-2015 (chi-square. = -0.908, p = 0.012, **Figure 30**). There are several possible explanations for the decline in numbers since 2010. Possible explanations include that the birds released from 2010 onwards have unusually high mortality rates. This high mortality level may also affect the population that was already present in the release area (for example by attracting predators into the area in search of easy prey). Alternatively, the Lesser White-fronted Geese released after 2010 do not mix with the extant population, and are therefore not recorded during winter counts in the Netherlands. Data on colour-ringing and resightings of individuals released are not publicly available for the Swedish birds. However, many of the birds released after 2010 are observed in the Netherlands, so they should make a contribution to the total numbers recorded during winter, even if they don't mix with the population that was established during the first release project.

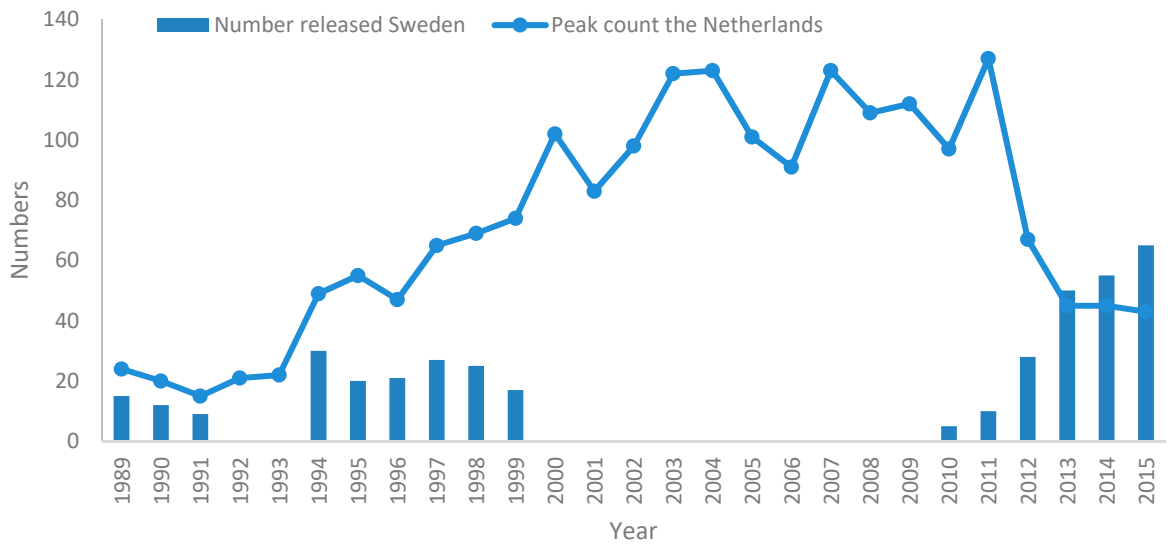


Figure 28. Population trend and annual number of releases for the Swedish reintroduced Lesser White-fronted Goose population. Trend data are based upon counts during winter in the Netherlands. Data from Koffijberg & van Winden (2013), updated with data from Waarneming.nl (2016) and Kees Koffijberg (pers. comm.).

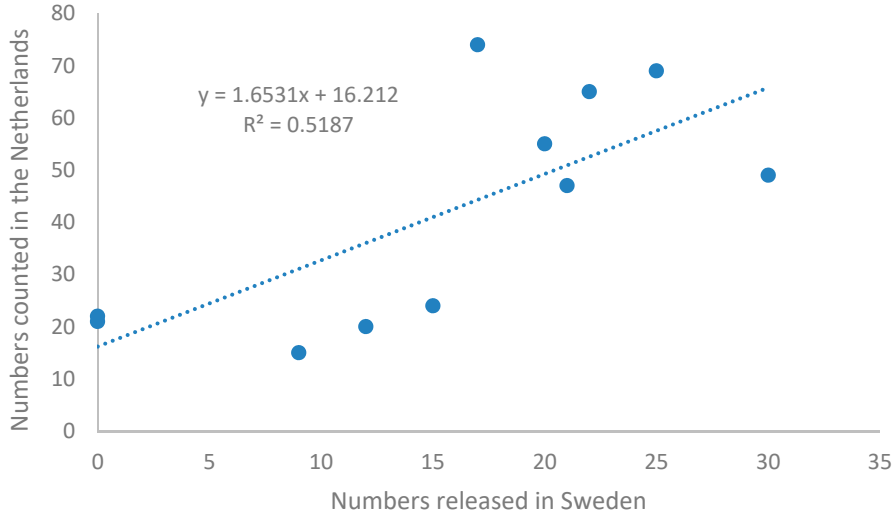


Figure 29. Relationship between number of birds released in Sweden and population size estimated during winter in the Netherlands, for the years 1989-1999 were both release numbers and estimates from the Netherlands exist (Koffijberg & van Winden (2013). Data are from the first release period in Sweden by using Barnacle Goose foster parents.

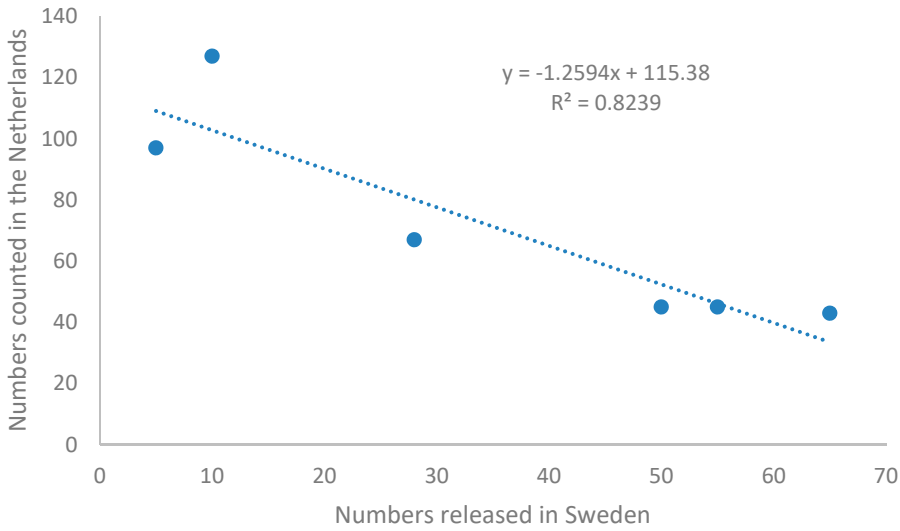


Figure 30. Relationship between number of birds released in Sweden and population size estimated during winter in the Netherlands, 2010-2015. Data for the Netherlands from Koffijberg & van Winden (2013), updated with data from Waarneming.nl (2016) and Kees Koffijberg (pers. comm.).

A multiple regression on population size as the dependent variable and releases and number of fledglings observed in autumn for the years 2010-15 as independents, show that the releases are affecting population size (numbers) negatively, and that this is significant (beta = -.631, p= 0.008). On the other hand, the number of fledglings produced naturally affects the population size positively as expected (beta=0.482, p=0.17), although with less magnitude than the negative influence of the releases after 2010. The releases in both 2014 and 2015 were larger than the estimated population size, and it is evident that this method does not work as the population is being negatively affected by releases, despite the intentions to increase the population size. Part correlations are -0.517 and 0.395 for releases and fledglings respectively.

The distribution of records has changed considerably when comparing all records from before 1981 when the first releases were conducted and in recent years as exemplified with data from the years 2000-2016. Since we are interested in understanding what is happening at the population level, we have exluded all observations of records of 1-2 individuals to remove the effect of stray individuals and vagrants. For geese, the family is the most important unit, so the smallest biologically interesting group is three individuals, - a pair with one gosling. One could argue that a pair without goslings is also valid, but at population level there is no transfer of migration- or site knowledge without the acompany of goslings. If a site is important at population level, we expect that at least once, a family with goslings would be recorded at the site within the generation time of the adults. From the maps in **Figure 31** it is evident that pre any of the reintroduction projects the Lesser White-fronted Goose had a northerly distribution in Sweden, with large numbers registered at some key inland breeding and moulting sites, and some three to four important staging areas around the river deltas in Väster- and Norrbotten. Looking at the current distribution (2000-2016), the species is now mainly found in central and southern Sweden, and where inland/farmland/cultivated areas predominate.

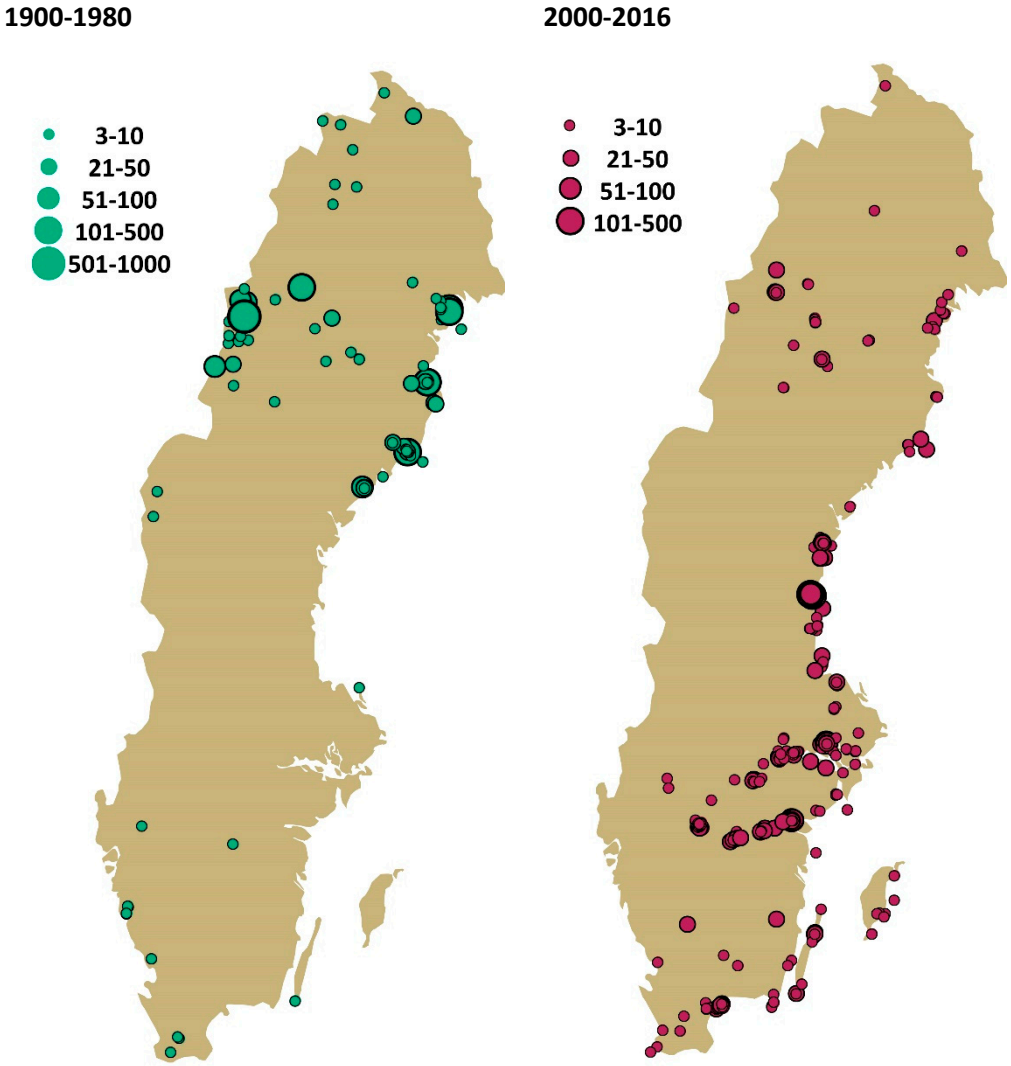


Figure 31. Distribution of groups (>3 ind.) of Lesser White-fronted Goose in Sweden in two time periods, 1900-1980 (pre reintroduction projects) and 2000-2016 (after the first release scheme with Barnacle Goose foster parents, and partly during the one without any parents). Open access data from the Swedish Reporting System (data downloaded 24.10.2016).

5.2.2 Migration routes for the reintroduced Swedish population

An unknown, but nevertheless large, number of the farmed and released Lesser White-fronted Geese in Sweden in the years 1980-1999 and 2010-2015 have been colour-ringed. At least all birds released in the years 1981, and in the period 1984-1991 were colour-ringed (von Essen 1993a, von Essen 1989), though Andersson & Holmqvist (2010) writes that "*Releases were made almost annually in 1981-199, all with colour-ring marked birds.*" However, no analyses or publications of this material are known to exist. Only anecdotal information for single individuals are available in some of the annual reports of the Swedish *Projekt Fjällgås* and in shorter popular articles (von Essen 1993a,b, Waldmann 1998, 2000). In general, the birds from the original releases (pre-2010) migrated to wintering grounds in the Netherlands (Andersson et al. 2004, **Figure 32**), although resightings of birds from that period also exist from many areas outside the "manipulated" migration route, such as from central Norway (Waldmann 1998, 2000), Estonia (Aivar Leito pers. comm), Finland (von Essen 1996a) and Spain (Kampe-Persson 2001). In addition to Swedish birds, Lesser White-fronted Geese from releases made in Finland have also been recorded in Spain during winter (Kampe-Persson 2001).

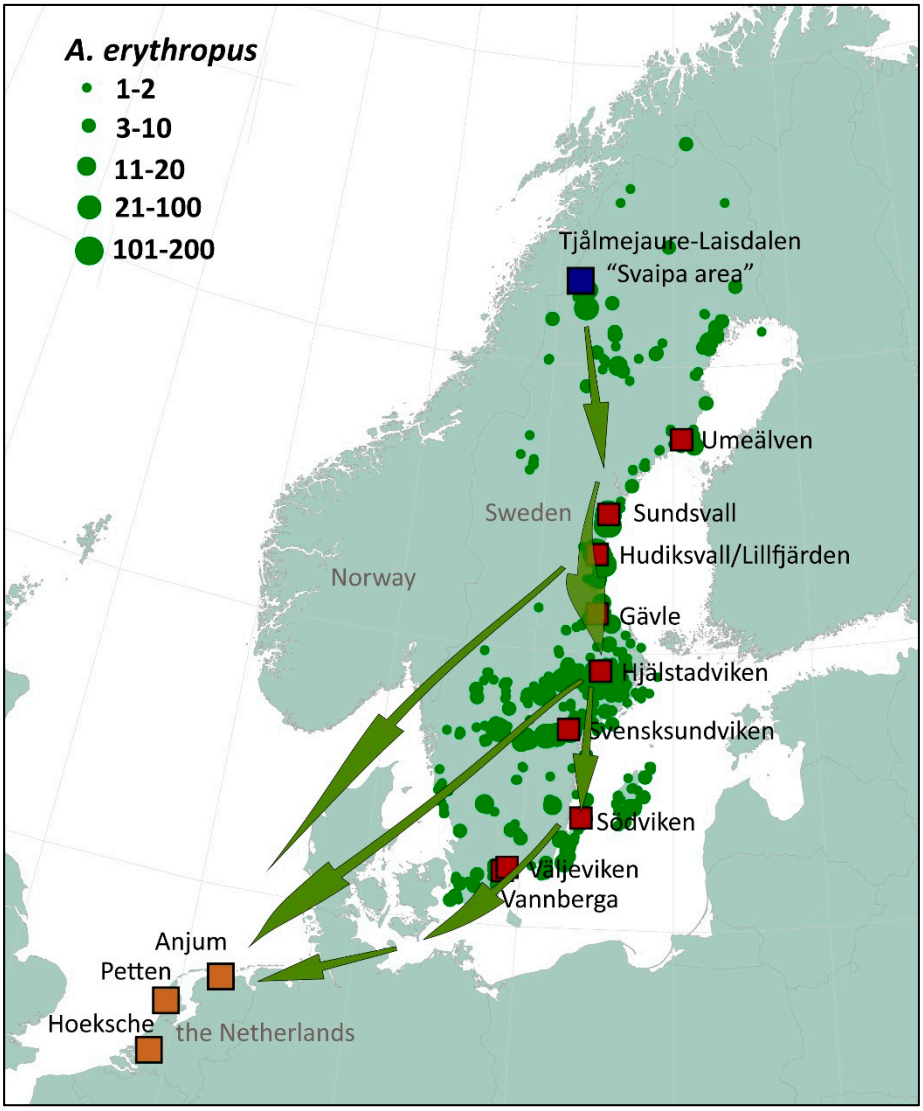


Figure 32. Presumed human modified migration routes by Lesser White-fronted Geese originating from the Swedish reintroduction project. Routes are after Andersson et al. (2004). The release area is shown as a blue square. Green dots represent all observations of "free-flying" birds from the Swedish Reporting System, for the years 2000-2016 (n=8370, data downloaded 24.10.2016). Red squares indicate sites where geese are regularly recorded. Brown squares indicate regular wintering sites in the Netherlands.

5.2.3 Wintering areas for the Swedish reintroduced population

Counts and observations of colour-ringed individuals revealed that the majority of Lesser White-fronted Geese that were released together with Barnacle Geese as foster parents flew to wintering areas in the Netherlands, which was the intention of releasing birds using this method (Koffijberg & van Winden 2013, von Essen 1991). Analyses of sightings of colour-rings after 1995-1996 when the coverage was better than the previous seasons, showed that 77 out of 92 colour-ringed individuals (84%) were seen at least once in the Netherlands (Koffijberg & van Winden 2013). When an annual (calculated) mortality rate of 7% was taken into account, this proportion was more than 90%, and in line with statements by Lambart von Essen and Åke Andersson, who estimated that up to 96% of the reintroduced Swedish birds were wintering in the Netherlands (Koffijberg et al. 2005).

However, following new releases since 2010, there has been an increasing tendency for birds to winter in countries other than in the Netherlands, including in Sweden (see **chapter 5.2.5**). Prior to 1981, and before any releases were made in Sweden or in Finland, there were only six records of Lesser White-fronted Geese in Sweden in December, with three records in January, and two records in February (data from the Swedish Reporting System, 2016).

5.2.4 Occurrence of released geese during the non-breeding season in Sweden and abroad

Since 2010, Lesser White-fronted Geese have been released in the Svaipa/Arjeplog area in Swedish Lapland without parent birds or foster parents. In addition, since 2013 birds have also been released around Hudiksvall without any parents/foster parents.

As discussed under section 3.4.1 these birds have not learned a migration route from their parents, and travel in different directions. Many of the birds have been subsequently recorded both in Sweden as well as in many other countries. A large number of these birds are reported via various national recording systems, and we have examined records available from within Sweden as well as several countries where Swedish-released Lesser White-fronted Geese are recorded.

In Sweden, most of the records following recent releases have been from around Hudiksvall, as well as from many other sites, in particular from around Hjälstadviken, near Enköping (Uppland) (Artportalen.se 2016). Hudiksvall is also where a large proportion of birds from previous releases (pre-2010) stage and moult. Monthly maxima for each month between January 2000 and December 2015 in Sweden are presented in **Figure 33**. Note that the report authors do not have access to data from the breeding areas and thus the true number of individual birds present in summer is higher than shown in the figure. Sweden is the only country from which we have not got access to complete datasets, even after several requests to the administrators of Artportalen.se.

As described in detail in **chapter 3.2** and 5.2.1, there are numerous reports of wintering Lesser White-fronted Geese from the Netherlands. Records from the Dutch online bird reporting system (Waarneming.nl) confirm the trend described in more detail in section 5.2.1. The Swedish Lesser White-fronted Goose population shows a decrease in total numbers wintering in the Netherlands despite the increase in numbers of birds released annually in Sweden since 2010 (**Figure 34**).

Most records of Lesser White-fronted Geese from Belgium are considered to be escapes from captivity (Waarmeningen.be and the Belgian Rare Birds Committee). All of the hitherto accepted records (n=15) of birds not considered to be escapes have involved single individuals, and all have been recorded after March 2009 (Waarnemingen.be). There are a number of records that are under consideration (n=20 records), all of these being since 2012. Most of these involve records of one or

two individuals, although there are also two records of a flock of four first-winter birds from January 2015. The four birds in January 2015 are undoubtedly the same group that was first seen in Norway and then later in the United Kingdom before they reached Belgium (see details later in this chapter).

There are a number of records of Lesser White-fronted Geese from Germany involving birds from post-2010 releases in Sweden. Although we have not obtained all potential data from Germany, some information is available on the website for the Germany birdwatching "Club 300" (2016). According to the records available from "Club 300", then there were at least two Lesser White-fronted Geese in Germany in winters 2011-2012, 2012-2013, and 2013-2014. In the following winter (2014-2015), no more than two Lesser White-fronted Geese were recorded at any one time. However, photographs posted on the same website show three different colour-ringed individuals during that same winter. During winter 2015-2016, only one Lesser White-fronted Goose was reported on the German Club 300 website. Photographs confirmed that this bird was not colour-ringed.

As records of Lesser White-fronted Geese are few and involve only 1-3 individuals, then it would seem that birds released in Sweden are not wintering in Germany. The Club 300 is a website designed with twitchers/listers in mind, i.e. the hard-core birdwatchers that seek to see as many species as possible, and the website acts to quickly spread information on rare birds. One would expect many more reports and possibly reports of more than just a couple of birds reported on any single day if they were commoner in the country. The fact that there are few records from Germany indicates that any birds missing in the Netherlands are probably not wintering in Germany, but may indeed have perished following release. This supposition of high mortality is also supported by the paucity of records from Belgium, where one also might predict that birds could winter in larger numbers.

Observations from Denmark show that in most winters few Lesser White-fronted geese are recorded with only singles or small flocks of up to 15 birds (**Figure 35**). However, in April 2010 a total of 67 were observed staging in Denmark (source Dansk Ornitologisk Forening's database, DOFbasen 2016).

There has recently been an increase in records of Lesser White-fronted Geese outside the breeding season from sites in Norway, other than the traditional staging areas for the wild Fennoscandian population in Finnmark County (**Figure 36**). These observations involve birds from the Swedish release project that commenced in 2010, and the origins of which are confirmed by observations of colour-ringed individuals or information from tracking of satellite-tagged individuals.

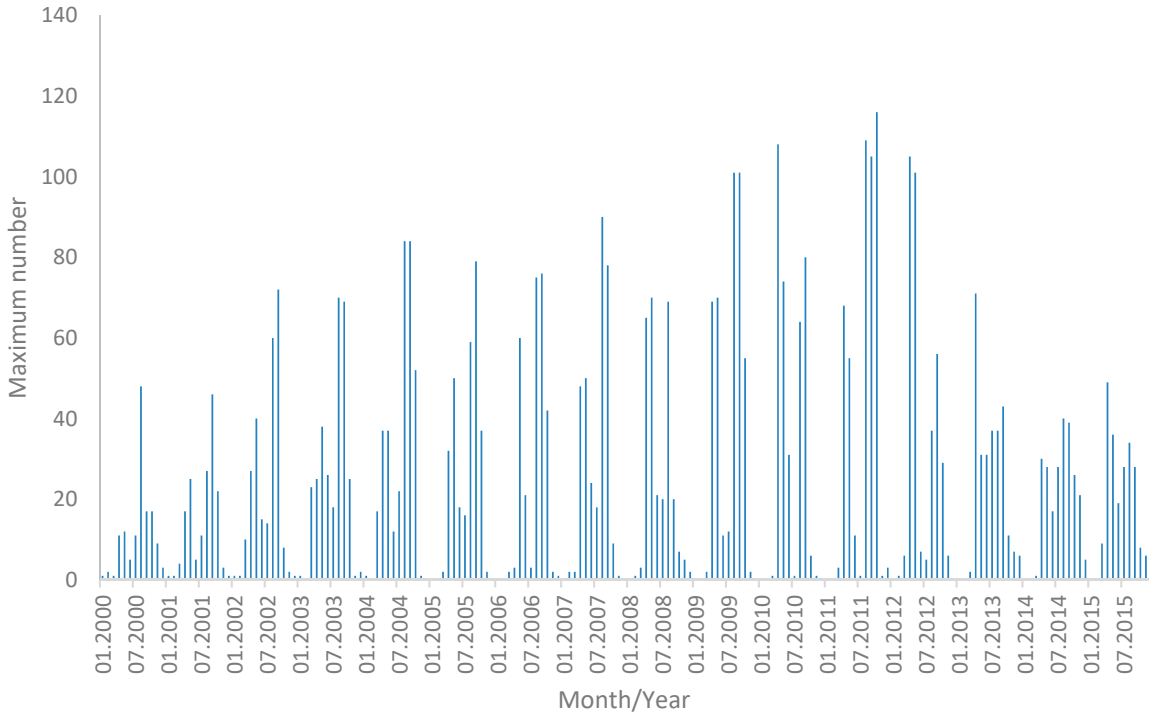


Figure 33. Monthly maxima of Lesser White-fronted Geese counted in Sweden in the period 2000-2015. Note that no counts are available during mid-summer when the geese are on the breeding grounds. Source: Artportalen.se 2016.

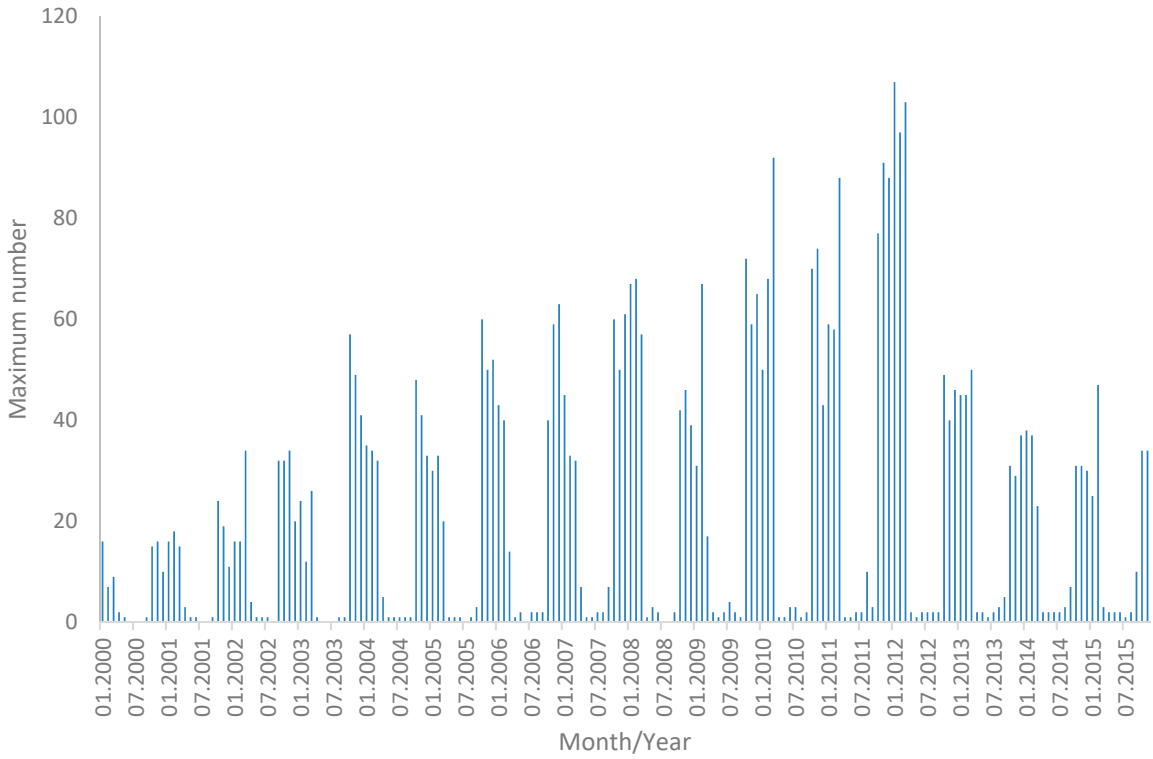


Figure 34. Monthly maxima of Lesser White-fronted Geese counted in the Netherlands in the period 2000-2015. Source Waarneming.nl 2016.

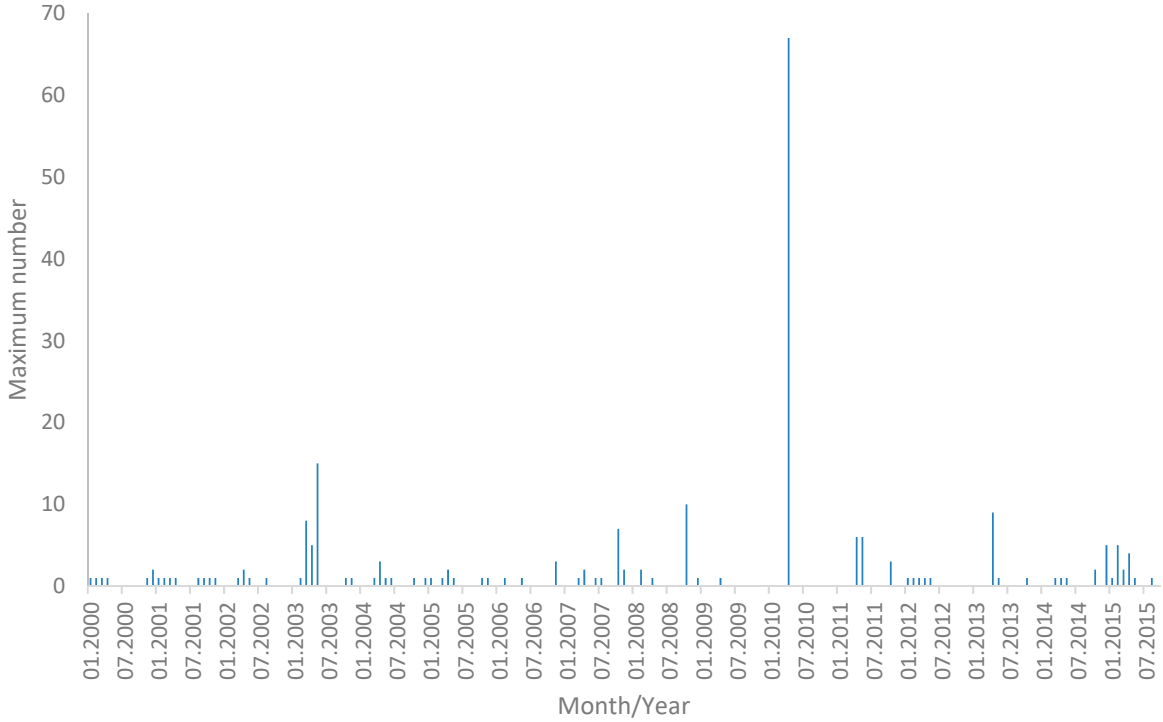


Figure 35. Monthly maxima Lesser White-fronted Geese counted in Denmark in the period 2000-2015. Source DOFbasen.dk 2016.

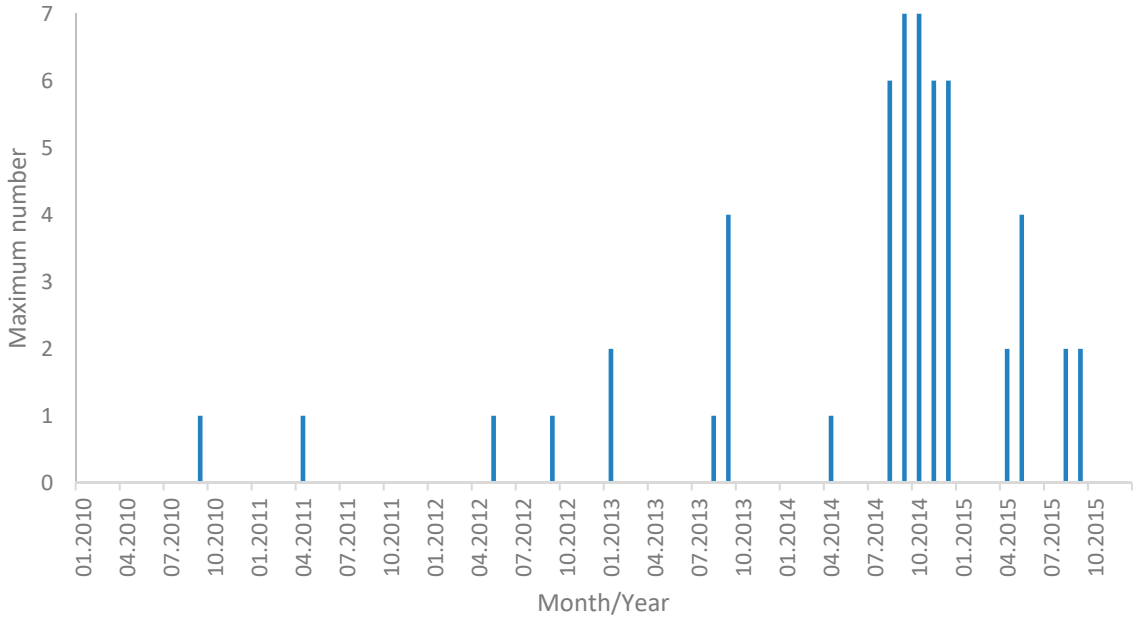


Figure 36. Monthly maxima of Swedish released Lesser White-fronted Geese recorded in Norway from 2010 onwards. Note that there are also records of birds from the previous release project pre-2010. Source: Artsobservasjoner.no 2016.

The Lesser White-fronted Goose is considered a rare vagrant in the United Kingdom (Owen et al. 1986, Parkin & Knox 2010, **chapter 3.2**). However, in the light of recent records of released birds from Sweden being recorded in the UK, it is becoming increasingly difficult to ascertain the true status of any birds observed. One Lesser White-fronted Goose that was equipped with a satellite transmitter in Sweden was tracked travelling westwards in late summer 2014, first flying to Norway where it was recorded at several sites, then to south-east England in late December. This individual was together with three other Lesser White-fronted Geese that were colour-ringed (Surfbirds 2016, BirdGuides 2016, German Geese Research 2016a), see **chapter 5.2.5** for further details on the movements and behaviour of this group. Finally, in early January 2015 the tagged bird was tracked to wintering grounds in Belgium although the flock had by that time split up (Rare Bird Alert 2016). A juvenile Lesser White-fronted Goose had been released in Sweden on 8th July 2015 which turned up in the Shetland Isles, Scotland on 7th October that year, and was last reported there on 5th December (Nature in Shetland 2016). Even more recently, two colour-ringed second calendar-year birds from the Swedish release project turned up in Orkney in March 2016 (Alan Leitch pers. comm.).

There were no records of Lesser White-fronted Geese from the Swedish release schemes being recorded in Hungary (David Bogyo pers. comm., Hungarian BirdWatcher's Site 2016) until 2015, when one colour-ringed individual was observed in Hortobágy National Park in company a flock from the wild Fennoscandian Lesser White-fronted Goose population on 30th September.

Two different colour-ringed birds from the Swedish release schemes have also been reported from Lithuania (Julius Morkūnas pers. comm.).

One Lesser White-fronted Goose (of unknown origin) was observed near Pärnu, Estonia on 27th March 2016, and presumably the same bird was observed near Polva on 1st April that year. Lesser White-fronted Geese from the wild Fennoscandian population have traditionally staged in Estonia, particularly in spring (Toming & Pynnönen 2009).

There are also a number of records from Poland of Lesser White-fronted Geese originating from recent releases in Sweden. One bird with a satellite transmitter that was released in Sweden was recorded at several sites in Poland during winter 2015-2016 (www.piskulka.net, www.blesgans.de, www.facebook.com/Birding Poland), and this same individual was also tracked to sites in Germany that same winter.

As can be seen from **Figures 33-35** above, there are large discrepancies between the number of Lesser White-fronted Geese that have been released between 2010 and 2015 and the number that are being reported as seen in the field. Despite the fact that more Lesser White-fronted Geese are being released each year in Sweden, numbers of birds observed in Sweden and the Netherlands have declined ever since. The decline in numbers is also apparent in the districts of Hälsingland and Uppland that are regularly used by Lesser White-fronted Geese (see **Figure 50**, **Figure 51** in **chapter 8.5**). There may be several possible explanations for this anomaly, and perhaps a combination of factors may be involved:

- Survival rates of the released individuals are very low and many birds quickly succumb soon after release.
- Geese are wintering in areas/countries for which we have no available data (e.g. Germany, Belgium).
- Observers are less willing to report Lesser White-fronted Geese seen in the field at present compared to for five years ago. This may be because these are not wild birds and thus are of less interest to many birdwatchers.

Today, there is now a small number of Lesser White-fronted Geese present throughout the year in the Netherlands, currently numbering at least 10 individuals (Koffijberg & van Winden 2013). Breeding has also been documented in recent years. In 2008, three pairs were breeding in the Netherlands, of which one involved a mixed pair of Lesser White-fronted Goose x Greylag Goose (Voslamber et al. 2010). The first breeding record is from 2002 (van den Jeugd et al. 2006). These are most likely of feral (Dutch park) origin and some of these have avicultural leg-rings. In addition, the sites where these feral individuals occur are outside the main places where Swedish Lesser White-fronted Geese tend to be recorded (Kees Koffijberg pers. comm.).

A classic example of how rapidly a small population of geese newly established in an area outside its natural range, and how it can increase to a very large population is the development of a breeding population of Barnacle Geese in the Baltic Region. In 1971, one pair bred on a group of small islands east of Gotland, and the population increased, reaching 450 breeding pairs in 1985, just 15 seasons later (Larsson et. al. 1988). In addition to the breeding adults, there were also large numbers of non-breeding individuals. The population continued to increase, and the numbers in Gotland alone numbered around 4,390 breeding pairs in 2005 (Feige et al. 2008). In addition, there are many thousands of pairs of Barnacle Geese breeding in other states around the Baltic Sea, and the total Russian/Baltic/North Sea population was in 2009 estimated to be 770,000 individuals (Fox et al. 2010).

The development of the breeding population of Barnacle Geese on Gotland and elsewhere in the Baltic region and its rapid increase illustrates just how easily goose populations can increase if remained uncontrolled. There is already one published record of a pair of Lesser White-fronted Goose that bred on the Swedish coast in Medelpad in 2006, producing two goslings, both of which survived to fledging. One of the birds in the pair was colour-ringed and had been previously seen in the Swedish mountains (Allberg & Marklund 2006). Despite the fact that one of the individuals in this pair was colour-ringed and probably from the Swedish release project, Kampe-Persson (2010) stated that there was no known link between these birds and the Swedish *Projekt Fjällgås.* However, the author does not elaborate on this statement, nor as to where the birds might have originated if they were not released in Sweden.

Whether or not Lesser White-fronted Geese could colonise islands along the Swedish coast in the same way as Barnacle Geese have done in the Baltic is a matter of conjecture. Nonetheless, this could have profound consequences if the birds should start to breed in new areas well away from traditional sites and at latitudes outside the species' natural range.

5.2.5 Establishment of a wintering population in southern Sweden

Since 2010, Lesser White-fronted Geese have been released in the Svaipa/Arjeplog area in Swedish Lapland without parent birds or foster parents. In addition, birds have also been released around Hudiksvall without any parents/foster parents since 2013.

Since 2010, there has been a marked and significant increase in numbers recorded during winter in Sweden, with a maximum of 21 wintering birds in 2014-2015 (**Figure 37**). Normally, Lesser White-fronted Geese have left Sweden in September or October at latest. Birds begin to return again in spring in March, which is considerably earlier than for the wild Fennoscandian population, which return to the staging areas in Norway in May. The main difference between the two periods 1900-1980 and 2000-2016 (**Figure 38**) is that all records before 1980 were single vagrants (1-2 ind). There is only one record with more than two individuals, when four birds were recorded in 1966 within a flock of 650-700 Bean Geese.

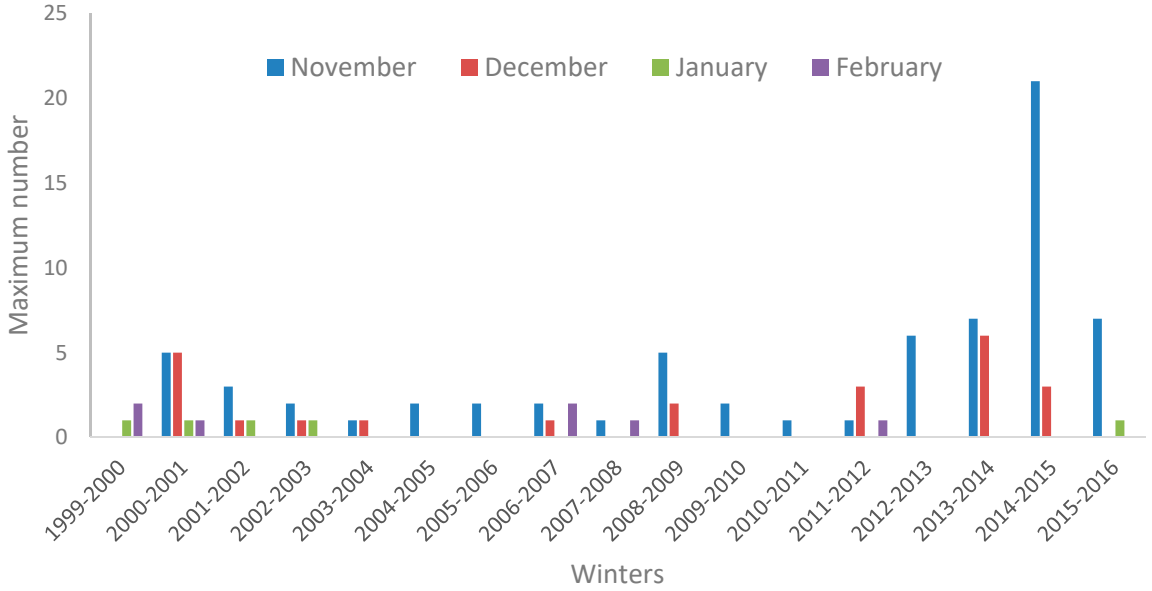


Figure 37. Wintering of Lesser White-fronted Geese in Sweden shown as maximum counts each month between November to February for the years 2000-2016. Data from the Swedish Species Reporting System (2016).

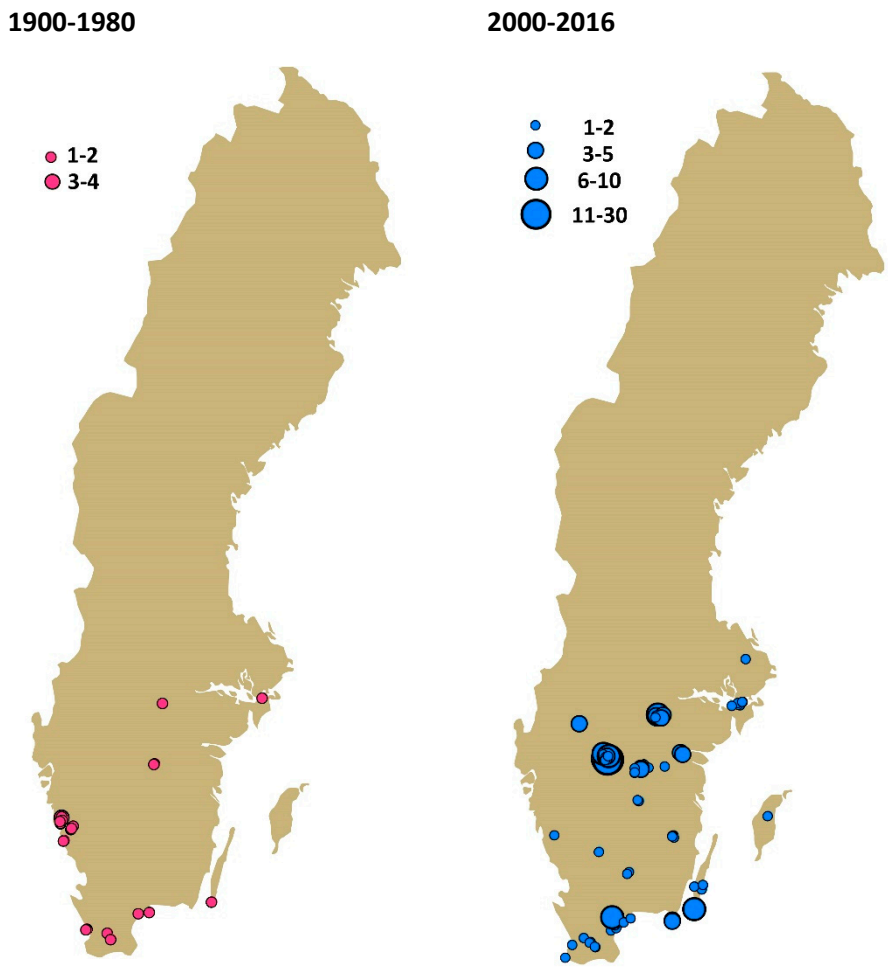


Figure 38. All open access records of wintering (November to February) Lesser White-fronted Geese in Sweden in the years 2000-2016 (n=189) and years 1900-1980 (n=50, pre reintroduction projects) registered in the Swedish Species Reporting System (data downloaded 24.10.2016).

Releasing large numbers of goslings and one year old birds with no knowledge of where to migrate will necessarily lead to a situation that birds will never leave Sweden. The establishment of regular wintering of Lesser White-fronted Goose in southern Sweden does have serious implications, as the southern parts have the most heavily hunted goose areas in Sweden. In Norway, the environmental authorities established a non-hunting zone for geese totalling an area of 38,000 square kilometres in Finnmark County. This was done to protect the Lesser White-fronted Goose as well as the dwindling population of Taiga Bean Goose from accidental shooting. By 2016 this non-hunting zone is still active, so hunting of Greylag Goose can only occur on the outer coastal areas of the county. There are no such large-scale hunting restrictions in place in southern Sweden, but will be necessary as an increasing part of their reintroduced population winters there. Lesser White-fronted Geese are regularly shot during legal hunting, with the latest known incidence as recent as 23rd August 2016 in Vesterålen, Norway (Norwegian Bird Ringing Central in letter, ref. 2016-01035).

5.2.6 Status of hybrids between Lesser White-fronted Goose and Barnacle Goose

The free-flying population in Sweden includes not only birds looking like text-book individuals of Lesser White-fronted Geese (which are themselves of mixed species genetic background), but also a number of hybrids between Lesser White-fronted Geese and Barnacle Geese that were used as foster parents in the period 1980-1999. When population estimates are given, neither Koffijbeg & van Windem (2013) nor any of the annual reports by the reintroduction project *Projekt fjällgås* (Andersson & Holmqvist 2011, Liljebäck et al. 2012, 2013) take into account the number of Lesser White-fronted Goose x Barnacle Goose hybrids which also belong to the Swedish free-flying population. Numbers on these are hard to obtain, but are reported occasionally in the Swedish Reporting System (2016) and in the annual reports by SOF/BirdLife Sweden (cf. Strid & Eriksson 2012, Strid & Wærn 2010, 2011). Hybrids are most likely underreported[3] since most ornithologists do not bother to report observations of hybrid birds, especially when they are controversial or of captive origin, as is the case with the free-flying Swedish reintroduced birds. At least five Lesser White-fronted Goose males are known to have paired up with Barnacle Goose females, and 1-4 broods have been observed annually since 2000 (maksimum of 4 broods in 2004). A maximum of 19 individual hybrids were recorded in 2009. Since these are an effect of the releases undertaken in Sweden they should be recognised as part of that population and for the years 2004-2015 they constitute on average 14.6% of the Swedish population (data from the period 2004-2014, **Figure 39**, **Figure 40**).

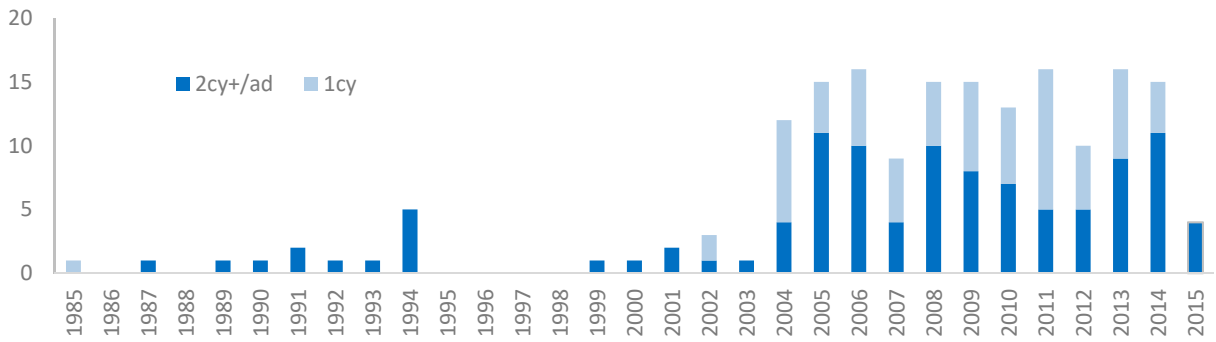


Figure 39. Minimum number of hybrid Barnacle Goose x Lesser White-fronted Goose individuals observed annually in Sweden in the years 1985–2015. The number of birds in 2015 is an absolute minimum as local journals and the Swedish magazine Fågelåret has yet to be published with validated data from 2015.

[3] Data prior to 2001 are probably underrepresented since the Swedish Reporting System for birds did not go online until autumn 2000.

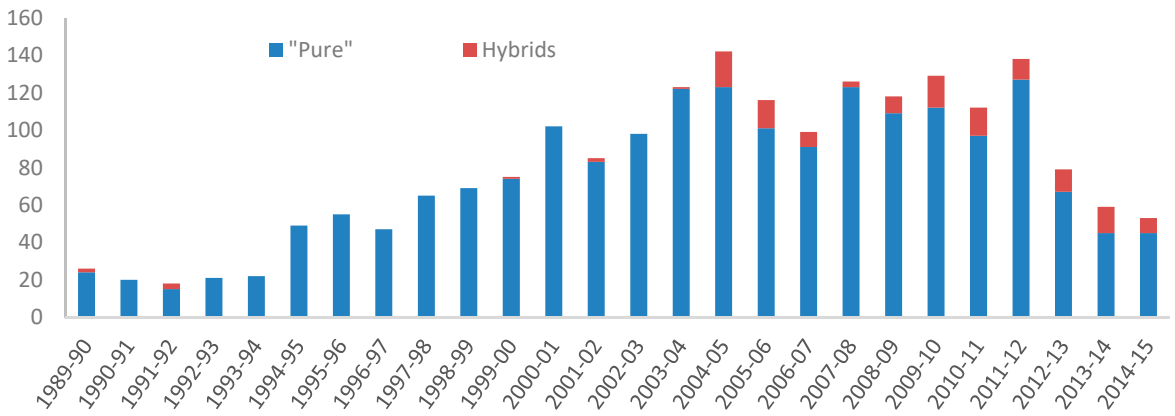


Figure 40. Population trend for the Swedish reintroduced free-flying population. It is estimated as peak number during winter in the Netherlands and total number of hybrids the preceding summer and autumn in Sweden (data from the Swedish Reporting System, Koffijberg & van Winden 2013, as well as annual reports in the magazine *Fågelåret*). "Pure" = Swedish free-flying reintroduced population, hybrids = Lesser White-fronted Goose x Barnacle Goose.

The hybridisation issue with the Barnacle Goose (foster parent species) dates back to at least 1999, when the project recorded their first hybrid breeding at Öster-Malma, when a three-year-old male Lesser White-fronted Goose that staged at Öster-Malma chose to stay, and paired up with an older female Barnacle Goose (von Essen 1999b). The clutch hatched, and the goslings were subsequently killed and sent to the Zoological Museum in Stockholm for documentation (**Figure 41**). However, Kampe-Persson & Lerner (2007) & Kampe-Persson (2010) documented hybrids between Lesser White-fronted and Barnacle Geese as early as in 1985 in Stockholm, several years before the hybrids reported from Öster-Malma in 1999. In addition, von Essen (1989) described a recovery of a Lesser White-fronted Goose that was released in 1982 which was found as dead in August 1985 on Novaya Zemlya in Russia. He believed that the individual had been imprinted on a Barnacle Goose and followed that species from the Netherlands to its breeding area in Russia. He further notes that hybridisation should not be a big problem in the reintroduced population and further refers to work by E. Fabricius (1983) who used Canada Goose as foster parents for Greylag Geese and found that 26% of male Greylag Geese later paired with female Canada Geese, while none of the Greylag Goose females paired with Canada Goose males.

Many of the hybrids that still occur in a "wild" state are from the former release project in Sweden between 1980 and 1999. Hybrids between these two species continue to appear and are observed both in the breeding areas, at staging sites as well as in the wintering grounds (**Figure 42**).

Hybrid pairs have continued to produce offspring since the first record of a hybrid pair between these two species in 1985. Since 2004 there have been annual records of 1-2 broods and possibly as many as 5 broods in 2004.

The maximum number of hybrid Lesser White-fronted x Barnacle Geese recorded in one month was in 2004 with 19 individuals, but also as late as in 2013 as many as 14 individuals were reported. However, not all areas where these birds may occur are checked on the same date, so the true numbers may be higher than data in **Figure 39**, **Figure 40** and **Figure 42** suggest. According to Liljebäck & Larsson (2015), there were between 6 and 10 individual hybrid Lesser White-fronted

Goose x Barnacle Goose in 2014. Up to six individual hybrids were observed at one time in the Netherlands in the first half of the year (i.e. late winter 2013-2014), whereas up to six were recorded in Sweden later in 2014 (between October and December). According to the Swedish Species Observation System (Artportalen) then there were in fact at least 11 hybrids present in 2014 (**Figure 39**).

According to a recent report from *Projekt Fjällgås* (Liljebäck & Larsson 2015) which summarises results from 2014, then first generation hybrids between Lesser White-fronted Geese and Barnacle Geese have been reported more or less annually in Sweden since 2002. Liljebäck & Larsson (2015) state that "*There has been no verified observations of second-generation hybrids".* This statement is both erroneous and misleading, as Kampe-Persson & Lerner (2007) report second-generation hybrids might have been produced and this has since been confirmed by Strid & Wærn (2011) (see **chapter 5.2.6**). The number of second-generation hybrids is low, but in recent years, there has still been a significant number of first-generation hybrids in circulation. According to Liljebäck et al. (2014) there were an estimated 6-10 individuals in 2014, but also this is found to be an underestimate as at least 15 hybrids were in circulation in Sweden, of which two broods of one and four goslings respectively.

Figure 41. Hybrid Barnacle Goose x Lesser White-fronted Goose offspring (1st calendar year, collected 14.09.1999) from the Swedish reintroduction project at Öster-Malma, deposited at the Zoological Museum in Stockholm, Sweden (Leg. A 996394). Photo: Tomas Aarvak.

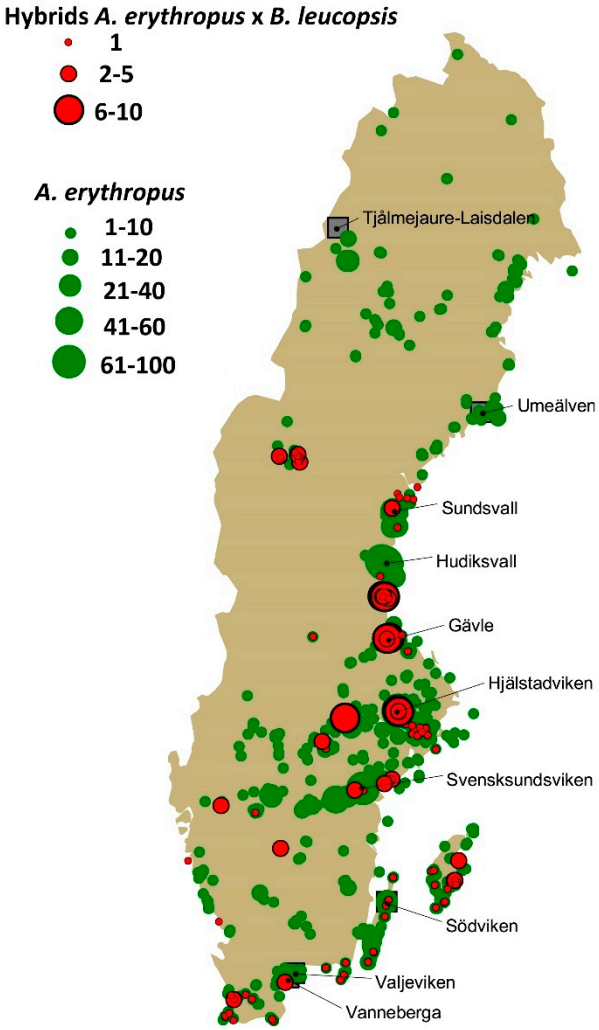


Figure 42. Distribution of hybrid Lesser White-fronted x Barnacle Goose hybrids in Sweden and observations of individuals registered as Lesser White-fronted Goose, of which the majority are birds originating from the reintroduction program that started with releases in 1981. Open access data from the Swedish Reporting System for the years 2001-2016 (data downloaded 24.10.2016).

First generation hybrid *A.erythropus* x *B. leucopsis*, Turku, Finland, 27 May 2008- Photo: Kalle Rainio/ Tarsiger.com. Additionally, second-generation hybrids have been found in Sweden.

5.2.7 The association of released geese with other waterfowl species

There are numerous records from countries where Lesser White-fronted Geese released in Sweden since 2010 have turned up where they have been reported associating with other goose species or other *Anatidae* species (**Table 3**). Such associations are recorded both for single individuals as well as for small groups of Lesser White-fronted Geese. We have here summarised information received from the various national rarities committees as well as from other internet sources. These records refer to birds known to have originated from releases in Sweden, as they are either colour-ringed and/or tagged with satellite transmitters.

Most of the winter records of Lesser White-fronted Geese are from the Netherlands, which is a natural consequence of the effort to direct the migratory route to new wintering grounds in the 1980s and 1990s. Lesser White-fronted Geese have been recorded together with a long list of goose species in the Netherlands, as follows: Greylag, Greater White-fronted, Tundra Bean, Snow, Canada, Barnacle, Brent, and Red-breasted Geese. There are very few records of Pink-footed Geese together with Lesser White-fronted Geese. In neighbouring Belgium, Lesser White-fronted Geese have been recorded associating with Greylag, Greater White-fronted, Pink-footed and Barnacle Geese.

Records from Germany during the past five years have involved Lesser White-fronted Geese associating with Greater White-fronted, Tundra Bean, Barnacle and Canada Geese, as well as with Common Shelducks *Tadorna tadorna* present in a mixed species flock.

Almost all of the records in Norway of Lesser White-fronted Geese originating from releases in Sweden from 2010 onwards have been in the company of Greylag Geese, although there are also records of Swedish Lesser White-fronted Geese associating with Pink-footed and Bean Geese in Norway.

From Denmark, there are records of Swedish-released Lesser White-fronted Geese associating with both Greylag, Greater White-fronted, Bean, Pink-footed, and Barnacle Geese. These individuals has also been recorded together with Egyptian Geese *Alopochen aegyptiaca*.

There have been recent records of Swedish-released Lesser White-fronted Geese turning up in the United Kingdom, as well as older records of Lesser White-fronted Geese from previous release programmes. One flock of four Lesser White-fronted Geese arrived in Suffolk in England at the end of 2014, having spent the previous three and a half months in western Norway. This flock associated with Greylag Geese whilst in Norway, whereas they were seen in the company of Greater White-fronted Geese in Suffolk, England. After having spent a few days in Suffolk, the birds flew onwards to Belgium in early January 2015 (see **chapter 5.2.4**), where they associated with both Greater White-fronted and Pink-footed Geese. A juvenile Lesser White-fronted Goose arrived in the Shetland Isles, Scotland on 7th October 2015. This bird was colour-ringed, and had been released in Sweden the same year. The bird remained in Shetland at least until 5th December 2015. Having arrived alone, it was later reported associating with Pink-footed Geese (Nature in Shetland 2016). Two colour-ringed birds were recorded in Orkney, Scotland in February 2016 (Alan Leitch pers. comm.).

Even in the country of release (Sweden), Lesser White-fronted Geese are frequently observed associating with other goose species. This includes the following: Greylag, Greater White-fronted, Bean, Pink-footed, Barnacle, Brent and Canada Geese, as well as in the company of Whooper Swans *Cygnus cygnus*.

As described in detail in **chapter 4.6** in this report, since 2010 Lesser White-fronted Geese have been released in Sweden without their parents. The idea has been to imprint these birds onto adults with

young in the mountains of Swedish Lapland (World Association of Zoos and Aquariums 2016). However, **chapter 3.2.2**. explains at length why it is very unlikely that these goslings would ever become imprinted on the free-flying population in the Swedish mountains. Rather than becoming imprinted on their own species, these Lesser White-fronted Geese attach themselves to flocks of other species. This is a typical behaviour for lone vagrant geese, regardless of species or their origin (captive or wild).

The risk of hybridising is considerable, particularly as there is a disproportionate sex ratio in the birds released in Sweden (predominantly males, see **chapter 5.7**), as well as the fact that there are a number of lone individuals circulating among flocks of other goose species throughout Europe. Such lone individuals are quite likely to migrate with their adopted goose flock and may never come in contact with any conspecifics. Although perhaps not exhaustive, Reeber (2015) and McCarthy (2006) lists the following species as hybridising with Lesser White-fronted Geese: Greater White-fronted, Snow, Barnacle, Red-breasted, Bar-headed, Canada, Cackling (described as probable), as well as possible hybrids with Ross's and Emperor Goose. In captivity, further hybrids are reported between Lesser White-fronted Geese and Greylag, as well as with Brent Goose (Horsbrugh 1910).

The risk of Swedish-released Lesser White-fronted Geese spreading to new areas in both Norway and elsewhere in Fennoscandia is great, especially when Lesser White-fronted Geese readily attach themselves to flocks of Greylag Geese, as described in the national summaries above. Greylag Goose is a widespread breeding bird species found over much of Fennoscandia, particularly in Norway and Sweden. This risk is a real one, as illustrated by the presence of Swedish Lesser White-fronted Geese in Greylag Goose flocks in Norway. The Lesser White-fronted Geese from the Swedish release project that was shot at the staging site for the Fennoscandian birds (Valdak Marshes in Finnmark) in May 2015 arrived with, and associated with, Greylag Geese.

Table 3. Summary table over waterfowl species with which Lesser White-fronted Geese released in Sweden from 2010 onwards have been observed associating with, and the countries where these species associations have been recorded.

Association with species/country	NL	BE	D	NO	DK	SWE	UK
Whooper Swan						X	
Greylag Goose	X	X		X	X	X	X
Greater White-fronted Goose	X	X	X		X	X	X
Tundra Bean Goose	X	X	X		X	X	
unspecified Bean Goose				X		X	
Pink-footed Goose	X			X	X	X	X
Snow Goose	X						
Canada Goose	X		X			X	
Barnacle Goose	X	X	X		X	X	
Brent Goose	X					X	
Red-breasted Goose	X						
Common Shelduck			X				
Egyptian Goose					X		

5.2.8 Site connectivity between reintroduced Swedish - and the wild Fennoscandian population

Many of the Lesser White-fronted Geese released in Sweden have been marked with individually identifiable coloured leg rings, allowing recognition of birds in the field. Reports of colour-ringed individuals allow us to build up a picture of some of the movements of Lesser White-fronted Geese from release programmes. Lesser White-fronted Geese released in Sweden since 2010 have been observed at several sites which are also utilised by, or have previously been utilised by, Lesser White-fronted Geese from the Fennoscandian population. A summary of known available records of colour-ringed individuals from releases in Sweden that have either been observed in Norway on at least one occasion or have been reported from sites known to be used by the Fennoscandian Lesser White-fronted Goose population is presented in **Table 4**. As can be seen, there are many records of Swedish Lesser White-fronted Geese in Norway, although not all ring codes have been read in full. In addition, some of the geese released in Sweden have satellite tags mounted on their backs. A limited amount of information is available as to the whereabouts of the Swedish Lesser White-fronted Geese. Although the intention was for the observations to be available online, many of the historical records of satellite tagged geese have been removed from the *Project Fjällgås* website. We do, however, have some information from screen grabs from the earlier movements of tagged birds. The addition of records of tagged individuals allows us to build up a better picture of the movements of the Lesser White-fronted Geese released in Sweden, and supplements the observations of ringed individuals presented in **Table 4**.

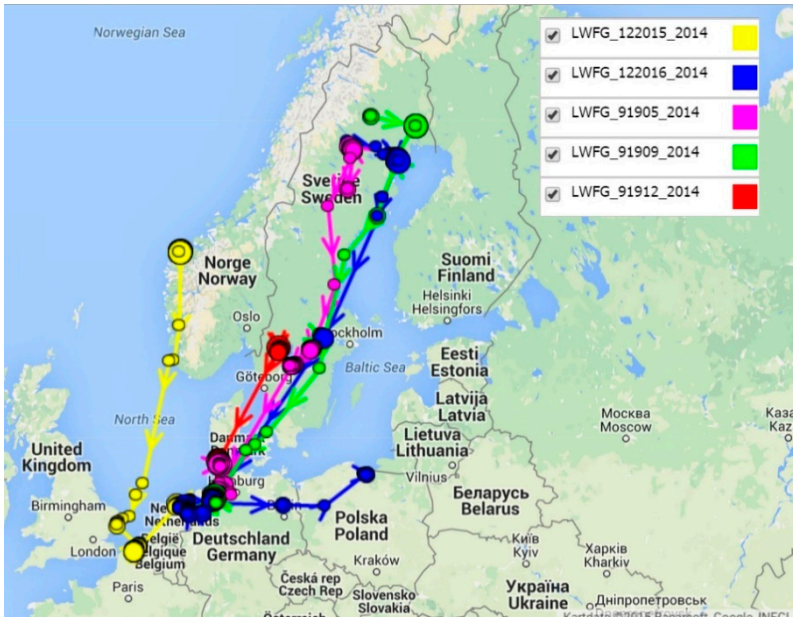


Figure 43. Movements of five Lesser White-fronted Geese equipped with satellite transmitters and released in Sweden. Screen grab from www.blesgans.de 10.05.2015.

Lesser White-fronted Geese from the Swedish release project have been recorded at the following sites which are also are important functional areas for the Fennoscandian Lesser White-fronted Goose population:

Valdak Marshes, Norway: the most important spring and autumn staging sites for Fennoscandian Lesser White-fronted Geese. Ringed birds from the current Swedish release programme have been recorded in both spring and autumn 2015. The individual recorded in spring was shot a few days after it first appeared in order to prevent it entering the Fennoscandian population. The individual recorded in autumn 2015 turned up a few weeks later on the wintering grounds in Hungary (see next page).

Nemunas Delta, Lithuania: Fennoscandian Lesser White-fronted Geese have been recorded incidentally at Nemunas (Šilute district) during the spring migration period. The first record was of a satellite-tagged male dubbed "Finn" which was recorded as having utilised the Nemunas Delta between 22nd and 24th April 2007, after which it lost its transmitter, but was still alive based upon later observations (Kaartinen et al. 2009). In recent years, colour-ringed birds from the Swedish release programme have been recorded at Nemunas Delta in spring, with at least three ringed individuals recorded there in 2014, and one ringed individual in spring 2015 (Julius Morkūnas pers. comm.)

A Swedish released bird was feeding together with Greater White-fronted and Barnacle Geese at Rupkalviai pastures, Nemunas delta. Lithuania on 19th April 2015. Photo: Boris Belchev.

Hortobágy national park, Hungary: During winter 2015-2016, a colour-ringed Lesser White-fronted Goose ("White 3") which had been released in Sweden 01.08.2014, was observed 30th September 2015 together with Fennoscandian Lesser White-fronted Geese at Hortobágy, Hungary. This same ringed individual has been observed at several sites (**Table 4**).

Poland: Poland is situated along the flyway for Lesser White-fronted Geese moving between the wintering grounds and spring-staging sites. This is confirmed by a direct observation of a satellite-tagged bird ("Finn") observed flying northwards over north-east Poland on 18th April 2007 (the same bird was later recorded in the Numenas Delta, Lithuania). During winter 2015-2016 one satellite-tagged Lesser White-fronted Goose from the Swedish release programme has wandered around Poland and sites in eastern Germany (http://jagareforbundet.se/projekt-fjallgas/folj-fjallgassen-med-satellit/).

That Lesser White-fronted Geese originating from Swedish releases have been observed at the natural staging sites used by Fennoscandian Lesser White-fronted Geese illustrates just how potentially easy it is for Swedish birds to enter into the Fennoscandian population. Lone geese will often try to tag along with other geese, although not necessarily of their own species. In the case of Lesser White-fronted Geese, there are four regular carrier species for presumed original wild birds, namely Greylag Goose, Greater White-fronted Goose, Bean Goose and Red-breasted Goose. In addition, Lesser White-fronted Geese released in Sweden have been imprinted on Barnacle Geese, the species used as foster parents during earlier releases. Many of the recent sightings of Swedish released Lesser White-fronted Geese in Norway (and other countries) have been in the company of Greylag Geese. At the time of writing the origins of the Greylag Geese that the Lesser White-fronted Geese are associating with is unclear. However, as the Netherlands are important wintering areas for Nordic Greylag Geese (Nilsson et al. 1999) then it is highly probable that Lesser White-fronted Geese also follow Greylag Geese to the Netherlands, or follow these back to Scandinavia in spring.

Table 4. Summary of observations of Lesser White-fronted Geese released in Sweden since 2010 and which have later been observed at sites in Norway and/or sites known to fulfil a function for the Fennoscandian population of Lesser White-fronted Goose. BE=Belgium, DE=Germany, HU=Hungary, NL=the Netherlands, SE=Sweden, NO=Norway. # = numbers of Lesser White-fronted Geese present. Individuals where the code or colour of ring were not recorded are marked a question mark (?) followed by roman numerals (I,II, III or IV) for those known to be unique individuals.

Bird ID				Date						
colour	Inscr.	bird no.	Satellite transm.	Start	End	Place name	Region	Country	# ind.	Associates/ carrier species
black	S		122014	08.08.2014	12.08.2014	islets west of Blomsøya	Alstahaug	NO		
black	S		122014	17.08.2014	19.08.2014	Stokkøya	Bjugn	NO		
black	S		122014	20.08.2014	22.08.2014	Skjørøya	Bjugn	NO		
black	S		122014	23.08.2014	26.08.2014	several sites Hareid	Hareid	NO		
black	S		122014	28.08.2014	21.12.2014	Makkevika	Giske	NO	6	
black	S		122014	28.08.2014	21.12.2014	Makkevika	Giske	NO	6	
black	S		122014	10.01.2015	10.01.2015	Stalhille - Weiden	(WSH) [WV]	BE		
black	S		122014	11.01.2015	11.01.2015	Stalhille - Weiden	(WSH) [WV]	BE		
black	S		122014	27.01.2015	27.01.2015	IJzervallei - Rillebroeken Woumen		BE		
black	?	I	91912	19.08.2014	21.08.2014	Fugletårnet, Verdal	Nord-Trøndelag	NO	3	Greylags
black	?	I	91912	21.08.2014	24.08.2014	Alnesfjæra, Levanger	Nord-Trøndelag	NO	3	
black	?	I	91912	27.08.2014		Värmlandsnäs, Säffle		SE	4	
black	?	I	91912	16.12.2014	16.12.2014		Schleswig-Holstein	DE	3	
black	?	I	91912	15.05.2015	18.05.2015	several sites	Oslo og Akershus	NO	1	
black	?	I	91912	16.10.2015	26.10.2015	several sites	Kvismaren/ Örebro	SE	?	
white	3		none	21.01.2011				NL		
white	3		none	30.01.2011				NL		
white	3		none	25.08.2011	25.08.2011	Hudiksvall		SE		
white	3		none	21.01.2012				NL		
white	3		none	27.03.2013	02.04.2013	Alblasserdam, polder Blokweer		NL		
white	3		none	31.12.2015	01.01.2015	Minsmere & North Warren	Suffolk	GB	4	
white	3		none	10.01.2015	10.01.2015	Stalhille - Weiden	(WSH) [WV]	BE		
white	3		none	11.01.2015	11.01.2015	Stalhille - Weiden	(WSH) [WV]	BE		
white	3		none	27.01.2015	27.01.2015	IJzervallei - Rillebroeken Woumen	[WV]	BE		
white	3		none	23.08.2015	09.09.2015	Valdakmyra, Porsanger	Finnmark	NO		Lesser White-fronts
white	3		none	30.09.2015		Hortobagy		HU		Lesser White-fronts
black	K			28.08.2014	21.12.2014	Makkevika, Giske	Møre og Romsdal	NO	6	
black	K			31.12.2015	01.01.2015	Minsmere & North Warren	Suffolk	GB	4	
black	K			10.01.2015	10.01.2015	Stalhille - Weiden	(WSH) [WV]	BE		
black	K			11.01.2015	11.01.2015	Stalhille - Weiden	(WSH) [WV]	BE		
black	K			27.01.2015	27.01.2015	IJzervallei - Rillebroeken Woumen	[WV]	BE		
white	S		yes	28.08.2014	21.12.2014	Makkevika	Giske	NO	6	
white	S		yes	10.01.2015	10.01.2015	Stalhille - Weiden	(WSH) [WV]	BE		
white	S		yes	11.01.2015	11.01.2015	Stalhille - Weiden	(WSH) [WV]	BE		

white	S		yes	27.01.2015	27.01.2015	IJzervallei - Rillebroeken Woumen	[WV]	BE		
blue	P			04.09.2013	17.09.2013	Gaulosen, Melhus	Sør-Trøndelag	NO	1	Greylags
blue	P			16.04.2014	26.04.2014	Ergavatnet, Klepp	Rogaland	NO	1	
blue	P			30.01.2015	30.01.2015	Wallach, Kr. Wesel		DE		
blue	P			18.02.2015	18.02.2015	Wesel Wea. Aue		DE		
blue	P			11.04.2015	12.04.2015	Leka	Nord-Trøndelag	NO	1	Greylags
blue	P			11.05.2015	14.05.2015	Valdakmyra, Porsanger	Finnmark	NO	1	Greylags
black	U			06.09.2014	08.09.2014	Karstø, Tysvær	Rogaland	NO	1	
black	8			09.10.2014	12.10.2014	Kråka, Ørland	Sør-Trøndelag	NO	1	
white	8			05.12.2014	05.12.2014	Hooge, Nordfriesland		DE		
white	8			19.04.2015	19.04.2015	Grandefjæra, Ørland	Sør-Trøndelag	NO	1	
white	8			23.04.2015	23.04.2015	Falstadbukta, Levanger	Nord-Trøndelag	NO	1	
white	8			30.04.2005	02.05.2005	Tautra, Frosta	Nord-Trøndelag	NO	1	Greylags
yellow	K			31.05.2015	31.05.2015	Engasjyen, Rana	Nordland	NO		
yellow	K			09.07.2015	09.07.2015	Hudiksvall		SE		
yellow	K			23.11.2015	23.11.2015	Waverveen, Waverhoek		NL		
black	?	I		19.08.2014	21.08.2014	Fugeltårnet, Verdal	Nord-Trøndelag	NO	3	Greylags
black	?	I		21.08.2014	24.08.2014	Alnesfjæra, Levanger	Nord-Trøndelag	NO	3	
black	?	I		19.08.2014	21.08.2014	Fugeltårnet, Verdal	Nord-Trøndelag	NO	3	Greylags
black	?	I		21.08.2014	24.08.2014	Alnesfjæra, Levanger	Nord-Trøndelag	NO	3	
black	3			31.12.2015	01.01.2015	Minsmere & North Warren	Suffolk	GB	4	
black	6			16.09.2013	19.09.2013	Kvismaren		SE		
black	6			28.08.2014	21.12.2014	Makkevika, Giske	Møre og Romsdal	NO	6	
black	6			29.09.2015	29.09.2015	Karlsholmviken	Uppland	SE		
?	?	I		28.08.2014	21.12.2014	Makkevika, Giske	Møre og Romsdal	NO	6	
?	?	I		28.08.2014	21.12.2014	Makkevika, Giske	Møre og Romsdal	NO	6	
white	?	I		10.04.2015	10.04.2015	Espern, Åkersvika, Hamar	Hedmark	NO	2	pink-footed
yellow	?	I		10.04.2015	10.04.2015	Espern, Åkersvika, Hamar	Hedmark	NO	2	pink-footed
?	?	I		27.05.2015	31.05.2015	Storeidvatnet, Vestvågøy	Nordland	NO		pink-footed
white	?	I		30.08.2015	30.08.2015	Storleiret, Frosta	Nord-Trøndelag	NO	1	
black	?	IV		13.09.2015	13.09.2015	Gjølsjøen, Marker	Østfold	NO	1	Greylags

5.3 Is the Swedish population reintroduced or supplemented?

An investigation into historical records of Lesser White-fronted Geese within the original range of the Fennoscandian population was presented by Andersson & Holmqvist (2010). Here the authors presented records of Lesser White-fronted Geese within the area where the geese were released in Swedish Lapland between 1981 and 1999.

Based on 23 records of birds from the original population in, or close to, breeding habitat within a distance of 50 km from the release localities they conclude that the releases into the area were a supplementation of the existing Fennoscandian Lesser White-fronted Goose population rather than a reintroduction: "*The large number of observations of birds from the Fennoscandian population proves that the release of goslings in the actual area was a supplementation of a small but extant population and not a re-introduction*". This statement is not a valid scientific conclusion, but rather a misinterpretation of the facts. If these two populations met and interbred in the release area, the few individuals left from the wild Fennoscandian population may potentially become swamped up into the new introduced population rather than birds from the Swedish releases making any contribution to the original wild population. This is evident since no Lesser White-fronted Geese with ecological characteristics of the wild Lesser White-fronted Geese have been observed there after late 1980's. Those remnants of the wild Fennoscandian Lesser White-fronted Goose population in the release area at the time of the first releases, were therefore soon eradicated, and the release activities would in that case have contributed to the extinction of the wild Fennoscandian population in Sweden. The migration route of the birds that later began breeding in these areas was changed to wintering areas in the Netherlands due to the release method of using Barnacle Geese to alter the migration route. The genetic composition of the released birds was degenerated through generations of captive breeding and they also carried genetic material from Greater White-fronted Geese.

More importantly, there are no records of the reintroduced population from Sweden within the major migration routes or areas of the wild populations throughout the 1980s and the 1990s, which would be expected if the released birds supplemented the original population, and thereby continued to use traditional migration routes. It has been argued by Kampe-Persson (2008) and Mooij et al. (2008) that the original migration route from these areas was in the direction of Western Europe, although no data exists to support this view. On the contrary, there are two ring recoveries from Sweden showing a similar migration history as has been proved for birds breeding in Finnmark, Norway (see **chapter 3**). The fact that there are no historical records of a build-up of migrating Lesser White-fronted Geese at potential staging sites on the Swedish coast suggests an eastern migration route. Hansson (2005) described that the original autumn migration route for the wild Fennoscandian Lesser White-fronted Geese breeding in the release area in Sweden went in a south-eastern direction crossing the Bothnian Bay at the narrowest point "Norra Kvarken". Our unanimous conclusion is therefore that, even when the first releases were made in Swedish Lapland whilst there were still genuinely wild birds in the area, estimated as 1-2 pairs annnualy in late 1970s Andersson & Holmqvist 2010), then the naturalness of this remnant population was destroyed by the introduction of birds of impure genetic make-up that lacked natural ecological traits and with a human modified migration route.

At the same time as the Swedish releases were started in Lapland in 1981, there were still Lesser White-fronted Geese breeding in Nordland County in Norway, to the west of the release site. NOF-BirdLife Norway's local branch in Rana municipality carried out regular monitoring of Lesser White-fronted Goose breeding sites, both in search of the geese themselves, as well as feeding signs (excrements) and other signs (moulted feathers). The last breeding record in Nordland was in 1988 (Norsk Ornitologisk Forening, avd. Nordland 2004).

In recent years, birds found in Rana municipality have proven to be from the Swedish releases e.g. colour-ringed birds described by Waldmann (1998, 2000). Similarly, birds observed at staging sites elsewhere in Nordland are also from the stock released in Swedish Lapland (colour-ringed individuals described in the Norwegian Species Reporting System: *Artosbservasjoner*). A Lesser White-fronted Goose observed at Sør-Herøy in Nordland in late October 1999 was extremely tame (Shimmings 2000). Despite the activities taking place on land, this bird settled in the bay around 25-30 metres from fishermen, and was still present some 5 hours later. This individual exhibited such abnormal behaviour that any ideas that it might be a wild bird were quickly eliminated.

Thus, the releases of Lesser White-fronted Geese in Swedish Lapland may well have been the final nail in the coffin for the already dwindling breeding population in the mountainous regions of the eastern part of Nordland County. Any records from the area post-1981 releases could equally be from the remaining wild birds, from the Swedish releases, or a mixture of both. Observations of Lesser White-fronted Geese bearing colour-rings from both the earlier releases in Sweden (and from the current project started in 2010, see **chapter 5.2**) clearly demonstrate that Swedish-released Lesser White-fronted Geese have been observed in Nordland (including at traditional staging and breeding areas for wild birds) since at least the mid 1990s.

Andersson & Larsson (2006) also used the term reintroduced and introduced throughout their whole article entitled "Reintroduction of Lesser White-fronted Goose *Anser erythropus* in Swedish Lapland". The information in the article of Andersson & Holmqvist (2010) does not alter the fact that the reintroduced population has a very different ecological and genetical character as compared to the original wild Fennoscandian population breeding in Sweden, and is now considered as a separate population that also today poses a threat to the wild Fennoscandian population. The release of 19 birds on average annually the first 11 years (208 ind. before a short halt of releases) in an area suspected to hold 1-2 pairs. This is not a supplementation as the released birds are of a different ecological and genetical character compared to the extant population. The releases represent a 50-100 fold number of birds in proportion to the birds originally present. The term supplemented is therefore misleading and the term reintroduced is the correct term for the Swedish population.

5.4 Is the Swedish reintroduced population a "wild" population?

A question that is often raised is as to whether the Swedish reintroduced population can be considered to be "wild" or not. Firstly, we need to define the term "wild". According to the Oxford English Dictionary *wild* is defined in the case of an animal or plant as "*living or growing in the natural environment; not domesticated or cultivated*".

We consider that the Swedish reintroduced population of Lesser White-fronted Goose cannot be classified as wild due to the following points:

- The reintroduced population is founded on birds that have been raised in captivity and are therefore considered as either domesticated or cultivated.
- The individuals that have been reared and released into the Swedish mountains and their offspring produced in the wild utilise parkland during the summer and have become very tame and allow close approach, thereby having lost their natural shyness to humans. They no longer exhibit the same nehaviour as genuinely wild Lesser White-fronted Geese.
- The birds have adapted to unnatural environments (agricultural land, town parks and one known instance of breeding in coastal rather than mountain habitats). This is contrary to the habitat choice of individuals from the wild populations of Lesser White-fronted Goose that do not occur in such environments.

- Unlike any wild population of Lesser White-fronted Goose, the Swedish reintroduced population regularly interbreed with other species (Barnacle Goose).

There is also a genuine risk, that as a result of the genetical and ecological traits of this population, it could become one of the many feral/reintroduced populations in Europe that are regarded as pest species and not something which occur naturally. Such a scenario could arise due to preference for agricultural habitats or parkland (see **chapter 5.6.2**), or through a rapid increase in numbers following breeding in new sites outside the natural range (see **chapter 5.2.4**). Such growth in populations have caused severe problems both towards agricultural and recreational interests, and are in many countries regarded as either "nuisance species" or "pest species". There are many examples of introduced wildfowl populations reaching pest proportions, and where numbers are so great that they are difficult to control. This includes birds released deliberately into former breeding areas e.g. Greylag Geese in Great Britain, or introduced for hunting and/or ornamental purposes in areas where they never occurred naturally e.g. Canada Geese in several European countries (Delany 1992, Austin et al. 2007). The problem of breeding, staging or even wintering within the confines of a town environment should not be overlooked. In such areas the public often defend what they consider to be wild birds and are often adversive to any measures that may be suggested (or even implemented) in order to alleviate the problem. Birds that become established in towns are often hand-fed by the general public and become so tame that any control measures become difficult to implement because the public will symphatize with such birds and defend them vigorously. The fact that Lesser White-fronted Geese spend some weeks (or months, depending upon individual strategies) in the town park at Lillfjärden in Hudiksvall in eastern Sweden, and that they allow close approach by people demonstrates that the geese are habitualised to human beings. This is not a surprise given that many geese have been released within the town park in Hudiksvall. However, it is perhaps surprising that birds released in Swedish Lapland also stage at Lillfjärden. The geese use Lillfjärden as a staging site both during pre- and post-breeding periods.

5.5 Genetic aspects

5.5.1 Captive stocks and hybridisation

Studies of captive Lesser White-fronted Goose stocks have shown that hybridisation between Lesser White-fronted Goose and Greater White-fronted Goose has occurred several times in the captive stock in Sweden that was used for releases in the 1980s and 1990s. It was found that the captive Lesser White-fronted Geese carry the mitochondrial DNA of Greater White-fronted Geese (cf. Ruokonen 2001), and evidently part of the nuclear DNA of the captive Lesser White-fronted Geese is inherited from Greater White-fronted Geese. In other captive stocks (in Finland), partly originating from the same stock, hybridisation with Greylag Goose has also been proven (Ruokonen et al. 2007): "*A total of 36% of the captive lesser white fronted goose stock was shown to be contaminated: 4% of the captive individuals had greater white-fronted goose mtDNA, 19% carried private microsatellite alleles from the greater white-fronted goose and 13% of the individuals showed both greater white-fronted goose mtDNA and microsatellite alleles. In reality, levels of genetic contamination may be much higher, but the similarities in nuclear alleles between the species make more detailed estimates impossible".*

"In this study the sampled individuals were traced back to 11 farm stocks of which 6 are in Sweden and five elsewhere in Europe (Fig. 1). In eight of the stocks, either nuclear or mitochondrial genes (or both) from an alien species were detected (Fig. 1). Because captive lesser white-fronted geese have been exchanged among breeding units, in an attempt to avoid possible inbreeding, it is probable that

genes from the greater white-fronted and greylag goose are widespread in captive stocks of the lesser white-fronted goose throughout Europe."

Because the mitochondrial and nuclear DNA of Greater White-fronted Geese are not linked in the captive Lesser White-fronted Goose stocks, and the mitrochondrial DNA is only inherited matrilineal, eliminating only the individuals proven to carry the mitochondrial DNA of Greater White-fronted Geese does not solve the problem, because there are also individuals possessing only mitochondrial DNA of Lesser White-fronted Goose, but nuclear DNA of both species.

Hybridisation between Lesser White-fronted Goose and Greater White-fronted Goose in the wild has not been recorded in DNA studies, even though more than 100 individuals of each species have been sampled covering the whole distribution range of Lesser White-fronted Goose, and despite the fact that the two species occur in mixed flocks during migration and wintering when pair formation is supposed to take place (Ruokonen 2001). Several stakeholders of continued reintroduction activities have claimed proof of high rates of hybridisation in the wild, but we question the validity of the scientific methods and many of the conclusions reached in such studies (see **chapter 7.3** for an elaboration of this issue).

<u>Based on studies on mitochondrial DNA, the genetic composition of the wild Fennoscandian Lesser White-fronted Goose population differs significantly from other Lesser White-fronted Goose populations and thus the Fennoscandian population is considered a separate management unit in conservation biology (Ruokonen 2001).</u>

In addition to the introgression of genes from Greater White-fronted Goose*,* the present free-flying reintroduced population in Sweden consists of a mixture of western and eastern mitochondrial DNA types of Lesser White-fronted Goose. In addition, a high percentage (>5%) hybridises with Barnacle Geese, the spcies that were used as foster parents in the Swedish reintroduction project during the 1980s-1990s (see **chapter 5.2.6**).

It is not known what effects hybridisation have on the ecological function of the birds. The genetic screening has only shown that the existing Swedish free-flying population has a hybrid origin and there exists no research on the effects of this. However, the hybridisation problem could manifest itself through change in habitat preferences (see below), increased vulnerability to predators and possibly a lower threshold for interbreeding with other *Anser* species. Based on the examination of photos, the free-flying reintroduced Swedish population may also differ morphologically from the wild Fennoscandian birds. Some birds had diminished eye rings and pale yellow and elongated bills.

In another experiment to establish even one more human mediated migration route and wintering area for Lesser White-fronted Geese released in Sweden, this time by use of ultra-light planes, a French project used birds originating from a zoo in Belgium (see **chapter 4.3**). These birds were also quite likely of hybrid origin, because experienced birders were not able to identify the birds as Lesser White-fronted Geese based upon the usual identification features such as swollen yellow eye ring and short triangular, intensively pink bill. The birds used had elongated, pale pink, slim bills typically associated with Greater White-fronted Goose. Only 12 of the 30 released birds were recaptured, although the original plan was to recapture all (Tegelström et al. 2001).

One study has tried to find support for the claim that it is normal with a large proportion of hybrids with Greater White-fronted Geese in wild Lesser White-fronted Goose populations (Nijman et al. 2010). However, the study failed to prove that the two sampled individuals (collected in England and the Netherlands, out of the normal wintering range of wild Lesser White-fronted Geese) were of wild origin and not escapes from local zoos or similar. This article is discussed in detail elsewhere in this

report (c**hapter 8.3**). Further, Nijman et al (2010) argue that the specimens are collected before the Swedish reintroduction project started. However, Western Europe has, at least since the 1850s, experience numerous deliberate releases and unintentional escapes from zoos and wildfowl parks (Barrat et al. 2010, Bauer & Woog 2011, Chiron et al. 2009, Fabregas et al. 2010, Kark et al. 2009, Sol et al. 2005) something which resulted in, amongst other things, the establishment of a "*European code of conduct on zoological gardens and aquaria and invasive alien species*" in 2012 (Convention on the conservation of European wildlife and natural habitats - 32th meeting of the Standing Committee 2012) for zoos and aquariums. Hybridisation involving Lesser White-fronted Geese is known from zoos in Europe at least since 1926 (Nagy 1950, **chapter 4.8**), and hybridisation between geese under captive and semi-captive conditions is common. In Sweden, the farm of Bengt Berg, that later supplied Lesser White-fronted Geese to the Swedish reintroduction project, had geese hybridise of several different constellations already from the establishment in late 1920s, such as Greylag Goose x Barnacle Goose, Greater White-fronted Goose x Snow Goose, Greater White-fronted Goose x Bar-headed Goose (Berg 1937).

5.5.2 Selection and gene flow

The question of genetics of the Lesser White-fronted Goose has been debated and discussed ever since the beginning of the release project in Sweden, with arguments for and against the use of captive stocks and the potentially negative effects of this. Regarding the issue of selection against individuals of hybrid origin the following basic population genetic principles are worth taking into consideration when dismissing the potential negative effects of birds of hybrid origin or very different subspecies:

In a small population with low effective population size (Ne), genetic drift is a stronger force than natural selection. Hence, in small populations even detrimental (e.g. hybrid) alleles can be driven to fixation despite a selection against them. This derives from the simple relationship between efficiency of selection (s) and effective population size (Ne) according to which natural selection on given locus is effective only when

$$s \gg 1/(2Ne)$$

In other words, selection must be very strong in small populations to be effective, which also means that more selective deaths are needed to selection response (adaptation). Hence, it is a not a wise strategy to increase the genetic load of a small population e.g. with foreign genes that are selected against, because this would mean that large proportion of the members of that population would be destined for selective deaths. Additionally, even if the selection would not drive the population to extinction, the small population could be swamped by detrimental alleles of hybrid origin or detrimental alleles that have increased in frequency in captivity due to inbreeding and relaxed selection.

Several of the reintroduction advocates have suggested that the wild Fennoscandian population is in need of released farmed birds to avoid inbreeding, but this can be refuted for several reasons. Ruokonen et al. (2010) showed how the genetic diversity increased equalling 0.56 per generation despite a dwindling population. This was shown to be related to an increased immigration of males of Russian origin (from the Western main population). The effect of male-mediated gene flow is potentially dichotomous. On the one hand, it helps safeguarding the Fennoscandian Lesser White-fronted Goose from loss of genetic variability, but on the other hand, it eradicates the original genetic characteristics of this population, the local adaptation. Additional input of birds of farmed origin would further drive a potential outbreeding process. Fortunately, no potential negative population genetic effects have been observed, such as inbreeding depression or imbalanced sex

ratios. On the contrary, the wild breeding population has an average brood size of 3.3 goslings per pair (1994-2015), or 3.2 goslings per pair (2010-2015). This is 0.6 goslings per brood larger than for the reintroduced population in Sweden with an average of 2.7 goslings per pair (1981-2015), which is the same also in the most recent years 2010-2015. The total relative reproductive success in the wild Fennoscandian population was considerably higher than in the reintroduced Swedish population in the period 1994-2015 (0.42 juveniles produced per individual in the Fennoscandian population as compared to 0.14 juveniles produced per individual in the Swedish reintroduced population - see **chapter 5.6.4** Population viability for details).

In a quantitative model by Ford (2001) it was predicted that even low levels of gene flow from a captive population to the wild will shift the wild population's mean phenotype. The fitness consequences of the phenotype shift depended on the details of the model, but a >30% decline in fitness could occur over a wide range of parameter values. In the model, Ford (2001) showed how the gene flow has two important implications for conservation efforts. Firstly, that selection in captivity may significantly reduce a wild population's fitness during supportive breeding and that even continually introducing wild individuals into the captive population will not eliminate this effect entirely. Secondly, the sensitivity of the model's outcome to the wild environment's quality suggests that conserving or restoring a population's habitat is important for preventing fitness loss during supportive breeding.

5.5.3 Introgression

Turning back to the discussion about introgression from birds of hybrid origin in Sweden, it has been difficult to validate and discuss the conclusions published by Amato (2010) because a report was never published. In the executive summary, he wrote that introgression could have two outcomes, either selected against, or neutral:

"*We would predict that if the genes make individuals less fit then they will be selected against in nature. If they are neutral, they will remain at current levels or decline through drift. Natural introgression is not uncommon in many closely related species but seems to be controlled mostly by positive assortative mating within species. While an unfortunate experiment, no specific management actions seem warranted for this subpopulation.*"

There could also be a third option in that the introgressed genes will be positively selected for, and we suspect that this is the case for the reintroduced population in Sweden. In Western Europe, a common belief is that the swift recovery of the many endangered goose populations since the early 1960s was caused by two factors; establishment of protected areas, but equally as important was the change in feeding habitat from natural wetlands to agricultural land (Fox et al. 2005). The latter seems to be a very important factor, with higher quality and easily accessible food and a relaxation from hunting and natural winter mortality. Only one species did not make this change in habitat use - the Lesser White-fronted Goose, which still feeds in natural steppe habitats or marshlands with salt tolerant grass species. This is probably one important explanation to the fact that the Lesser White-fronted Goose and the Greater White-fronted Goose have different population trajectories since they are exposed to quite similar levels of hunting throughout the year (which includes spring and summer hunting in Russia).

The reintroduced population in Sweden are founded on individuals bred in captivity, where a large proportion of the birds now moult in a town park, and where the majority spend the entire winter in agricultural fields in the Netherlands. The introgression of Greater White-fronted Goose (and apparently Greylag Goose) genes could be the sole explanation for this population being able to utilise agricultural crops efficiently, and since this provieds an advantage in energy available for

winter survival and spring migration (including bringing sufficient energy stores for successful reproduction), it will be positively selected for. Positive selection is a real likelihood, especially because a reintroduction program can tip the bias in favour of success where it will have specifically exploited circumstances to offer a population a set of "survival" habitats (outside of the breeding season) and a breeding habitat (in which to reproduce). Such linkages become hard-wired behaviourally because of family structures and the cultural learning, so offspring will adopt these traits. By their very nature, these projects will have linked opportunities that were not necessarily available to geese in recent evolutionary time (not least because many survival habitats are man-made). So, reintroduced goose populations can exploit a series of novel protein-rich feeding opportunities that were never available before. This may even circumvent evolutionary adaptations such as Lesser White-fronted Geese adaption to feeding on very dense short swards may become able to exploit longer swards that they are less efficient at handling because they are richer in nutritional content. For instance, the Bar-headed Goose *Anser indicus* has successfully established feral populations in European parks and farmland environments, which is very dissimilar from their original native habitats. It is natural that if a strategy for survival is successful in a modern landscape, no matter how alien to the original ecological context to which that organism was adapted, there will be positive selection for the traits that perpetuate that success.

5.5.4 Phylogenetics and future

With the new releases conducted in Sweden since 2010 with a new stock with different genetic composition (of Western Russian origin) than used in the first reintroduction years (zoo background with hybrid history with two other *Anser* species) it is clear that more thorough research is needed to understand how genetic drift, introgression, selection and migration shape genetic and phenotypic variation, and how this relates to population viability and potentially negative effects on neighbouring populations. With the first release project in Sweden introducing a 50-fold number of birds to the original almost extinct local population (in the release area), we would, as discussed above, expect that the original population has left few traces in the present mix of birds present throughout the year in Sweden. From our viewpoint, it is clear that a genomic approach, whether whole-genome sequencing, sequencing targeted portions of the genome or direct genotyping of a random subset (GBS), is necessary to improve the precision of estimates and not least, to understand the effects of past and ongoing releases of birds bred in captivity (cf. Shafer et al. 2014). Recent advances in genetic analytical methods has cast new light on phylogenetic relationships and evolutionary history of geese. Earlier incongruence in phylogenetic analyses could be caused by analytical shortcomings or the result of biological processes such as hybridisation, incomplete lineage sorting and gene duplication, and the relationship within the *Branta* and *Anser* families was never fully resolved (Ottenburghs et al. 2016). Recent technological advances have substantially reduced the cost of sequencing, though the assembly of whole genomes has remained a challenging computational problem. Scally et al. (2012) using whole genome analyses, gave astonishing insights into the evolution of hominids (humans *Homo*, chimpanzee *Pan sp.* and gorilla *Gorilla* genus) and showed how incomplete lineage sorting (ILS) affected interpretation of relationships. More specifically, they found that across the genome 30% of bases exhibited ILS and that the fraction of ILS varied with respect to genomic position more than expected under a model of genome-wide neutral selection. Interestingly that variation reflects local differences in the ancestral effective population size N_e during the period between the gorilla and chimpanzee speciation events. In geese, Ottenburghs et al. (2016) sequenced nineteen goose genomes and used an exon-based phylogenomic approach. For the controversial Bean Goose complex they reported a sister species relationship between the Pink-footed Goose and Tundra Bean Goose, but found that the phylogenetic relationship in this complex are highly influenced by incomplete lineage sorting and/or hybridization. Within the grey geese clade, the Lesser White-fronted Goose was, not surprisingly, established as a sister species of the Greater White-fronted Goose. The placement of the Lesser

White-fronted Goose in earlier studies (Lee et al. 2008, Ruokonen et al. 2000) in the clade with Taiga Bean Goose and Pink-footed Goose using mtDNA analyses, could be explained by incomplete lineage sorting and/or hybridisation. Again, this shows how pertinent it is to pursue in-depth studies on the genetics of the Lesser White-fronted Goose.

Our skepticism and warnings against possible negative effects are not without merits. Early warnings against the genetic compositions of the captive reintroduction stock and its possible negative effects proved to be correct when genetic analyses showed that the birds in the captive stocks were of hybrid origin (through their captive history). New worries and warnings have since been issued related to the massive releases of young birds without parents and subsequent lack of parental guiding to traditional wintering areas. This most likely has also genetic effects, as more recent studies on a related species, the Barnacle Gooose, has shown how recent changes in migratory traditions leads to genetic differentiation (Jonker et al. 2013). A newly established nonmigratory population of Barnacle Geese in the Netherlands was significantly differentiated from four other migratory populations and was characterised by high emigration and low immigrations rates. There was also evidence of minor mixing of individuals of a captive origin, or possible hybridisation with Cackling Geese (Jonker e al. 2013). For the Swedish reintroduced Lesser White-fronted Goose population with a human mediated migration route to the Netherlands, mixing with birds of captive/feral origin is expected in the Netherlands as well as mixing with birds stemming from the new large-scale releases of birds of captive origin that has been undertaken from 2010 and onwards.

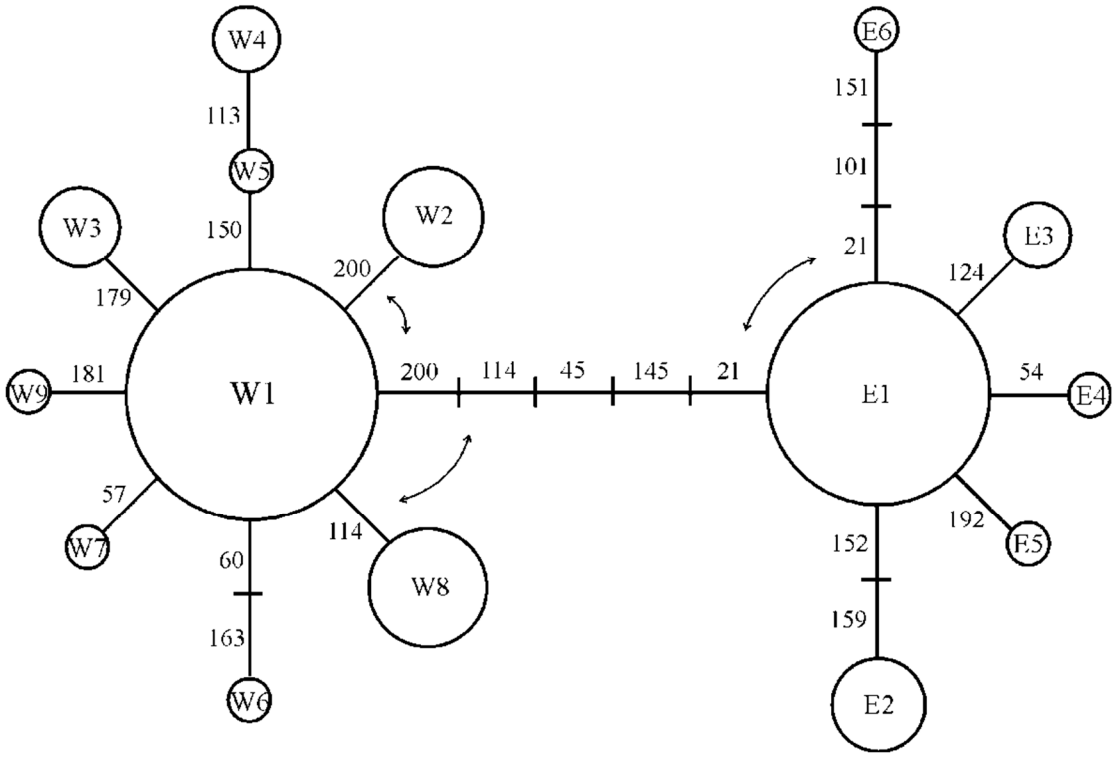


Figure 44. Minimum spanning network of mitochondrial haplotypes found in the study of Ruokonen et al. (2004). This shows how the Lesser White-fronted Goose has two clades of birds, which also is in line with knowledge that birds breeding west of Taimyr Peninsula in Russia, migrates to southwest, while birds breeding east of the Taimyr peninsula migrates southeast to China in winter. Each line indicates the number and locality of the nucleotide differences observed among the haplotypes, sizes of the circles are approximately proportional to the number of individuals. Arrows indicate possible reversals (nucleotide positions 21, 114 and 200). W=western haplotype (sampled to the west of Taimyr Peninsula), E=Eastern haplotype (sampled to the east of Taimyr Peninsula).

5.6 Ecological aspects

5.6.1 Manipulation of migration routes and establishment of new wintering areas

The Swedish reintroduced population was manipulated to establish a new wintering area by using of Barnacle Geese as foster parents, where the Barnacle Geese had already established a migration route to the Netherlands (von Essen 1982, von Essen 1991, von Essen 1993b, Andersson & Larsson 2006). The founder of the Swedish project, Lambart von Essen wrote (1982): "*In spite of the fact that the natural migration route of the Anser erythropus from Scandinavia goes in a southeast direction we have decided to try the Branta leucopsis as foster-parents*". The Swedish Association for Hunting and Wildlife Management contemplated using the Canada Goose, but deemed the species too big as a foster parent (von Essen 1982). The intention of using Barnacle Geese was that the Lesser White-fronted Geese would follow their foster parents to new wintering quarters in the Netherlands (the wintering area for the foster parents). The Swedish reintroduced population now winters in areas that are not traditional wintering areas for Lesser White-fronted Geese, and this is contrary to the claims by the stakeholders for continued releases (see review by Marchant & Musgrove 2011).

Close to 95% of the Swedish reintroduced population winters regularly in the Netherlands, but due to release activities in Sweden in recent years, an increasing number now winters in southern Sweden and, since 2014, also on the southwestern coast of Norway (data from the Norwegian and Swedish Report Systems) see **chapters 5.2.3-5.2.5**. This is yet another undesired negative effect of the reintroduction scheme in Sweden.

5.6.2 Change of habitat requirements

Wild, natural populations of Lesser White-fronted Geese are habitat specialists, almost exclusively exploiting natural steppe and saltmarsh habitat during migration and winter, as well as short-grazed semi-natural grasslands (including grazed coastal meadows), although also at times cereal stubbles (Jones et al. 2008, Karmiris et al. 2009, Toming & Tolvanen 2009).

Intensive studies of the diet of wintering Lesser White-fronted Geese in Greece have shown that the winter diet is mainly comprised of graminoids and aquatic plants at Lake Kerkini and of graminoids and halophytes at the Evros Delta. Lesser White-fronted Geese feed in marsh areas at the edge of Lake Kerkini, and the availability of feeding areas is influenced by the water regulation regime at that site. When feeding at the Evros Delta, the geese utilise halophyte vegetation in soils with high salinity. The study of the dietary preferences of Lesser White-fronted Geese wintering at both Lake Kerkini and Evros Delta showed that the geese are habitat specialists using marshy areas around lakes as well as saltmarshes and coastal meadows (Karmiris et al. 2014).

Studies of Lesser White-fronted Geese in China have also revealed that the species feeds mainly on graminoids, and that food is a constraint that explains the restricted distribution of Lesser White-fronted Geese during winter. The geese in China feed mainly on recessional grasslands (i.e. natural meadows exposed as floodwaters recede). By grazing on the shortest swards, Lesser White-fronted Geese rarely mixed with other goose species during feeding, as the other species present did not preferentially select shorter swards. The restricted diet of the Lesser White-fronted Goose was thought to explain the species' highly restricted winter distribution and global rarity (Wang et al. 2013).

The reintroduced Swedish population has, contrary to wild Lesser White-fronted Geese breeding in Fennoscandia and Russia, made the transition to feed on cultural habitats/farmland during winter in

the Netherlands and Germany, a trait not shared by wild Lesser White-fronted Geese. At the staging/moulting grounds in Sweden, the deviation in habitat choice is even more prominent, as the Swedish reintroduced population utilises fertilised and mown lawn areas in a park in the Swedish town of Hudiksvall as the main staging and moulting site for non-breeders. The use of public parks has never been recorded for wild Lesser White-fronted Geese. The adaptation to feeding on cultural habitats (farmland and lawns) might be influenced by the brood rearing process in the rearing pens prior to release. According to a memorandum sent to BirdLife International (Liljebäck 2015) then geese "*bred in captivity in Sweden fed on a mix of "natural grass", pellets and different kinds of vegetables (favouring salad and carrots)…*". Further, Liljebäck wrote in the same memorandum that this shows "*that wild-born LWfG are well adapted to thrive on "unnatural" food*". It should be emphasized in this context that the geese concerned are held in captivity, and therefore are not able to select what to feed on, being instead forced to eat what is made available to them in a captive environment. On this basis we consider the argument that wild-born Lesser White-fronted Geese are well adapted to thrive on "unnatural" food is a bold and incorrect statement, and cannot be used as an argument to defend the adaptation of the Swedish reintroduced birds to atypical feeding habitats such as grass lawns in a public park. Further, an adaptation to feeding on vegetables must be considered as undesirable. In England there are problems with Pink-footed Geese feeding on carrot crops, and in southern Norway, Greylag Geese are reported to do considerable damage to vegetable production, particularly to beans and lettuce crops. Once geese learn that there is a new food source available they can be difficult to stop, often resulting in complaints purporting damage and economic loss.

Liljebäck (2015) also argues that Greater White-fronted Geese, and more specifically the Greenland subspecies *A. a. flavirostris*, made a shift to agricultural land and that resulted in the recovery of the species/subspecies. Liljebäck argues that such shifts in diet may be beneficial for a species. However, Liljebäck has failed to address the reasons behind the recent major decline in numbers of Greenland Greater White-fronted Geese, despite the fact that the subspecies has all but abandoned the traditional natural habitats in favour of more modern monocultures. The recent declines in numbers of Greenland Greater White-fronted Geese have been most significant at sites with large numbers of birds, mainly feeding on intensive agricultural habitats (Francis et al. 2011). Although geese may benefit from feeding on agricultural land by achieving more rapid increase in body condition in terms of increased body reserves, feeding on agricultural habitats may in fact be detrimental in terms of reproductive success. Prop & Black (1998) examined the build-up of body reserves in Barnacle Geese staging in two distinct habitat types during the spring migration, and how this affected subsequent reproductive success of these same individual birds. One group of birds fed on traditionally managed staging islands with low-intensity management (natural hay meadows lacking in alien plant species, no artificial fertilisers, hand-cutting of hay meadow areas), whereas the other group of birds fed on intensively-managed agricultural fields (sown grass fields including monocultures, use of artificial fertilisers, machine-harvested to produce silage). Although the accumulation of fat stores (as measured by recording the abdominal profiles for individual birds) was higher on agricultural land compared to traditional habitats, then the amount of gain in protein content was higher for the birds using traditional habitats. Despite achieving the highest fat scores, the geese using the agricultural fields had a depressed probability of successful breeding and this was perhaps due to insufficient protein acquisition during the crucial spring-fattening period. This study showed that the geese did not benefit from feeding on agricultural land, but there were however benefits in terms of improved reproductive success when feeding on traditional habitats.

A further issue is that Liljebäck made no mention in the memorandum that the wild Fennoscandian population of Lesser White-fronted Geese <u>has not</u> made the transition to new habitats, and that this population continues to feed exclusively in traditional natural/semi-natural habitats. As stated repeatedly elsewhere in this current report, there are many reasons why a change in migration route

or change in habitat choice for Fennoscandian Lesser White-fronted Geese must be avoided, as these changes may well be detrimental to the population. The risk of mixing with released birds from Sweden could lead to a change in choice of feeding habitat.

At the wintering site at Oude Land van Strijen in the southwestern Netherlands, Lesser White-fronted Geese feed in damp grass fields. Birds feed in a similar habitat in the Harger and Pettermerpolder in Nord-Holland. The birds also exhibit prolonged feeding in trenches and ditches in these areas. This was the situation up to at least winter 2007/2008 (Ouweneel et al. 2008). A search of photographs of Lesser White-fronted Geese taken in the Netherlands in the period autumn 2010-winter 2015/2016 shows that some are also feeding on intensively managed agricultural grasslands, often in the company of other goose species. These photographs reveal that Lesser White-fronted Geese have also made the switch to intensive farmland in the wintering areas, a habitat that is not natural for the species as the habitat type itself is man-made.

In the process of updating the ISSAP, it would be beneficial that the International Lesser White-fronted Goose working group consider this deviation in habitat choice as well as the human-modified migration route and if the adaptation to agricultural land could be an effect of introgression of genes from other goose species, that have adapted to feeding on agricultural land.

A flock of Swedish reintroduced Lesser White-fronted Geese feeding on a recently mown lawn at Lillfjärden, Hudiksvall in Sweden in July 2015. Grass lawns are not natural habitats for wild Lesser White-fronted Geese. Note also the close proximity of the geese to the observer and the public footpath in the bottom right corner of the photograph. Photo: Paul Shimmings

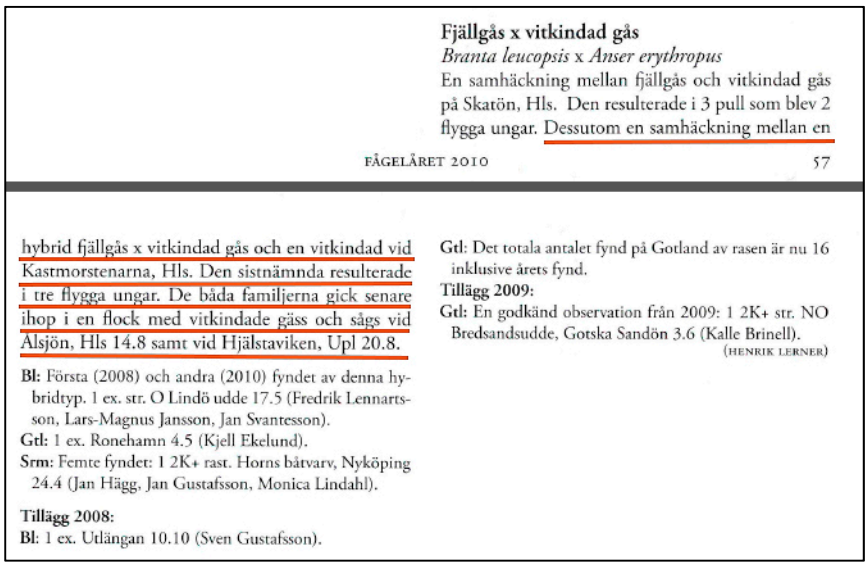
Another view of the flock shown in the previous photograph. Note that these Lesser White-fronted Geese are feeding close to the trees in the foreground and to the tall fence and tall vegetation in the background, areas where predators can easily conceal themselves. Indeed, a domestic cat was concealed in the very same vegetation at the time the photograph was taken. Wild Lesser White-fronted Geese are birds of open habitats and not of enclosed locations such as that shown here. Photo: Paul Shimmings

5.6.3 Hybridisation with the foster parent species

The use of Barnacle Geese as foster parents in the Swedish reintroduction project has led to hybridisation between the two species, with second-generation hybrids also recorded (Kampe-Persson & Lerner 2007). This problem was claimed by the Swedish Environmental Protection Agency (SEPA), to have been resolved as obvious hybrid birds were shot in 2012, but it does not alter the fact that hybridisation has occurred, and still occurs. In 2013 at least 14 hybrids were observed in Sweden (minimum 3 broods and 11 goslings produced), and in 2014 a minimum of 8 hybrids were observed (minimum 2 broods and 5 goslings produced (Swedish Reporting System 2016). Based on population size data for the last 5 years (2009-2013, where estimates exist from both Sweden and the Netherlands), it can be concluded that the Swedish reintroduced population contains on average 10.5% Barnacle Goose x Lesser White-fronted Goose hybrids (hybrid occurrence data are gathered from the Swedish Reporting System and population size estimates from Koffijberg & van Winden (2013) (in the latter only estimates for “pure” looking Lesser White-fronted Geese are given). For a full overview of the history and occurrence of such hybrids in Sweden, see **chapter 5.2.6**).

The concern that Lesser White-fronted Goose x Barnacle Goose hybrids could well be fertile has previously been raised by others, and that such individuals could potentially pair with other geese and produce second-generation hybrids. Such fears have not been unfounded. The first confirmed record of a hybrid Barnacle Goose x Lesser White-fronted Goose attempting to breed was in 1989. A male hybrid Lesser White-fronted x Barnacle Goose bred unsuccessfully with a female Canada Goose where none of the six eggs hatched, at Gussjön, Ångermanland in 1989 (Sjöberg 1990, Kampe-

Persson & Lerner 2007). In 2010, a female hybrid Barnacle Goose x Lesser White-fronted Goose which was paired to a male Barnacle Goose was observed incubating on a nest at Skatön in Hälsingland on 31st May 2010 (Stefan Persson & Lars Henningson pers. comm.). Three goslings hatched on 11th June, proving that the eggs were fertile. These young birds were later also observed in autumn. The record is included in the Swedish Reporting System, and has been validated and accepted by the regional report committee and subsequently published (Strid & Wærn 2011).



Fjällgås x vitkindad gås
Branta leucopsis x *Anser erythropus*
En samhäckning mellan fjällgås och vitkindad gås på Skatön, Hls. Den resulterade i 3 pull som blev 2 flygga ungar. Dessutom en samhäckning mellan en

FÅGELÅRET 2010 57

hybrid fjällgås x vitkindad gås och en vitkindad vid Kastmorstenarna, Hls. Den sistnämnda resulterade i tre flygga ungar. De båda familjerna gick senare ihop i en flock med vitkindade gäss och sågs vid Älsjön, Hls 14.8 samt vid Hjälstaviken, Upl 20.8.

Bl: Första (2008) och andra (2010) fyndet av denna hybridtyp. 1 ex. str. O Lindö udde 17.5 (Fredrik Lennartsson, Lars-Magnus Jansson, Jan Svantesson).
Gtl: 1 ex. Ronehamn 4.5 (Kjell Ekelund).
Srm: Femte fynden: 1 2K+ rast. Horns båtvarv, Nyköping 24.4 (Jan Hägg, Jan Gustafsson, Monica Lindahl).

Tillägg 2008:
Bl: 1 ex. Utlängan 10.10 (Sven Gustafsson).

Gtl: Det totala antalet fynd på Gotland av rasen är nu 16 inklusive årets fynd.
Tillägg 2009:
Gtl: En godkänd observation från 2009: 1 2K+ str. NO Bredsandsudde, Gotska Sandön 3.6 (Kalle Brinell).
(HENRIK LERNER)

Figure 45. Screen dump from the Swedish annual bird report for 2010.The first validated and accepted record from the Swedish Reporting System of fertile first generation hybrids from the Swedish reintroduction project breeding and producing three young, second generation hybrid individuals (Strid & Wærn 2011).

5.6.4 Population viability

The Fennoscandian wild population of Lesser White-fronted Goose has an annual mortality rate of around 33%, and an annual return rate between years of 80% (BirdLife Norway, Lesser White-fronted Goose Conservation Project data). Figures for mortality rate for birds released in Sweden and in Finland are difficult to interpret, not least as methodology used in calculating mortality rate and return rate for released birds is not the same as methodology used in calculating such rates in the wild Fennoscandian population. Calculations on mortality and return rates need to take into account rates for all age classes, and also take into account the likelihood of individually marked individuals being identified in later seasons.

Regardless of the lack of standardised methodology to calculate mortality and return rates for released versus wild birds, one thing is clear, namely that the return rate for released Lesser White-fronted Geese is lower than for wild birds, and that higher mortality rates for released birds is the likely cause for this. This assumption is supported by the data on the population development of the Swedish reintroduced Lesser White-fronted Goose population that in the period 2010-2015 have continued to decline despite continued releases that in numbers exceed the population size in each year. This is evidenced by count trend data both from the Swedish staging areas as well as from the main wintering areas in the Netherlands. It has been shown that mortality in summer can be high, also for adult birds. In 2012, it was discovered that a relatively high proportion of the Swedish Lesser White-fronted Goose population were predated by White-tailed Eagles in the Swedish mountains, and that 30% of the birds released in 2010 were killed (Liljebäck et al. 2012). With such a low return

rate and corresponding high mortality rate, the Swedish Lesser White-fronted Goose population cannot be sustainable, and we question the long-term viability of this population.

In addition, the Swedish reintroduced population is also suffering from lower production as compared to the wild Fennoscandian population. As the annual number of breeding pairs (spring population size) is not known, a comparison between years or populations, in total numbers of broods or juveniles is not straightforward as they are not independent of the population size. However, average brood size is as such independent and can be compared, as good years produce bigger broods than in poor breeding years.

In the Swedish reintroduced population, the average brood size of fledged juveniles in autumn is 2.7 for the years 1986-2015 (287 juveniles, 106 broods). The corresponding figure for the wild Fennoscandian population is 3.3 in the period 1994-2015 (594 juveniles, 181 broods).

The proportion of broods produced in the Swedish reintroduced population is far lower than in the wild Fennoscandian population. From the accessible data on number of broods produced in the Swedish reintroduced population in the period 1994-2015 (99 broods) compared to the number of broods produced in the wild Fennoscandian population in the same period (181 broods), it is evident that the proportion of pairs that successfully produce young is considerably lower in the Swedish reintroduced population, as the size of that population was higher than the wild Fennoscandian population during much of this period. Since the size of the Swedish reintroduced population is not estimated during spring migration as is the case with the wild Fennoscandian population, we have used the wintering population size numbers in the Netherlands and Greece respectively (**Figure 47**). Numbers from Greece are estimated since count coverage has been of high quality only since 2005. Estimates are based on spring total numbers, juvenile production and expected mortality for adults and juveniles until mid-winter. For Greece, actual (average 65 ind.) and estimated numbers (average 62 ind.) are closely correlated (Chi.sq.=0.916, p<0.000, n=12) with an average of 104% indivdiuals observed in comparison with numbers estimated. Comparing the winter population size for the Netherlands (average number of ind.=84.0) and Greece (average number of ind. =62.1) shows that the size of the Fennoscandian population has been on average 74% of the Swedish reintroduced population in the years 1994-2015 (**Figure 47**). Dividing the annual number of goslings counted in autumn with corresponding total estimate of winter population size the preceeding winter gives an estimate of effective production in these populations. The Swedish reintroduced population produced on average 0.14 juveniles per adult (n=21, SE=0.071), while the corresponding figure for the Fennoscandian population is 0.47 (n=21, SE=0.025), a threefold significant difference (t=4.338, df=40, p<0.000, SE=0.074) (**Figure 46**).

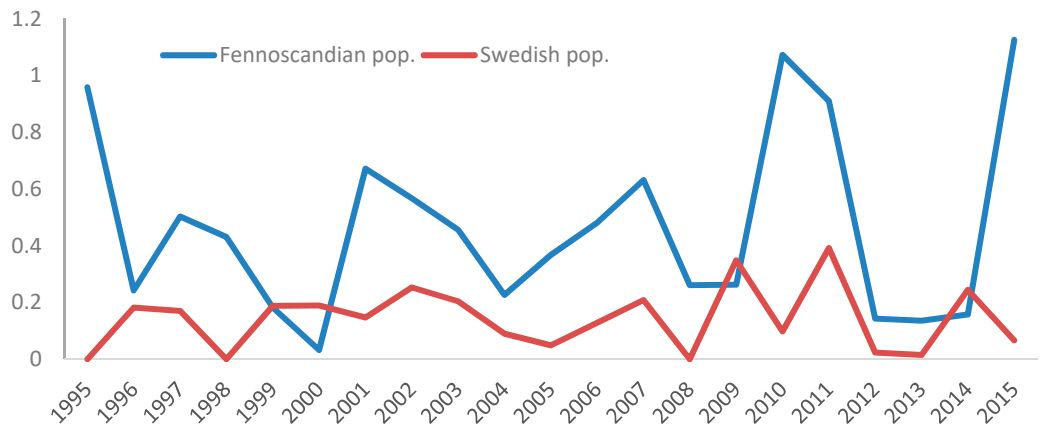


Figure 46. Annual estimate of juveniles produced per adult in the winter population the preceeding winter for the Swedish reintroduced population and the wild Fennoscandian population for the years 1994-2015.

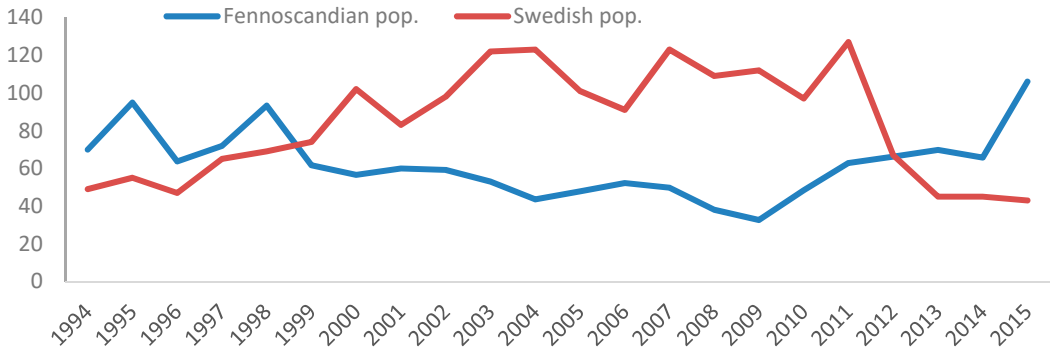


Figure 47. Annual winter population size for the Swedish reintroduced population in the Netherlands (sums) and for the Fennoscandian population in Greece (expected) for the years 1994-2015.

Figure 48. A Lesser White-fronted Goose with deformities, from the captive breeding stock at Öster-Malma, deposited at the zoological museum in Stockholm, Sweden. Photo: Tomas Aarvak.

5.6.5 Changes from natural behaviour

A phenomenon typically attributed to captive history of birds is changes associated with behaviour. Captive born birds will show less fear for humans and predators. In the Finnish restocking project (1987-1997), one of their conclusions for explaining its failure was that the birds did not show natural shyness and therefore had increased mortality (Markkola et al. 1999). As an example they wrote "*The released birds were observed in yards, and once one individual landed in a kennel and was killed by dogs*"

The reduced shyness is also a behaviour typical for the reintroduced Swedish Lesser White-fronted Geese. Amongst other aspects, this is also expressed by their preference to moult and stage in a city environment. The fact that many of these do not behave like wild birds from the original population are evident from descriptions like: "*The bird was very tame and followed the observer during the morning. Migrated later northwards (Bertil Persson 21.5)*" and "*The bird at Hornborgasjön came straight into a group with preschool children who sat eating*" (Tyrberg 2001).

From photographs, it is easy to determine that they are of birds originating from captive projects since these are not shy and can be approached at close range. The lack of natural shyness of the Lesser White-fronted Geese at the town park by Lillfjärden in Hudiksvall was clearly highlighted in summer 2015, when one of the authors of this report approached a flock of lesse White-fronted Geese down to two metres, without the birds exhibiting any fleeing response such as would be expected in wild geese!

Reduced antipredator behaviour in captivity have been proposed to explain the higher invasiveness of wild-caught exotic species, and a recent multispecies experiment showed the loss of antipredatory responses and escape abilities in captive-bred birds compared with wild-caught ones. An intraspecific comparison between the wild-caught and first generation captive-bred birds pointed to a rapid loss of natural anti-predator behaviour in captivity (individual lifetime) rather than to differences among species (evolutionary exposure) (Carrete & Tella 2015).

Lesser White-fronted Goose at Lillfjärden, Hudiksvall, Sweden in July 2015. This photograph was taken from a distance of two metres from the goose. Note the relaxed posture of the bird, which was completely unperturbed by the presence of the photographer, allowing the photographer to lie down besides the bird. During the same photo session several walkers, including noisy children and dogs, passed at a distance of 5-10 metres from the geese. Photo: Paul Shimmings