Population Status and Assessment Report

AEWA European Goose Management Platform

EGMP Technical Report No.26

Population Status and Assessment Report 2025

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Prepared by the AEWA European Goose Management Platform Data Centre

Compiled by: Iben H. Sørensen[1], Ryan R. Germain[1], Fred A. Johnson[1], Hans Baveco[2], Kees Koffijberg[3] and Jesper Madsen[1]

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[1] EGMP Data Centre, Department of Ecoscience, Aarhus University, Denmark
[2] Wageningen Environmental Research, The Netherlands
[3] Sovon, Vogelonderzoek, Nederland

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DISCLAIMER

Preface

This report provides the 2025 status, offtake assessment and management guidance for the goose populations managed under the EGMP. The information covers aspects related to population status, survival, and productivity, as well as assessment of cumulative impact of derogation and legal hunting and, for some populations, management recommendations.

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Executive Summary

This report provides the 2025 status, offtake assessment and management guidance for the goose populations managed under the EGMP. The information covers aspects related to population status, survival, productivity, as well as assessment of cumulative impact of derogation and legal hunting and, for some populations, management recommendations.

Pink-footed Goose – Svalbard population
In 2023, the Data Centre committed to investigate potential biases in the biannual counts by exploring the use of GPS-tagged birds to estimate detection probabilities. Since then, detection probabilities have been estimated for the November 2022-2024 and May 2023-2025 censuses. Combined GPS tallies from the November counts revealed a detection probability of 0.84 (sd = 0.04), indicating a negative bias in fall counts. For spring counts, the locations of GPS-tagged individuals were provided to the observers in Trøndelag, Norway in May 2024 and 2025 to increase the probability of a complete census, whereas observers were not provided this information in 2023. The detection probability for May 2023 was 0.82 (sd = 0.08), again indicating a negative bias, whereas the detection probability for May 2024-2025 (combined) was 1.06 (sd = 0.04), indicating a positive bias. The updated IPM for Pink-footed Goose now accounts for these biases by drawing year-specific detection probabilities from these distributions for all November counts and all May counts prior to 2024, whereas the May 2024 and May 2025 counts were directly corrected for their positive biases. Beginning with the May 2024 estimate of 87,598 (75,263 – 101,044), the population grew to an estimated 98,192 (83,108 – 114,511) birds in November 2024. The estimate of the May 2025 population size is 78,749 (63,873 – 96,605). Harvests and harvest rates were increasing prior to the implementation of the adaptive harvest management program in 2013 but have been somewhat stable since. Estimates of annual survival have generally decreased during the entire period of record, although there is quite a bit of uncertainty associated with the estimates in the last few years (due to the cessation of the capture-mark-recapture program). The suggested harvest quota for the 2025/2026 hunting season, based on the estimated population of 78,749 individuals and 15 days above freezing in Svalbard in May 2025 is the realistic maximum of 20,000 individuals. For comparison, the realized harvest averaged 9,838 (sd = 449) during the last three years. The 2025 harvest quotas for Norway and Denmark this year are thus 6,000 and 14,000, respectively.

Taiga Bean Goose
In the Scandinavia/Denmark and UK population, winter counts in Denmark (835 individuals), Scotland (169 individuals) and England (1 individual) resulted in a total of around 1,000 geese. This is very similar to last year's result (1,174 individuals), both in terms of numbers and distribution. Research on the West Siberia/Poland and Germany population is ongoing, and some important information updates have been made available for the revision of the Taiga Bean Goose ISSAP. Population size continues to be estimated at 15,000-20,000 individuals. Harvest, if any, of both these populations should be minimized. With respect to the Finland and NW Russia/Sweden, Denmark and Germany population, the integrated population model has generally been successful at mediating all sources of count and harvest data to provide biologically reasonable and robust estimates of population status. This is encouraging because each data set has some degree of bias, including less than complete counts, missing counts from important parts of the range, and a mix of Taiga and Tundra Bean Geese in both counts and harvest. Coping with these biases has become increasingly challenging, however, because of potential changes in count methodology and unknown changes in the spatial and temporal distribution of birds. We can thus offer no formal assessment this year. However, March counts have been relatively stable in recent years, and the population is likely well above the median recovery target of 70,000. A conservative recommendation would be to maintain harvest below 3,000 to avoid precipitating a decline in population size (recent harvests have averaged about 500 birds).

Greylag Goose – NW/SW European population
Despite considerable improvements in data availability, it has still not been possible to move from the information-gap decision model at population level to a dynamic and model-based management at MU level. However, technical progress has been made, including the development of a flyway population model, a utility model used to evaluate various offtake strategies in terms of their ability to meet population targets, and a model for estimating number of breeding pairs from post-breeding counts. In 2022, a post-breeding population of 540,115 individuals in MU1, resulting in an estimated ~132,000 breeding pairs, and a post-breeding

population of 748,110 individuals in MU2, equivalent to ~180,000 breeding pairs, indicate that both MUs are well above the set targets of 70,000 and 80,000 breeding pairs, respectively. In January 2024, the wintering population was estimated at 932,910 individuals, which also indicates a population size well above the target of approximately 545,000 individuals in winter. With a reported offtake of at least 425,393 Greylag Geese in 2023/2024, we continue to suspect that the reported offtake is biased high.

Barnacle Goose – Russia/Germany and Netherlands population

This report provides an assessment of the population status of all management units (MUs) in the Russia/Germany and Netherlands population of Barnacle Goose for the period 2005/06-2023/24. Data from field counts and estimates from the IPM both indicate an estimated flyway population size of about 1.6 million individuals in January 2024, which is equivalent to four times the Favourable Reference Population size (FRP). Hence, after being stable at a level of around 1.4 million individuals, the flyway population size seems to have increased again in the past two seasons despite reports on losses caused by outbreaks of avian influenza. Converted into breeding pairs, numbers in the Russian MU1 are well beyond the FRP (and also the 200% threshold level) whereas the Baltic MU2-population has now dropped below the threshold of 200% of the FRP (calling for coordination if significant levels of offtake under derogation is likely to affect the local breeding populations in Denmark, Finland, or Sweden). In the North Sea MU3-population, number of breeding pairs has increased (or recovered) lately and is now above the FRP, but numbers are still below the 200% threshold, thus requesting coordination of derogation in Germany and the Netherlands. Gaps in monitoring effort mainly exist in the summer period.

Barnacle Goose – Greenland/Scotland and Ireland population

After a peak flyway population of 80,000 in 2006 and 2012, abundance declined to 62,438 (52,845 – 72,986) in March 2025. For much of the period of record, abundance on Islay exceeded that in all other wintering areas, but that pattern has been reversed since 2018. The total harvest rate of adults has increased over the period of record, from around 0.01 to a peak of 0.05 (0.04 – 0.07) in 2017. Thereafter, harvest rate declined to 0.03 (0.02 – 0.04) in 2024. Annual survival rate of adults (including both harvest and natural mortality) declined at the same time harvest rates were increasing, suggesting that harvest may have contributed to the decline in flyway abundance, although poorer than average reproduction could also have played a role. There currently is a 4% probability that the March 2025 population is below the FRP of 54,000. Because of the proximity of the population to the FRP in recent years, the Adaptive Flyway Management Plan requires tighter coordination of offtake between Iceland and Scotland to ensure the population does not fall below the FRP.

Action requested from the EGM IWG:

The EGM IWG is requested to take note of the Population Status and Offtake Assessment report and provide further guidance to the Secretariat and Data Centre.

1 Introduction

The first international management plan to actively manage a migratory population of waterbirds in Europe was adopted in 2012 and implemented in 2013. The plan was for the Svalbard population of Pink-footed Goose and was based on the concept of adaptive management (AM). AM provides a framework for making objective decisions in the face of uncertainty about an ecological system and the impact of management actions. To reduce this uncertainty and improve management over time, AM relies on an iterative cycle of monitoring, assessment, and decision-making.

In 2013, plans for the first iterative cycle were published in the form of a population status report and a harvest assessment report. In May 2016, the European Goose Management Platform (EGMP) was established, following a resolution adopted by the Meeting of the Parties of the African-Eurasian Migratory Waterbird Agreement (AEWA). The platform functions under the framework of AEWA, which provides for the conservation and sustainable use of the migratory waterbird populations it covers. The platform addresses the conservation and management of declining, as well as growing, goose populations in Europe. This is achieved by a coordinated flyway approach amongst all Range States concerned.

The setup of EGMP benefited from experiences with Svalbard Pink-footed Geese and was initially extended to include Taiga Bean Geese. In 2017, four more populations were added to the EGMP; the NW/SW European population of Greylag Goose, as well as the three populations of Barnacle Goose: the Russia/Germany and Netherlands population, E. Greenland/Scotland & Ireland population and the Svalbard/SW Scotland population. In some specific populations, management units have been established to delineate subpopulations, which are considered to have their own demography and/or dispersal and thus need a specific management and conservation approach. Thus, four goose species and their respective management units are currently part of the EGMP (Table 1-1).

During the 8th Session of the Meeting of the Parties to AEWA (MOP8) in 2022, it was decided to split the Taiga Bean population into three populations based on the management unit delineation. The three new populations follow the previous management units as following; the Western MU is now the Scandinavia/Denmark and UK population; the Central MU is now the Finland and NW Russia/Sweden, Denmark and Germany population, and the Eastern1 MU is now the West Siberia/Poland and Germany population. At the same time birds belonging to the former Eastern2 MU were listed as a population of Bean Goose (subspecies *johanseni*) in the AEWA Annexes (UNEP/AEWA Secretariat 2022). However, it has since been recommended by the AEWA Technical Committee and BirdLife International that these birds should be treated as a population of Taiga Bean Goose, and this change is expected following MOP9 in 2025.

Table 1-1. Overview of populations and Management Units (MUs) covered under the EGMP and relevant management documents

Population	**Management/Action Plan (ISSMP/ISSAP)**			**Adaptive Flyway Management Plan (AFMP)**		
	Link	**Adopted**	**Review**	**Link**	**Adopted**	**Review**
Svalbard population of Pink-footed Goose	ISSMP	2012	2025	Not developed	-	-
Scandinavia/Denmark and UK population of Taiga Bean Goose (former Western MU)	ISSAP	2015	2025	Not developed	-	-
Finland and NW Russia / Sweden, Denmark and Germany population of Taiga Bean Goose (former Central MU)	ISSAP	2015	2025	Not developed	-	-
West Siberia/Poland and Germany population of Taiga Bean Goose (former Eastern1 MU)	ISSAP	2015	2025	Not developed	-	-
NW/SW European population of Greylag Goose consisting of 2 MUs; MU1 (migratory) and MU2 (sedentary)	ISSMP	2018	2030	AFMP	2020	2026
Russia/Germany and Netherlands population of Barnacle Goose consisting of 3 MUs; MU1 (Arctic), MU2 (Baltic) and MU3 (North Sea)	ISSMP	2018	2030	AFMP	2020	2026
E. Greenland/Scotland & Ireland population of Barnacle Goose	ISSMP	2018	2030	AFMP	2020	2026
Svalbard/SW Scotland population of Barnacle Goose	ISSMP	2018	2030	Not developed	-	-

This report, together with the EGMP Database, comprises a joint population status and harvest assessment for all populations covered by the EGMP. The EGMP Database provides a shared platform for the most up-to-date monitoring information on each population managed under the EGMP (including data sources), whereas this report focuses on the assessment results and management guidance, to be reviewed at the annual meeting of the International Working Group.

Previous EGMP reports are available at: https://egmp.aewa.info/resources/publications.

For populations/species where the cumulative impact of derogation and legal hunting is assessed and/or management guidance provided, input and output files of the assessment runs from previous years are available at: https://gitlab.com/aewa-egmp. Most recent files (current assessment) and further details are available from the EGMP Data Centre (egmp@ecos.au.dk).

Information on indicators related to other aspects of the management plans, such as socioeconomic issues and ecosystem services provided by geese, are presented in the Adaptive Flyway Management Programmes (AFMPs) in the annex 'Indicator factsheets'. All AFMPs are available here: https://egmp.aewa.info/resources/action-and-management-plans-adaptive-flyway-management-programmes.

1.1 The assessment processes

The assessment process is pictured in Figure 1.1-1 and consist of three steps;

1) *Monitoring.*

Periodic monitoring and other data collection is essential for keeping track of the implementation progress for the EGMP ISSMPs, ISSAPs and AFMPs, not least regarding the process for setting hunting regulations and assessing the impact of derogation. Monitoring data refers to measures of abundance (counts or indices based on samples), data on productivity (counts of young and adults) and survival, and data to describe offtake (either hunting bags or derogation data). Monitoring and data collection are ongoing activities, which take place throughout the year, and are conducted according to agreed protocols. Data from monitoring activities are compiled by the EGMP Data Centre, by Sovon Vogelonderzoek Nederland for the Russia/Germany and Netherlands population of Barnacle Goose, and by NatureScot for the E. Greenland/Scotland and Ireland population of Barnacle Goose. See Appendix A for coverage in each country and population and the EGMP Database for overview of data.

2) *Assessment.*

The data produced by monitoring provides information to estimate the status of the populations and are used along with other information to evaluate progress towards reaching management objectives, as well as to facilitate learning after decisions are made.

For populations/species where population models have been developed, demographic information like population size, productivity and survival rates are based on model estimates, and updated as new data are received. For populations/species without population models and/or updated data, the most current information received from the range states and their monitoring networks is presented. Due to delays in acquiring certain data, some information presented in this report will differ from that in previous reports and may also be subject to updates in future reports.

For populations/species where only derogation is allowed, the cumulative impact of offtake is assessed through retrospective and prospective analyses, investigating the effect of derogation at the population and at the MU level. The effect of the current level of derogation and environmental variables (e.g., avian influenza) is also projected into the future.

For huntable populations/species, a harvest strategy is derived, and annual management guidance is provided. This happens either through a formal adaptive harvest management process as for Pink-footed Goose, or through consensus on quotas informed by simulations as is done for the Finland and NW Russia/Sweden, Denmark and Germany population of Taiga Bean Goose (formerly known as the Central MU).

No reporting is provided for the Svalbard/SW Scotland population of Barnacle Goose.

3) *Decision-making.*

The decision-making process takes place by national representatives at the IWG annual meetings. Decision making at each decision point considers management objectives, resource status, and knowledge about consequences of potential actions. Decisions are then implemented by means of management actions on the ground.

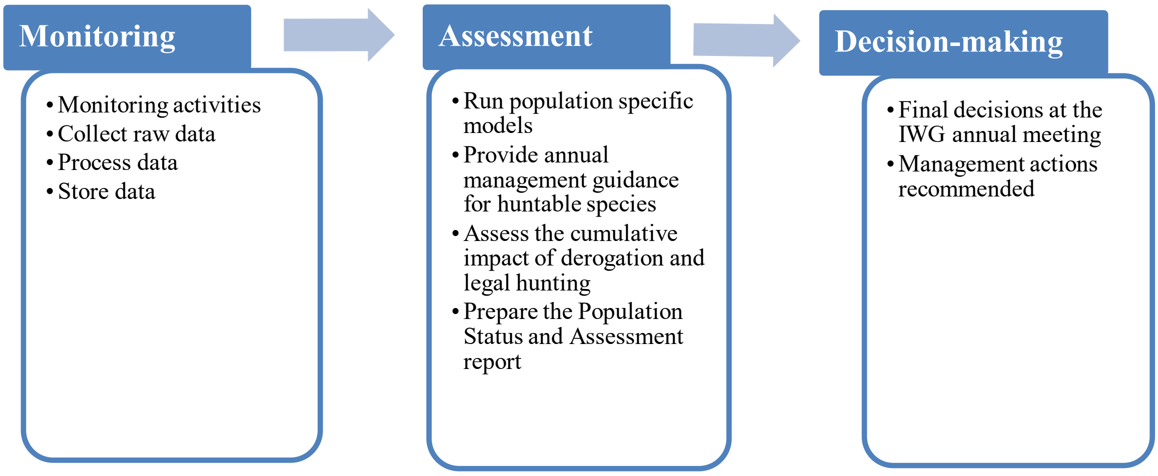

Figure 1.1-1. The EGMP assessment process, including annual activities related to monitoring, assessment and decision-making.

2 Monitoring and assessment methods

2.1 Population size

Counts of geese managed under the EGMP are performed at different times throughout the year. The counts can be either total counts or counts collected through a sampling program with the aim of estimating the total population size and/or to monitor a trend.

January census: All goose populations managed under the EGMP are covered by the International Waterbird Census (IWC), which takes place during mid-winter in January and has been implemented in most countries forming part of the respective Eurasian flyways. These counts focus on wetland areas, but in some countries include schemes specifically for geese as well, covering occurrence in farmland areas. Field work is usually carried out by a large network of volunteers during daytime on feeding sites or at dawn/dusk at roost sites, but precise methods, and especially coverage, may vary slightly between countries. In addition, some countries (e.g., The Netherlands, Belgium) account for missing geese in the network of counting sites by estimating missing counts ("imputed") with algorithms that account for the long-term trend and the phenology in similar census areas within the region (Hornman et al. 2021; Onkelinx et al. 2017). That way the data used for trend calculations represent a complete dataset and is not subject to variation in counting effort. Goose counts are collected by national coordinators and reported to Wetlands International who coordinates the IWC (van Roomen et al. 2025).

For several species, the January census provides the best available knowledge on the size of the total flyway population, as it has relatively high coverage in all countries and has been in place since the late 1950s, allowing for analyses of long-term time series (Fox and Leafloor 2018). Also, it takes place towards the end of the hunting season for most species, thus allowing an assessment of the effects of offtake. However, for widely dispersed species like e.g., Greylag Goose, the January census only provides information on the overall trend of the entire flyway population, as coverage is currently regarded too low to assess total population size. Moreover, the January count is not suitable to assess the size and trend for some populations and specific MUs as different MUs mix during winter. For these reasons, specific counts are also organised at other times during the year, in order to assess the size of the respective MU-populations. Under the EGMP, data from the IWC is currently only used directly in the assessment of the NW/SW European population of Greylag Goose.

Autumn census: In continental Europe, special population counts have previously been made for all grey geese (*Anser sp*.) in November, as well as in September for Greylag Goose (Madsen et al. 1999). In recent years, most Range States have performed additional counts as for example in Sweden, where goose counts are performed in September-November and January each year, and in The Netherlands and Belgium where counts are carried out from September to March/May and cover the entire wintering season. A general issue with the autumn counts is that for huntable species, the count will occur after the start of the hunting season, which from a modelling and assessment perspective complicates the assessment process. For Greylag Goose, most Range States now perform post-breeding counts prior to the hunting season (see below).

Spring census: Counts during spring, just before the assessment process in May/June and after the hunting season, is on the other hand the best time of the year to provide knowledge on the population size of huntable species shortly before breeding. For the Svalbard population of Pink-footed Goose a total count is organized in early May, just before they leave for the breeding areas and are highly concentrated in only a few areas. For the Finland and NW Russia/Sweden, Denmark and Germany population of Taiga Bean Goose, a count (in addition to the autumn and mid-winter count) is organized in March, when most of the population is gathered in Sweden and good coverage is possible. To estimate population sizes of breeding waterfowl and wader species, including Greylag Goose, France has recently introduced a spring census which will take place at regular intervals (currently planned for every six years).

Summer census: For populations where management is performed at a MU level (e.g., Greylag Goose and the Russian population of Barnacle Goose), summer is the only period in which the size of the population in each MU can be assessed. Summer counts take place from mid-July to early September, under the assumption that birds from the respective MUs have not yet left the country or can be accounted for. This type of census does not only cover breeding birds and their offspring, but also failed breeders and non-breeders (i.e., all individuals within the respective MU). So, compared to regular breeding bird surveys in spring (delivering number of breeding pairs), they give a more comprehensive account of abundance (expressed in individuals) in the post-breeding period, while the number of breeding pairs must then be calculated from the results of the post-breeding censuses. Summer counts are carried out during daytime and focus on wetlands and waterbodies, which in summer host nearly all birds during daytime. Hence, coverage is regarded as high (usually >90%), but in some large countries (e.g., Norway and Finland) it is a challenge to coordinate such counts, and alternative sampling approaches are being developed. Data is collected through volunteer networks but with substantial professional input (more so than during winter). In the IPM-framework, for the Russia/Germany and Netherlands population of Barnacle Geese, the number of breeding pairs is set as the number of individuals of 2 years and older divided by 2.

All data is provided by national coordinators or agencies, but in some specific cases may also rely on published information (see EGMP Database for details).

2.2 Reproduction

In migratory geese, productivity is typically expressed as the proportion of young in the autumn population and is assessed at the autumn staging and wintering grounds by observing the number of young vs. adults in flocks of geese – also called age-ratio counts. Such age counts have been performed for many European goose populations for several decades by skilled experts, providing a long-term time series of their breeding performance (Madsen, Cracknell, and Fox 1999; Hornman et al. 2024). Counts are usually done in October and November, Greylag Goose is however already assessed during July and August (in some cases in combination with the summer census), as it is otherwise difficult to distinguish juveniles from adults (see Koffijberg 2022). Assessing productivity at the staging and wintering grounds is, however, likely to be affected by several factors as we are compelled to sample from an open population, in which the temporal and spatial age composition can vary, e.g. due to differential migration, mortality and flocking behaviour (Gupte et al. 2019). The effect of such factors has been investigated, with the Svalbard Pink-footed Goose as a case study (Jensen et al. 2023).

2.3 Offtake and survival

Hunting bags: All range states allowing hunting have harvest monitoring schemes in place; ranging from national harvest data recording across harvest data schemes at regional level/s to harvest data collection by wildfowling clubs (UK). Data are generally gathered on an annual basis, but often with a time lag in publishing the data. Furthermore, in most countries, data are gathered for each huntable waterbird species. Most countries have legislation that requires harvest bags to be reported by all hunters, with the exception of Sweden, France, UK and Wallonia, Belgium that have no legislation requiring harvest bags to be reported by all hunters. Moreover, in most countries waterbird harvest data are collected for all individual hunters throughout the country, but in some countries, data are only collected for hunting units, or only a sample of hunters is surveyed. Thus, in general there is an absence of harmonisation among the different hunting bag collecting schemes in Europe. Moreover, there is a lack of information on how calculations are made with the local/regional data to produce the national hunting bag statistics. Thus, reliable inference about flyway totals is very difficult to attain (Aubry et al. 2020). Furthermore, it is not always clear whether the national derogation data (see below) are additional to, or included in, the reported hunting data in countries where both hunting and derogation occurs. For some species, bias in hunting bag reporting is suspected (Johnson and Koffijberg 2021). Hunting bag data are available online in the following countries: Belgium, Denmark, Finland, Germany, Greenland, Iceland, Norway and Sweden (a link is provided in each country name).

Derogation: EU Member States are obliged to report all derogations to the European Commission in annual derogation reports (according to Article 9 in the Birds Directive (Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds), see EU 2020). However, for a number of Member States, the data is only available after a delay of several years. Furthermore, in some countries this reporting involves several administrative levels and with some uncertainty as to the true number of birds killed. Derogation data are available from the EU Eionet central data repository (https://ec.europa.eu/environment/nature/knowledge/rep_birds/index_en.htm), but for this report data has also been provided by the countries themselves or taken from drafts data available through the EU central data repository mentioned above.

Wings and heads: In Denmark, Iceland, Scotland, and Sweden hunters may, on a voluntary basis, submit wings from shot geese to national wing surveys. These wing samples contribute to the knowledge of the temporal variation in the hunting bag, as well as knowledge of age ratio among shot birds. In Denmark, Sweden, Finland, and Latvia, hunters have also been invited to submit (photos of) heads of shot Bean Geese to the national hunting organisation for sub-species identification to estimate the proportion of Taiga Bean Geese in the hunting bag.

Crippling rate: In several goose species, X-ray images have been used to assess the proportion with embedded shotgun pellets (Noer et al. 2007). The incidence of embedded shotgun pellets is an expression of hunting exposure and also plays an important role in the ISSMP/AFMP process from an ethical viewpoint and as they are sub-lethal injuries potentially affecting fitness of the geese. Crippling rate is defined here as the proportion of individuals with at least one embedded shotgun pellet, assessed by processing of X-ray images. Whereas the crippling ratio is the crippling rate divided by the harvest rate. Harvest rate is defined as the proportion of the population being shot (Clausen et al. 2017). In general, there is a need for standardized crippling assessment, which is in progress among those institutes collecting data.

Survival: Survival estimates can be obtained from analysis of various methods of capture-mark-recapture, where the bird is first captured and marked and then seen/captured using a combination of observations of marked individuals (for example taken from the geese.org database) and recoveries of metal-ringed individuals provided by e.g. EURING (van der Jeugd 2003; Kéry et al. 2006).

2.4 Population assessment methods

Integrated population models (IPM) are currently used to derive estimates of abundance and demographic rates for four goose populations covered by the EGMP: Svalbard Pink-Footed Goose (Johnson et al. 2020), the Finland and NW Russia/Sweden, Denmark and Germany population of Taiga Bean Goose (Johnson, Heldbjerg, and Mntyniemi 2020), E. Greenland Barnacle Goose (McIntosh et al. 2021), and the Russian-Germany-Netherlands population of Barnacle Goose (Baveco et al. 2021). IPMs represent an advanced approach to modelling, in which all available demographic data are incorporated into a single analysis (Schaub and Abadi 2011). IPMs have many advantages over traditional modelling approaches, including the proper propagation of demographic uncertainty, better precision of demographic rates and population size, and the ability to handle missing data and to estimate latent (i.e., unobserved) variables. They also have the capacity to guide the development of effective monitoring programs. IPMs can also be used to derive optimal offtake strategies or to project the future consequences of offtake strategies that have been defined a priori. Finally, use of a Bayesian estimation framework for IPMs provides a natural framework for adaptation, in which demographic parameters can be updated over time based on observations from operational monitoring programs.

Estimates of abundance, survival, and productivity from an IPM are based on the joint statistical likelihood of all the data used in the model. This likelihood is combined with any prior information that may be available to provide what are called posterior estimates of demography. Because the entire historical record of data is always used, all posterior estimates may change slightly each year as new data are added to the historical record. Moreover, posterior estimates from the IPM are unlikely to match perfectly those derived from an independent analysis of an individual source of data. For example, estimates of survival from analysis of capture-mark-recapture (CMR) data are likely to be slightly different than posterior estimates of survival derived from the IPM. This is because the CMR analysis only uses CMR data, whereas the IPM uses the CMR data, plus census data and all other sources of demographic data, to estimate survival. Thus, a great benefit of using the IPM is more reliable estimates of abundance and demography, which better reflect all the demographic information available for a population, and which are not so sensitive to any sources of bias (e.g., which may occur in CMR-data due to neckband loss or differential survival between marked and unmarked birds).

3 Results and Discussion

3.1 Pink-footed Goose *Anser brachyrhynchus*

3.1.1 Range states and management units

This chapter compiles monitoring data on the population status of the Svalbard population of Pink-footed Goose, as well as providing guidance for the upcoming hunting season (2025/2026). The range states for this population include Norway, Denmark, Belgium and the Netherlands (Figure 3.1-1). More recently, Pink-footed Geese have established a new migration route through Sweden and Finland with breeding grounds in Novaya Zemlya in north Russia. This new group consists of at least 4000 individuals and is expected to increase further, partly due to immigration from the traditional flyway (Madsen et al. 2023). Around 5,000 birds were counted in Sweden and Finland in November 2024, all assumed to belong to the breeding group from Novaya Zemlya. In the draft revised Pink-footed Goose ISSMP, it is currently proposed to consider the breeding grounds of the new group as a range expansion. Thus, the new group will be included in the Svalbard population, adding Sweden, Finland, and Russia to the list of Range States. This approach has previously been approved by the AEWA Technical Committee and the Pink-footed Goose Task Force.

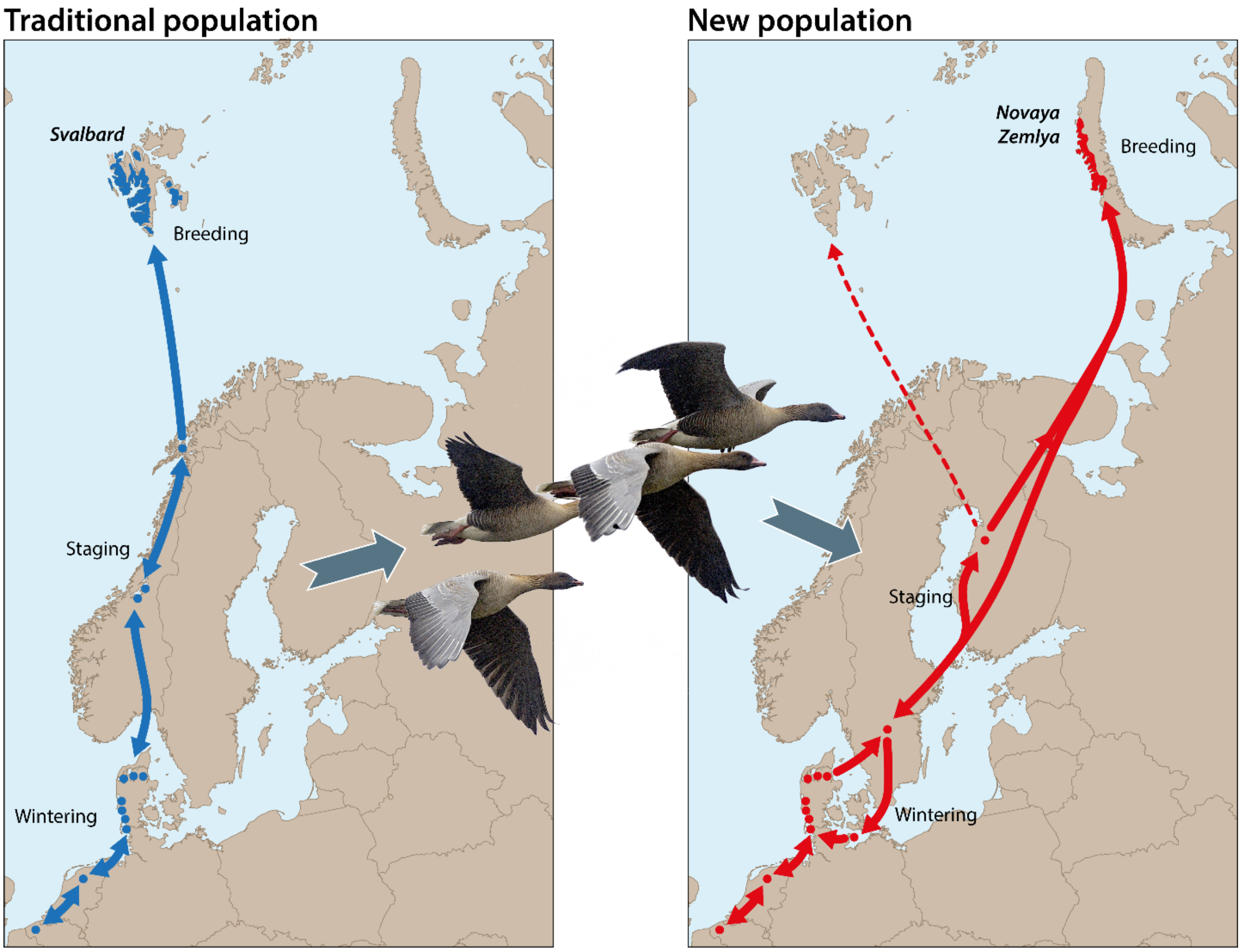

Figure 3.1-1. Annual distribution and migration route of Svalbard Pink-footed Goose traditional population (left) as well as the new breeding group (right) (Madsen et al. 2023).

3.1.2 Population FRP and target

No FRP has been set for this population. The population target was set at 60,000 individuals in spring to help reduce agricultural conflicts, particularly in Norway, as well as tundra degradation due to grazing on breeding grounds in Svalbard.

3.1.3 Management strategies

Legal hunting of Svalbard Pink-footed Geese occurs only in Norway and Denmark. A harvest strategy, which is updated each year, prescribes the harvest quota necessary to maintain the population near its target of 60,000 birds. The harvest quota is allocated between Norway (30%) and Denmark (70%) based on historical proportions of the harvest.

3.1.4 Assessment protocol

We used the integrated population model described by Johnson et al. (2020). Annual changes in population size in May are described by a difference equation:

$$N_{t+1}^{M} = N_t^M\left[s_t + r_t\theta_t\left(1 - \upsilon h_t^n - \upsilon h_t^d\right)\right]$$

where N_t^M is May population size in year *t*, s_t is the annual survival rate, r_t is the ratio of young of the year to older birds at the start of the hunting season, θ_t is survival from natural causes, h_t^n and h_t^d are per capita harvest rates of birds aged >1 year in Norway and Denmark, respectively, and υ is the differential vulnerability of young relative to older birds in the harvest.

Population size in November is a function of population size in May, six months of natural mortality, and the portion of harvest in Denmark occurring prior to November:

$$N_t^N = N_t^M\theta_t^{6/12}\left[\left(1 - h_t^n - h_t^{\dot{d}}\right) + r_t\left(1 - \upsilon h_t^n - \upsilon h_t^{\dot{d}}\right)\right]$$

where N_t^N is November population size and $h_t^{\dot{d}}$ is the harvest rate of older birds in Denmark prior to November.

Within the IPM, we specified a generalized linear model for reproductive rate (*r*) using the number of thaw days (*D*) in May in Svalbard as a covariate: $r_t = \frac{\gamma_t}{(1-\gamma_t)}$, where γ_t is the binomial probability of young, and:

$$log\left(\frac{\gamma_t}{(1-\gamma_t)}\right) = \beta_0 + \beta_1 D_t$$

Raw data and the results of the 2025 update of the IPM are available from the EGMP Data Centre.

Posterior estimates of natural mortality, differential vulnerability of young to harvest, and the regression coefficients expressing the relationship between thaw days and reproductive success were used to derive an optimal harvest policy. We used a computation algorithm known as stochastic dynamic programming (SDP), which can explicitly account for various sources of uncertainty in modelled systems (Marescot et al. 2013).

For computational purposes, the optimal value (*V**) of a management strategy (*A*) at time *t* is the maximum (max) of the expectation (*E*) of the temporal sum of discounted population utilities:

$$V^*(A_t|x_t) = \max_{(A_t|x_t)} E\left[\sum_{\tau=t}^{\infty} \lambda^\tau u(a_\tau|x_\tau)|x_t\right]$$

where $\lambda = 0.99999$ is the discount factor for an infinite time horizon. This particular discount factor means that population utility 100 years hence will still retain 99.9% of its current value, in keeping with the desire to protect exploited resources for use by future generations (Sumaila and Walters 2005). Population utility $u(a_\tau|x_\tau)$ is action (a_τ) and resource-dependent (x_τ) and is defined as:

$$u(a_\tau|x_\tau) = \frac{1}{1 + exp(|N_{t+1} - 60| - 10)}$$

where N_{t+1} is the population size (in thousands) expected due to the realized harvest quota and the population target is 60 (thousand). The 10 (thousand) in the equation for population utility represents the difference from the population target when utility is reduced by one half. Thus, the objective function devalues harvest quotas that are expected to result in a subsequent population size different than the population target, with the degree of devaluation increasing as the difference between population size and the target increases. The optimal harvest strategy was computed using the publicly available software MDPSolve (© 2010 – 2011 Paul L. Fackler, https://github.com/PaulFackler/MDPSolve), which is a set of SDP tools written in the proprietary MATLAB® programming language.

3.1.5 Population status

a) Abundance and trends

We begin by providing updates on some monitoring issues that have come to light over the past few years. For most of the period of record the November count was less than the Lincoln-Peterson (LP) estimate in May, which is not biologically realistic. When combined with the available productivity data, the IPM therefore concluded that the November count must be biased low. Around 2015, however, the November count "caught up" with the May LP estimate and greatly exceeded it in 2020 and again in 2021. Again, when combined with productivity data, the IPM concluded that the November count had become biased high. Moreover, the May count has always been less than the May LP estimate, which is not surprising because counts (i.e., a "census") are often biased low (Fryxell et al. 2014). Beginning in 2010, May LP estimates were able to "arbitrate" between the November and May counts (both of which likely have biases). In 2021, however, the May LP estimates were discontinued. The IPM now had difficulty interpreting the decreasing May count and the increasing November count. In 2023, the Data Centre committed to investigate the magnitude of bias in the biannual counts by exploring the use of GPS-tagged birds to estimate detection probabilities. A total of 109 Pink-footed Geese (mainly adult females) were GPS-tagged in western Finland in spring 2017 and 2018, in Svalbard in 2018, in Denmark in 2021 and in Norway in 2022 (Madsen et al. 2023; Schreven et al. 2024). However, precise positions of counted birds have only been available since November 2022.

We compared the time and location of counts with that of GPS-tagged individuals in the November 2022-2024, and May 2023-2025 censuses. We tallied the number of GPS tags not present in a counting area on the day of the count, those recorded once in a counting area, and those recorded twice (i.e., double counted). We pooled GPS tallies from the November 2022, November 2023, and November 2024 censuses to increase sample size. We did not, however, pool all GPS tallies from the three May censuses. In May 2024 and 2025, the locations of GPS-tagged individuals at the start of the counts were provided to the observers in Trøndelag, Norway (where the majority of the population is concentrated in May) to increase the probability of a complete census. Observers provided GPS-positions of their counting points and time of visit. Based on the counts of GPS-tagged birds not present, counted once, and counted twice in a circle of 1 km radius around the counting points and within +/- 1 hour around the visit by the observer the estimated detection probability during the May 2023 count was 0.82 (sd = 0.08), indicating a negative bias. In May 2024-2025, however, the pooled estimated detection rate was 1.06 (sd = 0.04), indicating a positive bias (Figure 3.1-2). During the November counts the estimated detection probability pooled across all three years was 0.84 (sd = 0.04), indicating a negative bias (Figure 3.1-3). Detailed methods for the comparison of counts versus GPS-tags are available from the EGMP Data Centre on request. For all November counts as well as May counts prior to 2024, we assumed the estimated means and sampling variances were constant over time but allowed year-specific detection probabilities to be drawn from these distributions. The May 2024 and 2025 counts were corrected for the year-specific positive bias.

Accounting for these GPS-based biases resulted in little change in population estimates prior to about 2017, partly because estimates of spring population estimates based on a capture-mark-recapture program (since discontinued) were able to "arbitrate" between the May and November counts (which are both biased). The greatest difference in population estimates based on the new GPS corrections occurs in the most recent years, which coincides with when the IPM was previously having trouble reconciling the difference in raw counts between May and November of the same year (as was originally reported in 2023).

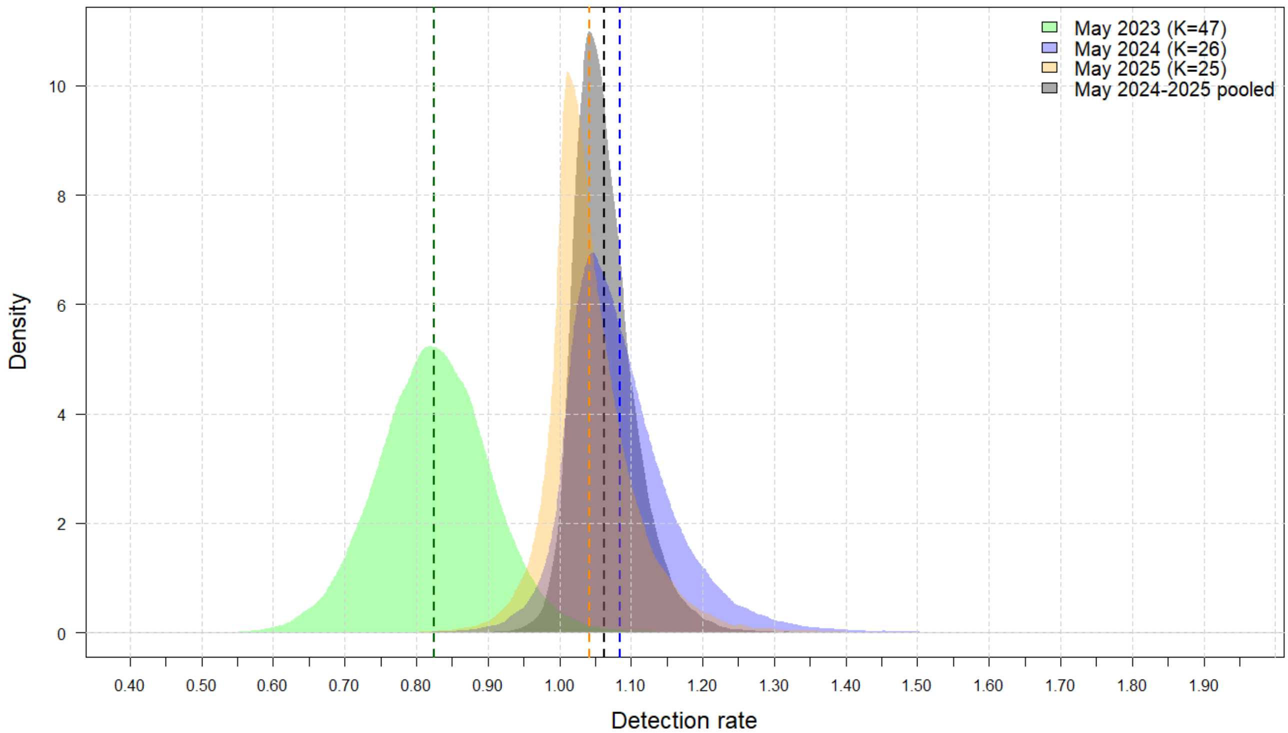

Fig. 3.1-2. Estimated distributions of detection rates during May counts of Svalbard Pink-footed Geese based on the co-location of counted geese and GPS-tagged individuals. Values below 1.0 indicate a negative bias in the counts, while values greater than 1.0 indicate a positive bias (i.e., double counting). *K* represents the number of GPS tags active (included in counts) each season. For the current version of the IPM, detection rates for May counts prior to 2024 were drawn from the May 2023 distribution, representing the estimated negative bias in those years. May 2024 and 2025 counts were corrected for their positive bias (where locations of GPS-tagged birds were provided to observers) based on the pooled distribution (grey).

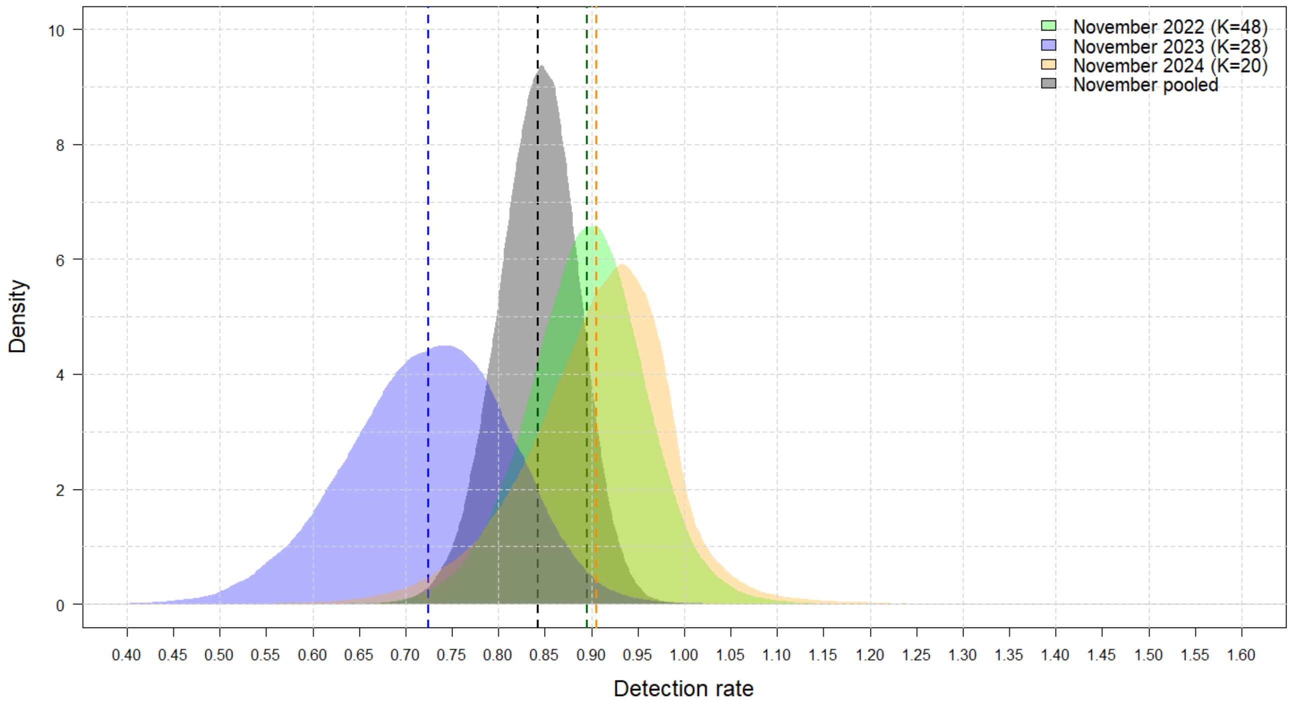

Fig. 3.1-3. Estimated distributions of detection rates during November counts of Svalbard Pink-footed Geese based on the co-location of counted geese and GPS-tagged individuals. Values below 1.0 indicate a negative bias in the counts, while values greater than 1.0 indicate a positive bias (i.e., double counting). *K* represents the number of GPS tags active (included in counts) each season. For the current version of the IPM, detection rates for all November counts were drawn from the pooled distribution (grey).

Estimated population sizes in May and November are provided in Figure 3.1-4. The reader should be aware that historic estimates may have changed as a result of an accumulation of monitoring data over time. Beginning with the updated May 2024 estimate of 87,598 (75,263 – 101,044), the population grew to an estimated 98,192 (83,108 – 114,511) birds in November 2024. The estimate of the May 2025 population size is 78,749 (63,873– 96,605). Notably, only 4,354 Pink-footed Geese were counted in western Finland in May 2025, compared to the substantially higher counts of 6,850 and 9,942 in May 2023 and 2024, respectively. Hence, the growth of the segment migrating via Sweden and Finland reported in previous years may have levelled off, but further monitoring over the next few years will help clarify these trends.

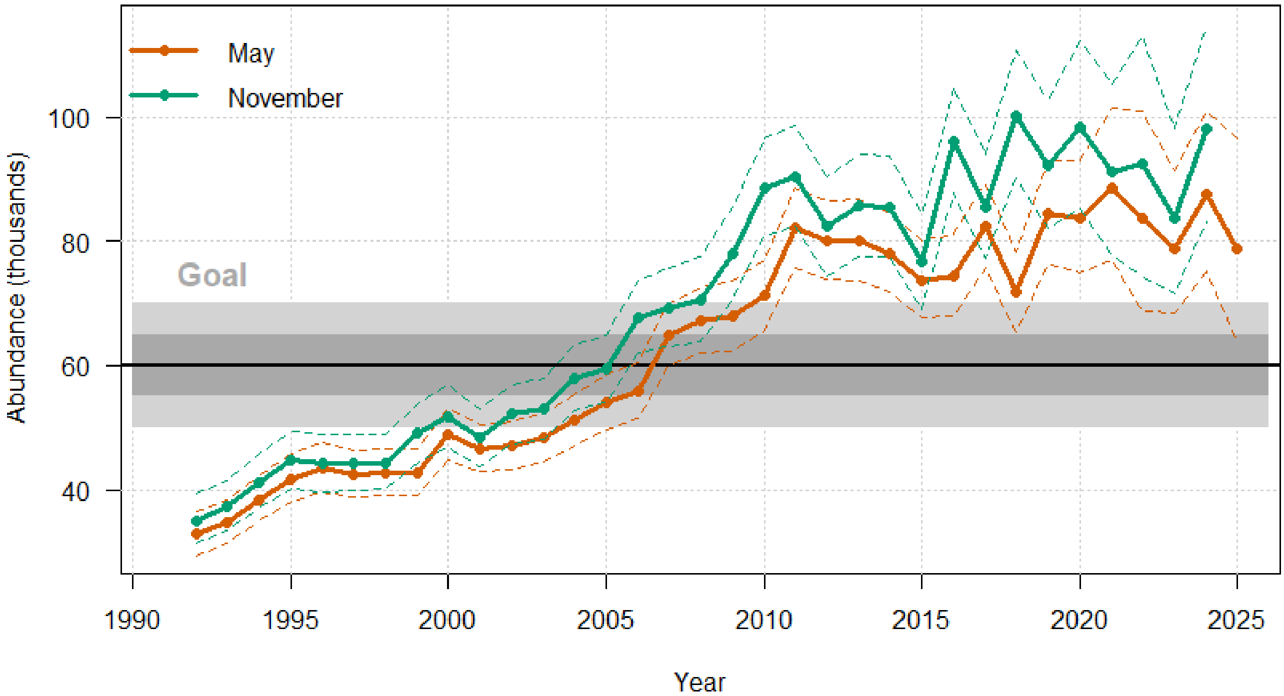

Figure 3.1-4. IPM-based estimates of abundance of Svalbard Pink-footed Geese in May and November, relative to the goal of 60,000 (95% credible intervals are indicated by the dashed lines). The dark grey band centered on the goal defines near-complete stakeholder satisfaction with population sizes, while the light grey band exhibits ≥½ of maximum satisfaction.

b) Mortality and trends

Posterior estimates of country-specific harvests of Svalbard Pink-footed Geese are provided in Figure 3.1-5. Posterior estimates of annual harvest and survival rates of the flyway population are provided in Figure 3.1-6. Harvests and harvest rates were increasing prior to the implementation of the adaptive harvest management program in 2013 but have been somewhat stable since. We note that harvest has decreased substantially in Denmark during the last four years for reasons that are unclear (possibly related to geese using non-traditional areas and because the Danish Hunters' Association – following the decision taken during IWG8 – encouraged Danish hunters to reduce their offtake in 2023/24 due to uncertainty about population size). Estimates of annual survival have generally decreased during the entire period of record, although there is quite a bit of uncertainty associated with the estimates in the last few years (due to the cessation of the capture-mark-recapture program). In particular, the apparently large increase in annual survival in 2023 and then sharp decline in 2024 should be viewed with some scepticism.

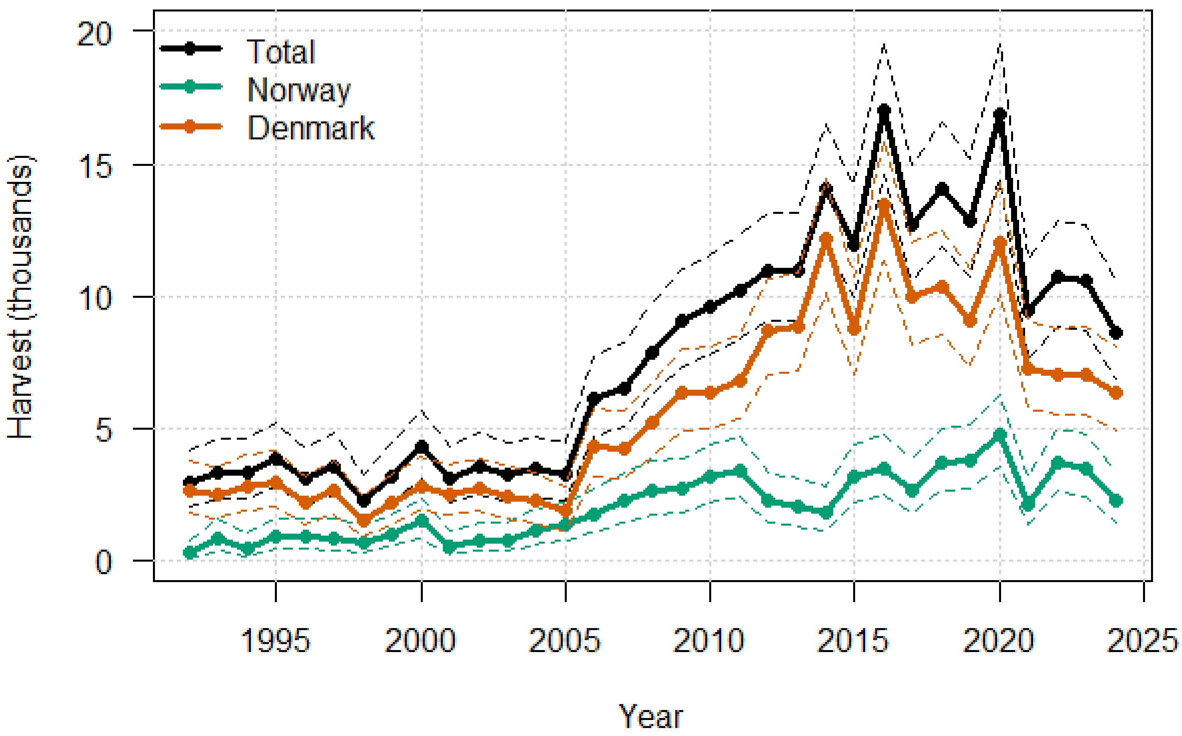

Figure 3.1-5. IPM-based estimates of harvests of Svalbard Pink-footed Geese (95% credible intervals are indicated by the dashed lines).

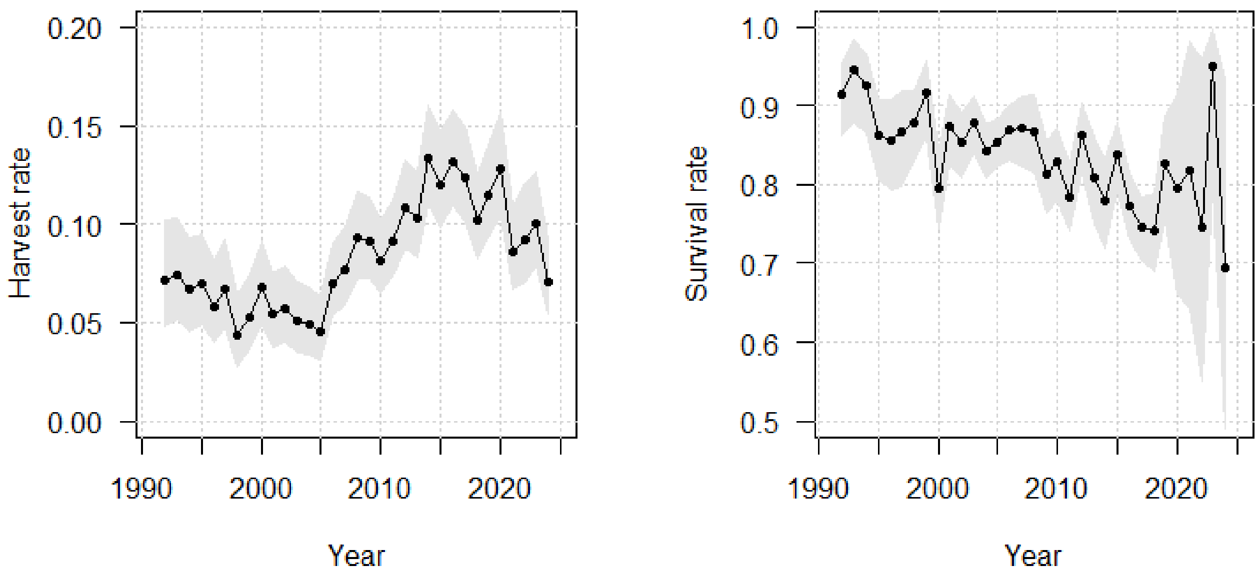

Figure 3.1-6. IPM-based estimates of harvest and annual survival rates of adult Svalbard Pink-footed Geese (95% credible intervals are indicated by the shaded polygons).

c) Reproduction and trends

Estimates of productivity, as indicated by the post-breeding proportion of young in the population, have been variable, with an average proportion of 0.19 (*se* = 0.01) young (Figure 3.1-7). Productivity has generally increased over the period of record and is highly correlated with the increasing number of days in which the mean air temperature is above freezing in May in Svalbard. The post-breeding proportion of young reached a maximum of 0.37 (0.32 – 0.41) in 2018 following a record 27 days above freezing in May in Svalbard. In contrast, the record low proportion of 0.13 (0.12 – 0.14) occurred in 1998, following 0 days above freezing in May in Svalbard. In 2024, the estimated post-breeding proportion of young was 0.20 (0.19 – 0.21), following 11 days above freezing in May in Svalbard.

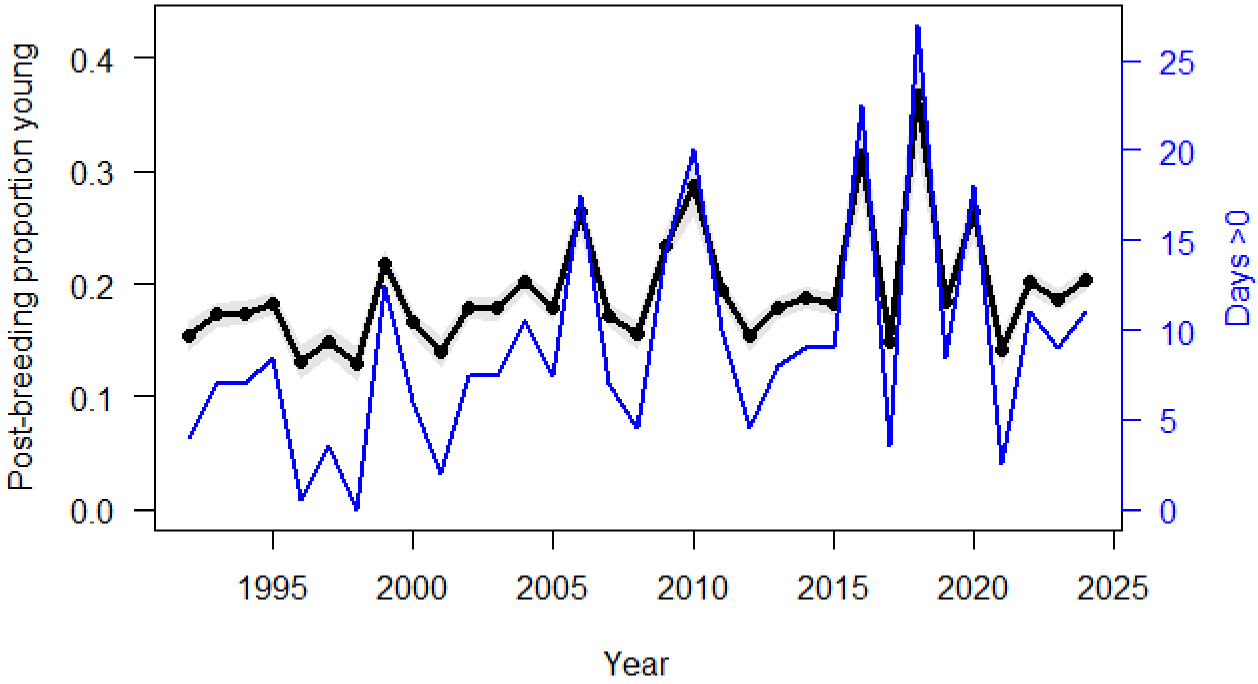

Figure 3.1-7. IPM-based estimates of the post-breeding proportion of young for Svalbard Pink-footed Geese (95% credible intervals are indicated by shaded polygon). In blue are the number of days above freezing in May in Svalbard.

3.1.6 Management guidance

The optimal harvest management strategy based on results of the IPM, candidate harvest quotas, and the objective function expressing the level of satisfaction with various population sizes recommends harvest quotas ranging from 0 to a maximum of 20,000 (capped based on limited harvest capacity, reflecting a maximum harvest of 17,000 achieved in the past) within the most desirable range of population sizes (i.e., 55,000–65,000) (Figure 3.1-8). Harvest quotas for population sizes <55,000 are very low unless the number of days above freezing in May in Svalbard is very high. Harvest quotas for population sizes >65,000 increase rapidly with small increases in population size, regardless of the number of days above freezing in May. For a population at its goal of 60,000, and with a mean number of 12 days above freezing, the harvest quota is 10,000. Moreover, for a population near its target of 60,000, small changes in population size or days above freezing in Svalbard can lead to changes in quotas that are well below those which can be regulated effectively. The management strategy in Figure 3.1.8 also depicts the evolution of May population size, days above freezing in May, and harvest quotas since implementation of AHM in 2013.

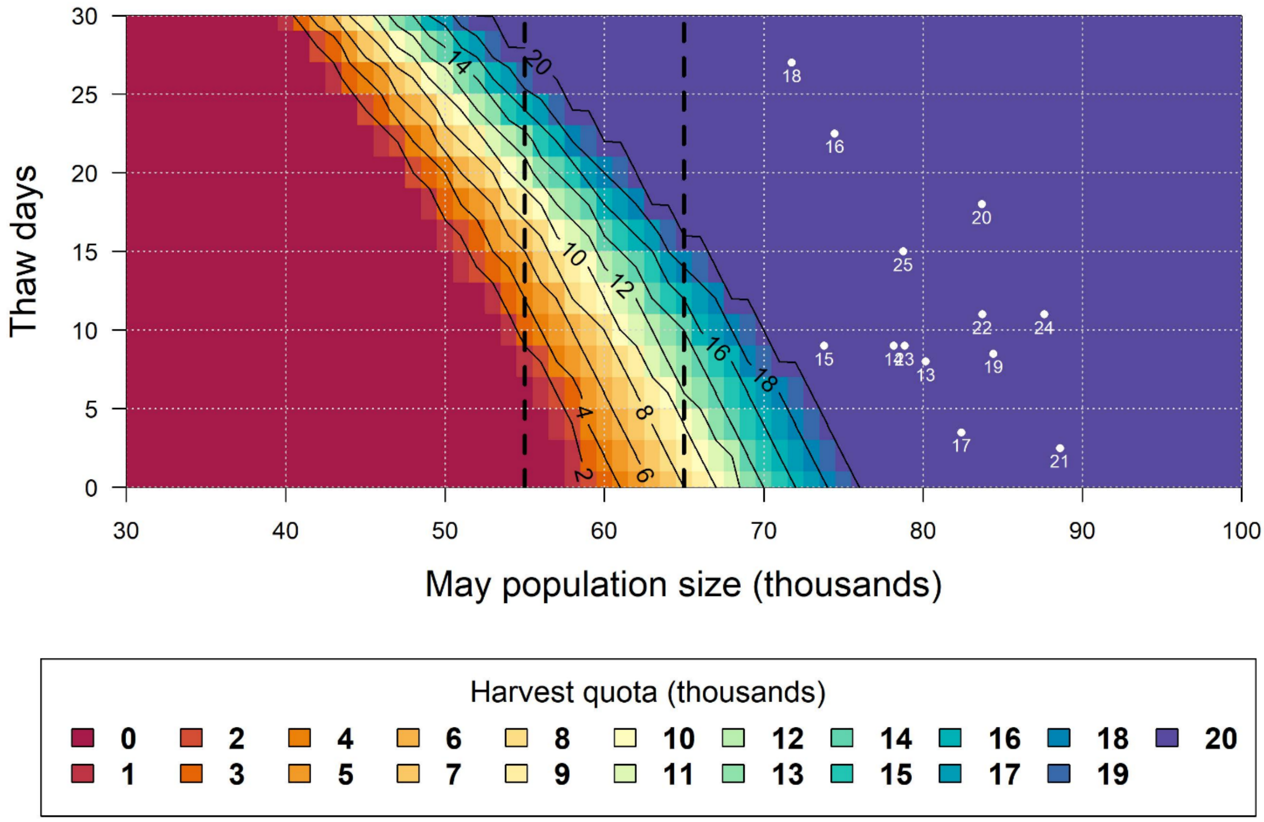

Figure 3.1-8. Optimal harvest quotas for Svalbard Pink-footed Geese based on an IPM and an objective to maintain population size near 60,000. Thaw days represents the number of days above freezing in May in Svalbard. The black vertical dashed lines depict near-complete stakeholder satisfaction with population sizes. Also depicted are population sizes and days above freezing for the years in which AHM has been in place, with 13 = year 2013 and 25 = year 2025.

The estimated breeding population this year is 78,749 individuals. With 15 days above freezing in Svalbard in May 2025, the predicted proportion of young in the fall is 24%, suggesting a post-breeding population size of 97,649 individuals. Accordingly, the optimal harvest quota for the 2025/2026 hunting season is at the maximum capacity of 20,000 which, if achieved, would result in a spring population of 73,692 in 2026 due to the warm spring and high production of the population. For comparison, the realized harvest averaged 9,838 (sd = 449) during the last three years. If we use a quota of 20,000 and the agreed upon allocation of the quota (30% for Norway, 70% for Denmark), harvest quotas for Norway and Denmark this year are 6,000 and 14,000, respectively. During the last three years, the harvest in Norway and Denmark averaged 2,893 (sd = 363) and 6,909 (sd = 177), respectively. Thus, harvests will have to be increased considerably to achieve the population target of 60,000 in spring. If harvest rates continue to be below 10%, we could expect further population growth.

3.2 Taiga Bean Goose *Anser fabalis fabalis*

3.2.1 Range states and management units

This chapter provides monitoring and assessment information for three populations of Taiga Bean Geese (formerly referred to as the Western, Central, and Eastern 1 Management Units (MUs), Figure 3.2-1). Birds belonging to the former Eastern 2 MU are currently listed as a population of Bean Goose (subspecies *johanseni*) in the AEWA Annexes. The three recognized populations of Taiga Bean Geese are delineated as:

- Scandinavia/Denmark and UK population: Breeding in Northern and Central Sweden and Southern and Central Norway, wintering in Northern Denmark and Northern and Eastern United Kingdom;
- Finland and NW Russia/Sweden, Denmark and Germany population: Breeding in Northernmost Sweden, Northern Norway, Northern and Central Finland and adjacent North-western parts of Russia, wintering mostly in Southern Sweden and South-east Denmark;
- West Siberia/Poland and Germany population: Breeding in upper Pechora region and western parts of west Siberian lowlands of Russia, wintering mostly in North-east Germany and North-west Poland.

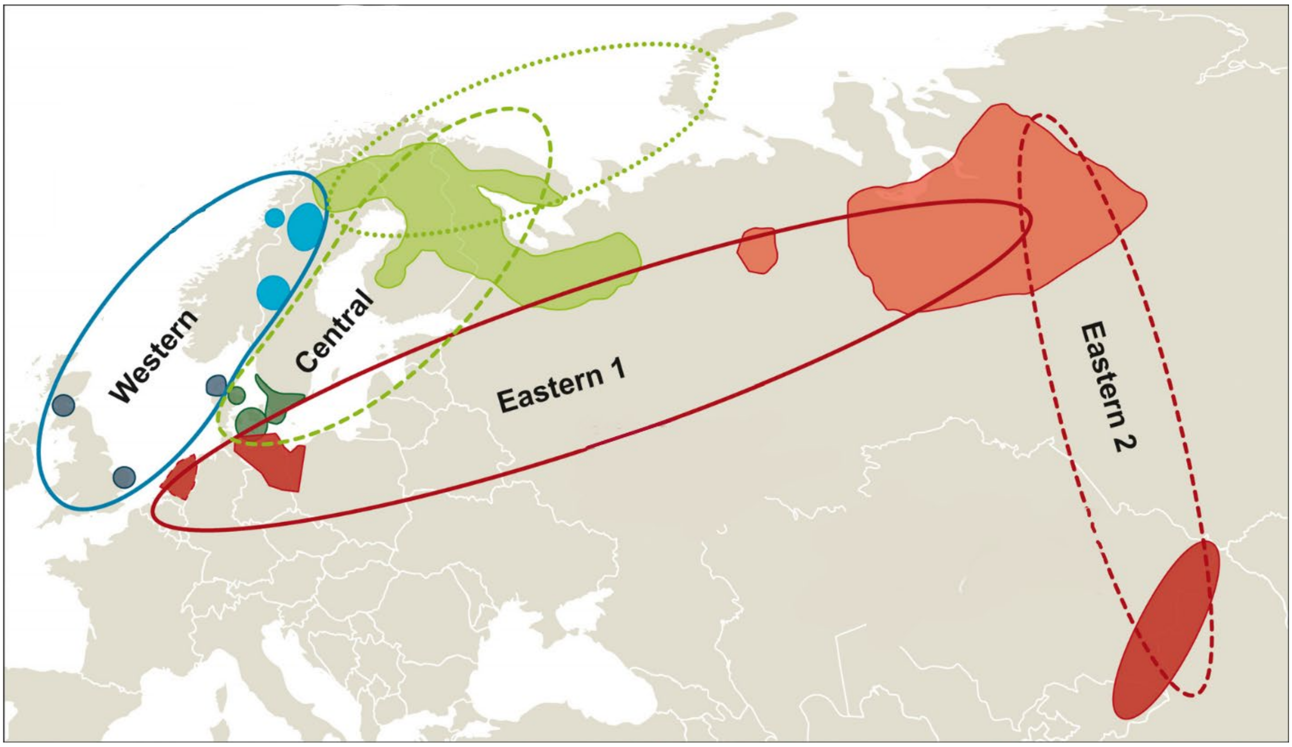

Figure 3.2-1. The former Western, Central and Eastern1 Management Units (now Scandinavia/Denmark and UK population, Finland and NW Russia/Sweden, Denmark and Germany population and West Siberia/Poland and Germany population, respectively) of Taiga Bean Goose (green dotted line indicates linkages between breeding areas in northern Fennoscandia and known moulting areas in Novaya Zemlya and the Kola Peninsula). Birds belonging to the Eastern2 MU are currently listed as a population of Bean Goose (subspecies *johanseni*) in the AEWA Annexes.

In addition to the range states mentioned above, Taiga Bean Geese also occur regularly in Estonia, Latvia, Lithuania, Ukraine and Belarus during migration or in small numbers in winter. In The Netherlands, it has meanwhile become a vagrant species.

3.2.2 Population targets

To restore and maintain the total population at a favourable conservation status of 165,000 – 190,000 geese, population targets have been specified for each management unit: 5,000 – 10,000 individuals in the Scandinavia/Denmark and UK population, 60,000 – 80,000 individuals in the Finland and NW Russia/Sweden, Denmark and Germany population, and 100,000 individuals total in the West Siberia/Poland and Germany population and the Eastern 2 MU, with stable or increasing trends in all (Marjakangas et al., 2015).

3.2.3 Management strategies

The abundance of Scandinavia/Denmark and UK geese is currently considered too small to support hunting and are protected from hunting in UK and in Denmark by a regional hunting ban. Taiga Bean Geese from the West Siberia/Poland and Germany population are hunted in Belarus, Latvia, Russia and Poland, but the bag sizes in these range states are generally not known and data are insufficient to develop a sustainable harvest strategy. An effective protection of the wintering population of Taiga Bean Goose is in place in Germany, as all hunting on Taiga Bean Geese has been banned in the Federal State of Mecklenburg-Vorpommern. For the Finland and NW Russia/Sweden, Denmark and Germany population, the EGMP is operating under an interim harvest strategy intended to allow population size to reach the median target of 70,000, while still providing limited hunting opportunity.

3.2.4 Assessment protocol

An annual stock assessment for the Finland and NW Russia/Sweden, Denmark and Germany population is conducted by updating an integrated population model (IPM), which was first adopted in 2020 and then revised in 2021 to exclude relatively small numbers of Tundra Bean Goose (*A. f. rossicus*) from count and harvest data. The IPM relies on harvest estimates (FI, SE, DK), and population counts in March (SE), October (SE), and January (SE, DK), along with mildly informative prior distributions for key demographic rates (a full description of the model can be found here: TBG IPM). The anniversary date of the IPM is March, with population size also estimated in the following months of October and January. The IPM predicts changes in abundance using a discrete, theta-logistic model:

$$N_{(t+1)}^{M} = N_t^M 1 + \left[(\psi(1+\gamma_t) - 1)\left(1 - \left((N_t^M)/K\right)^{\theta}\right)\right] - H_t$$

where N^M is the March population size, ψ is intrinsic survival from natural causes, γ is the intrinsic rate of reproduction, K is carrying capacity in the breeding season, θ is a parameter describing the type of density dependence (i.e., concave, linear, or convex), H is total harvest, and t is year.

Abundance in October, N^O, is predicted as a function of March abundance:

$$N_t^O = N_t^M + N_t^M\left[\left(\psi^{7/12}(1+\gamma_t) - 1\right)\left(1 - \left(\frac{N_t^M}{K}\right)^{\theta}\right)\right] - H_t^F$$

in which we assume seven months of natural mortality, all reproduction, and a portion of the total harvest occurring prior to October, where H^F represents the harvest in Finland.

Abundance in the following January is conditional on October abundance:

$$N_t^J = (N_t^O - H_t^D - \alpha H_t^S)\psi^{3/12}$$

where H^D and H^S represent harvests in Denmark and Sweden, respectively, and where α represents the proportion of the Swedish offtake occurring prior to January.

Abundance in the following March is thus:

$$N_{t+1}^{M} = \left(N_t^J - (1-\alpha)H_t^S\right)\psi^{2/12}$$

where $(1-\alpha)$ represents the proportion of the Swedish harvest that is taken after the regular season to help prevent crop damage (i.e., "conditional hunting").

The IPM has generally been very successful at mediating all sources of count and harvest data to provide biologically reasonable and robust estimates of population status. This is encouraging because each data set has some degree of bias, including less than complete counts, missing counts from important parts of the range, and a mix of Taiga and Tundra Bean Geese in both counts and harvest. However, during the last couple of years the IPM has had increasing difficulty harmonizing the data sources and providing reasonable results. This could be attributed to changes in count methodology or observers, as well as unknown changes in the spatial and temporal distribution of birds, such that the extent of bias has likely not been relatively constant (as we have largely assumed). With the addition of the 2024-2025 data, the IPM was unable to fully reconcile the various sources of data.

We here list known problems with the count data, which seem to have become worse over time:

- The March Bean Goose count in FI, SE, NO, and DK is critical as it is largely composed of Taiga Bean Geese and because it helps measure population status against the median recovery target of 70,000. The count is partly based on citizen-science data. Based on the observers' advice, we have assumed a temporally constant number of 4,000 Tundra Bean Geese occur in that survey, which is probably not entirely accurate. Moreover, GPS tags available in March 2020 and 2021, suggested that perhaps 20% of Taiga Bean Geese occur outside the counting areas. But sample sizes were small, and we have no sense of whether the count bias is relatively constant over time.
- Until recently, the October count in SE has been higher than the March count, reflecting successful reproduction. But in three of the last four years, the October count has been lower than the March count, which is not biologically feasible unless there is a complete reproductive failure. Citizen-science data from Finland in October in recent years seem to suggest there may be large numbers of Taiga Bean Geese remaining in Finland at that time. We had heretofore assumed that Finnish birds had fully moved into SE prior to the count. Finally, GPS data from October 2019 suggest that a relatively large proportion of Taiga Bean Geese occurred outside the counting areas in SE, although it is important to note that sample size was very low. Again, we have no way of knowing how this count bias might change from one survey to another.
- Finally, there are the January Bean Goose counts in SE and DK. Counts in DE have not been made available to us, so we always knew the January counts were negatively biased. However, if the abundance in DE during January was relatively stable, then the January counts could still be useful in understanding population development. Unfortunately, the number of Taiga Bean Geese wintering in Germany has likely declined over time (Thomas Heinicke, personal communication), perhaps in response to warmer winters.

Considering these problems, we lack confidence in our ability to provide a reliable population assessment this year. With the help of the Taiga Bean Goose Task Force, we recommend a thorough review of all data, followed by necessary or desirable changes to monitoring protocols. As a result of that review, we are hopeful we can make at least some improvements to the IPM so that a more complete population assessment is available next year.

3.2.5 Status – Scandinavia/Denmark and UK population (Western MU)

a) Abundance

The size of the Scandinavia/Denmark and UK population of Taiga Bean Goose is assessed primarily at the wintering grounds in Denmark and Scotland.

In Denmark, dedicated Bean Goose counts were carried out in the Pandrup area on 13 January and Thy on 17 January, just before the general IWC count on 18-19 January 2025. These are the two main areas known to be used by this population of Taiga Bean Goose, and the count resulted in a total of 835 geese located at six sites in Thy; none were recorded in Pandrup. The total was thus lower than in 2024. Two Tundra Bean Geese were recorded during the counts. On 14 October, in conjunction with a NOVANA count, 398 birds were counted at Sjørring Sø in Thy. Bean Geese in Northwest Jutland are notoriously difficult to locate, and this year's total is low compared to the maximum number recorded in January 2022. Counts would be improved by introducing more dedicated counts through November to February.

In Scotland, the wintering population is also relatively small, yet the behaviour of flocks utilising several different roosting and feeding areas during any given day makes it difficult to count the birds in the Slamannan Plateau landscape. This past winter, the highest visual count of 169 birds were counted during a field count on 10 December 2024 (Figure 3.2-2). Due to the weather conditions, a few Pink-footed Geese may have been included in this flock.

A single individual was reported from England, where only a non-significant part of the population now seems to be wintering. All counts since 2018 have been of less than 10 individuals.

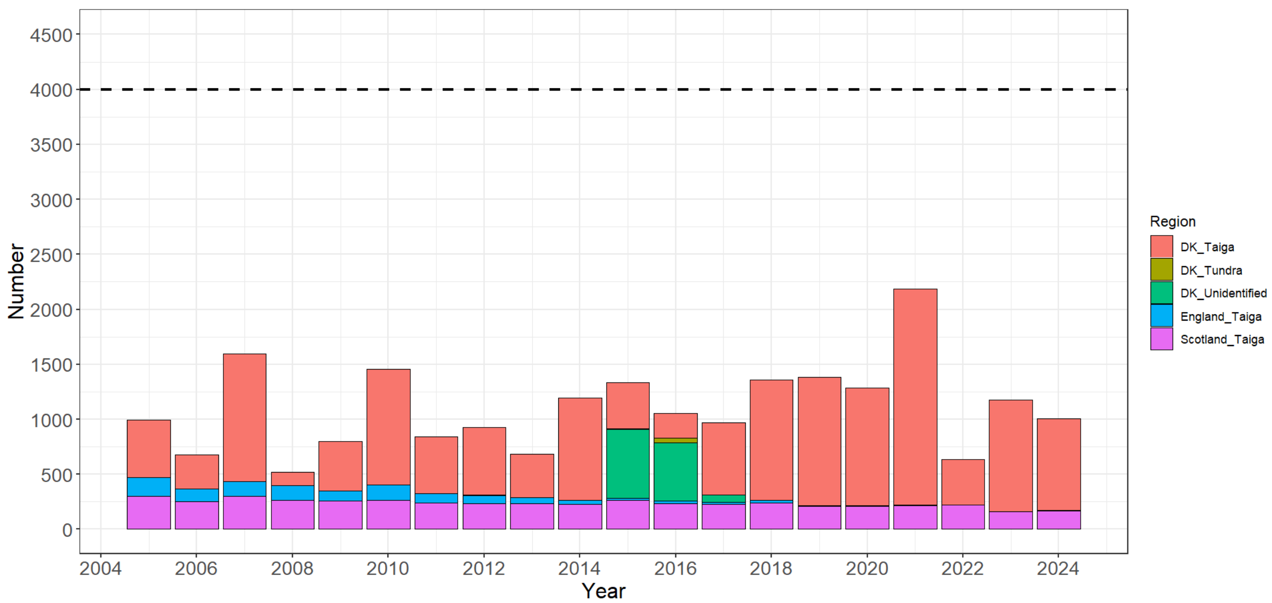

Figure 3.2-2. Population size of the Scandinavia/Denmark and UK population of Taiga Bean Goose during winter since 2005/2006 in the UK and since 2015/2016 in Denmark. The number of Tundra Bean Geese and unidentified Bean Geese are included for Denmark. The dashed black line represents the target for the wintering population.

b) Survival

No survival information is currently available for the Scandinavia/Denmark and UK population of Taiga Bean Goose, although perhaps information based on ringed birds could provide some insight. The population is protected from hunting.

c) Reproduction

Four different age counts were carried out in Scotland on 10, 12, 29 October and 17 November 2024. In total, 197 individuals were aged, 18 of which were juveniles. To avoid repeated counts of the same individuals, we only include the largest flock here, of 78 birds in total. This flock was aged on 29 October and consisted of 8 juveniles and 70 adults, resulting in a juvenile percentage of 10.3% (Figure 3.2-3). The overall juvenile percentage in the four flocks was 9.1%.

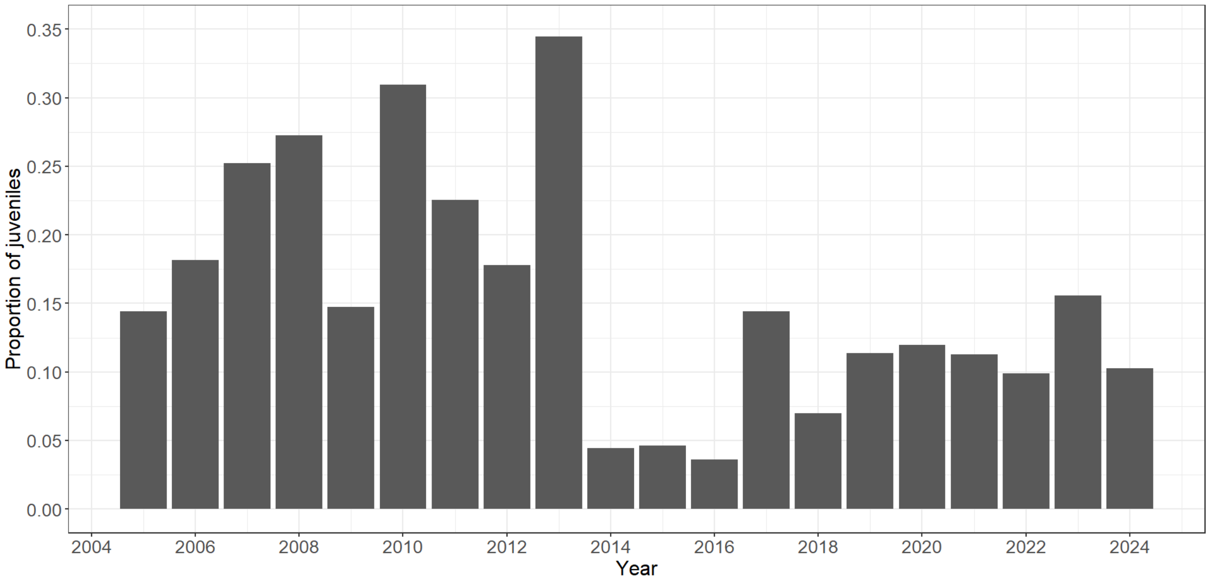

Figure 3.2-3. Annual proportion of juveniles in the Scandinavia/Denmark and UK population of Taiga Bean Goose since 2005.

3.2.6 Status – Finland and NW Russia/Sweden, Denmark and Germany population (Central MU)

a) Abundance and trends

The raw March counts were approximately 71k, 74k, 65k, 74k, and 73k in 2021 to 2025, respectively, reflecting a relatively stable population. If we acknowledge both the presence of the tundra subspecies and incomplete survey coverage, there currently may be as many as 80,000 Taiga Bean Geese in this population, well above the median recovery target of 70,000.

b) Mortality and trends

At this time, we can only provide raw harvest data for Bean Geese in FI, SE, and DK. With harvest restrictions in place in all three countries, the recent harvest has averaged about 500 birds. Prior to harvest restrictions starting in Finland in 2013, the Bean Goose harvest averaged over 9,000 birds, which was likely unsustainable.

c) Reproduction and trends

We rely on the IPM to assess how reproductive success may have changed over time, as reliable field data are unavailable. Thus, we can offer no assessment of reproduction at this time.

3.2.7 Status – West Siberia/Poland and Germany population (Eastern 1 MU)

Although available information on the status of the West Siberia/Poland and Germany population is still limited, a recent publication by Rozenfeld et al. (2024) presented important new results related to migration routes and timing, as well as the conservation status of key staging sites of this population. Based on the movements of 25 geese tagged with GPS/GSM transmitters during 2019–2023, almost 60% of all stopover sites are located in Russia, where the birds spend more than half of their days while on migration. Pairs with broods spend significantly more time on pre-migration sites and autumn stopovers, with the overall migration speed being lower than for pairs without broods. Key stopover sites are located in the Baltic Region, the Sviyaga-Vyatka interfluve and the centre of the River Volga Region. Only 15.3% of stopovers are covered by the existing network of protected areas, and Taiga Bean Geese probably spend more than 80% of the migration period in unprotected areas (Rozenfeld et al. 2024).

Taiga Bean Goose is officially included in the Red Data Books of Yanao (2023) and Krasnoyarsky kray (2022) and thus protected in large parts of their Russian breeding range (Sonia Rozenfeld pers. comm.). In the Red data book from Krasnoyarsky kray, the population is estimated at 17,000-20,000 individuals. This corresponds well with data from the wintering areas, compiled for the revision of the Taiga Bean Goose ISSAP (in prep.), as 10,000-15,000 Taiga Bean Geese were reported wintering in Germany in 2020 and 2021 (Heinicke et al., in prep.) and the Polish wintering population was estimated at 5,000 birds.

3.2.8 Management guidance

Birds in the Scandinavia/Denmark and UK population are largely protected from hunting, and given the status of this population, harvest restrictions should remain in place. For the Finland and NW Russia/Sweden, Denmark and Germany population, we can offer no formal guidance on allowable harvest this year. However, in light of past analyses and the relatively stable March count in recent years, we feel comfortable suggesting that as many as 3,000 birds could be harvested without effecting a decline in population size (although other factors could nonetheless precipitate a population decline). For the West Siberia/Poland and Germany population, abundance and harvest pressure are so poorly known that no guidance can be offered.

3.3 Greylag Goose *Anser anser*

This chapter compiles monitoring data on the population status of the NW/SW European population of Greylag Goose and provides an update on the establishment of the monitoring and modelling frameworks necessary to perform a dynamic and model-based assessment at the MU level (Nagy et al. 2021).

3.3.1 Range states and management units

The range states for the NW/SW European population of Greylag Goose include Norway, Sweden, Finland, Denmark, Germany, The Netherlands, Belgium, France, and Spain. Geese belonging to this population also occur regularly in Poland, Czech Republic and Portugal, but these countries are not included as principal Range States as numbers recorded here constitute less than 1% of the total population. Based on the recognition of regional differences in migratory behaviour and the human-wildlife conflicts related to this population, it has been agreed to define two MUs (Nagy et al. 2021).

MU1 includes the breeding populations in Norway, Sweden, Finland, and Denmark that subsequently stage and winter also in The Netherlands, Germany, and Belgium. Some birds from this MU migrate to the southernmost wintering sites in France and Spain. MU2 is the mainly sedentary populations of The Netherlands, Belgium, and Germany, including also a small French breeding population of c. 2400 pairs. Although the German population is generally regarded as sedentary, breeding birds in the eastern part of the country are known to show migratory behaviour (Bairlein et al. 2014) (Figure 3.3-1).

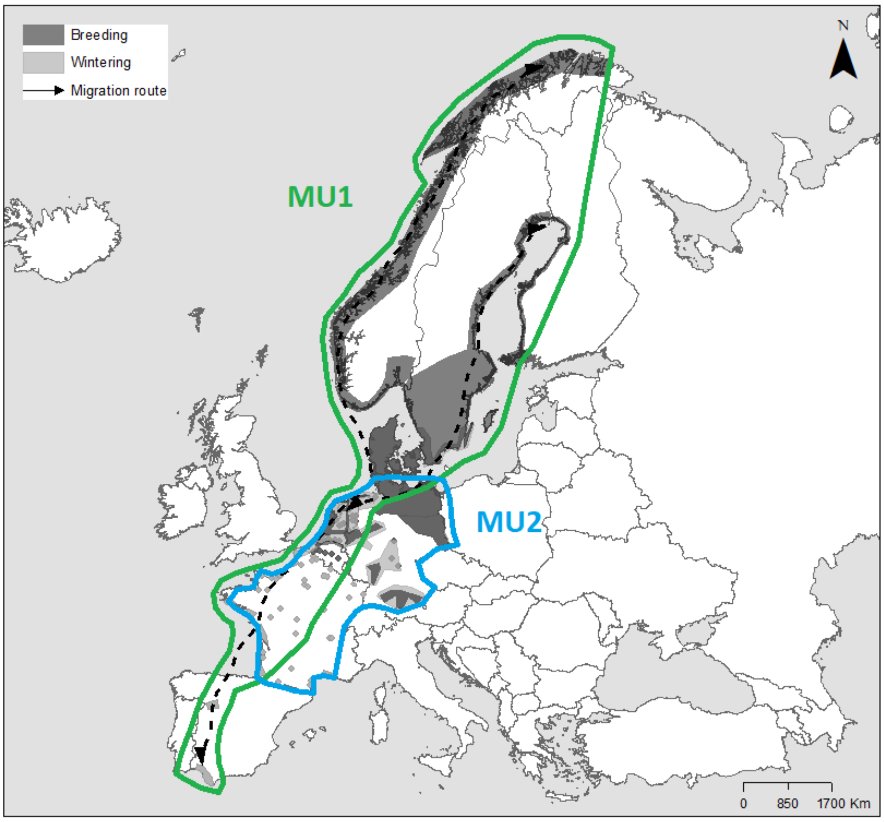

Figure 3.3-1. Annual distribution and main migration routes for the NW/SW European population of Greylag Goose including breeding (medium grey) and wintering (light grey) areas, as well as areas, which are both used during the breeding and wintering period (dark grey) as presented in the ISSMP (up for evaluation in 2030). The two management units (MUs) are also shown: MU1 for the migratory population (in green) and MU2 for the sedentary population (in blue).

3.3.2 Population FRPs and targets

The FRP for the breeding season is 31,100 pairs for MU1, 72,980 pairs for MU2 and 104,080 pairs for the whole population. The wintering FRP is 370,400 individuals for the entire population (Nagy et al. 2021). Targets for MU1 and MU2 are 70,000 and 80,000 breeding pairs, respectively, resulting in an approximate wintering population size of 545,000 individuals.

3.3.3 Management strategies

In the face of deep uncertainty related to estimates of population size and offtake at the flyway level, an information-gap ("info-gap") decision model was developed in 2020 to allow decision makers to make informed choices about the magnitude of offtake until a dynamic, model-based management of the population could be established based on more reliable monitoring information (Nagy et al. 2021; Johnson and Koffijberg 2021). As agreed, the info-gap decision model was ceased after a 3-year period, however the dynamic, model-based management has not yet been established.

Based on the info-gap decision model, range states agreed on a management criterion of a 15% reduction in the flyway population size over 10 years, which meant an annual finite growth rate of 0.96 – 1.00 (EGM IWG5_MEETING_REPORT). To move beyond the rather crude info-gap approach, the AFMP mandated the establishment of "an internationally coordinated population management programme for both [management units], including offtake under hunting and, if necessary, under derogations, encompassing monitoring, assessment and decision-making protocols" (Nagy et al. 2021). Considerable progress has been made in this effort, including the development of a flyway population model, which characterizes the dynamics of both breeding segments (MU1 and MU2) and accounts for the mixing of the two segments during autumn and winter. Based on input from the IWG, a utility model for Greylag Geese has also been developed that describes the relative level of satisfaction among stakeholders as the number of breeding pairs deviate from their agreed-upon targets. This utility model can be used to evaluate various offtake strategies in terms of their ability to meet population targets.

It should be noted that the current modelling framework is used to simulate how varying levels of offtake in different seasons and areas might affect whether the MU populations are near their targets when the ISSMP comes up for review in 2030. It is *not* intended to prescribe the magnitude and distribution of offtake at this time because current estimates of offtake are apparently biased high. Moreover, we note that while derogation is a legal means of alleviating local socio-economic conflicts, it cannot be used in a planned manner to meet a population target. However, once more reliable empirical estimates of offtake are available, the model can be used to forecast the population trajectory under those levels of offtake to help determine whether the population is trending toward the target or FRP (e.g., as is done with Barnacle Geese). Also, given reliable estimates of derogations, the model could be used to help prescribe the level and distribution of recreational hunting to help attain population targets.

3.3.4 Assessment protocol

a) Population model

We use a post-breeding projection matrix, decomposed into summer and winter components. The summer component consists of the two breeding management units (MU1 and MU2), and the winter component consists of two wintering areas (North and South) (Figure 3.3-2). There is a broad overlap in the wintering distributions of the two breeding units. The southern unit is largely comprised of MU1 birds and is of special concern as short-stopping of migratory birds may eventually cause the range to fall below the FRR.

We also divide the annual cycle of Greylag Geese into a breeding season (March – August) and a wintering season (September – February) (Figure 3.3-3). We recognize the definition of seasons is somewhat arbitrary as it must represent a compromise of phenology that varies among countries.

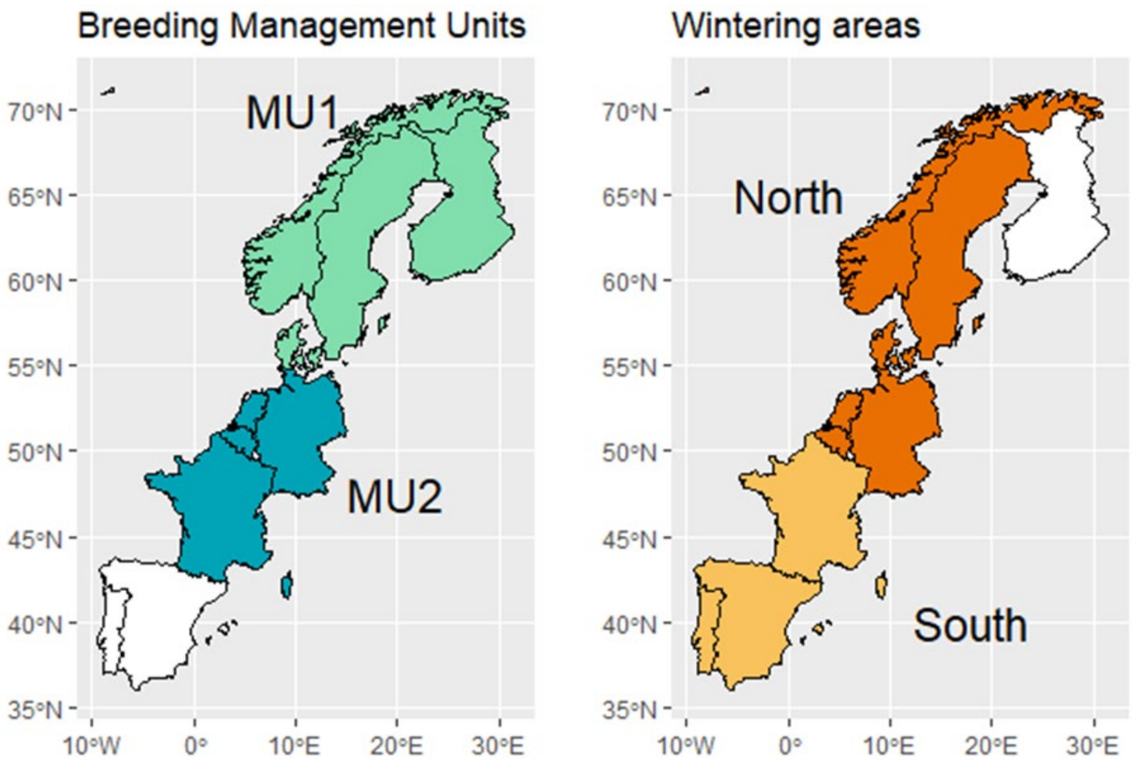

Figure 3.3-2. Breeding management units and wintering areas for the NW/SW European population of Greylag Goose.

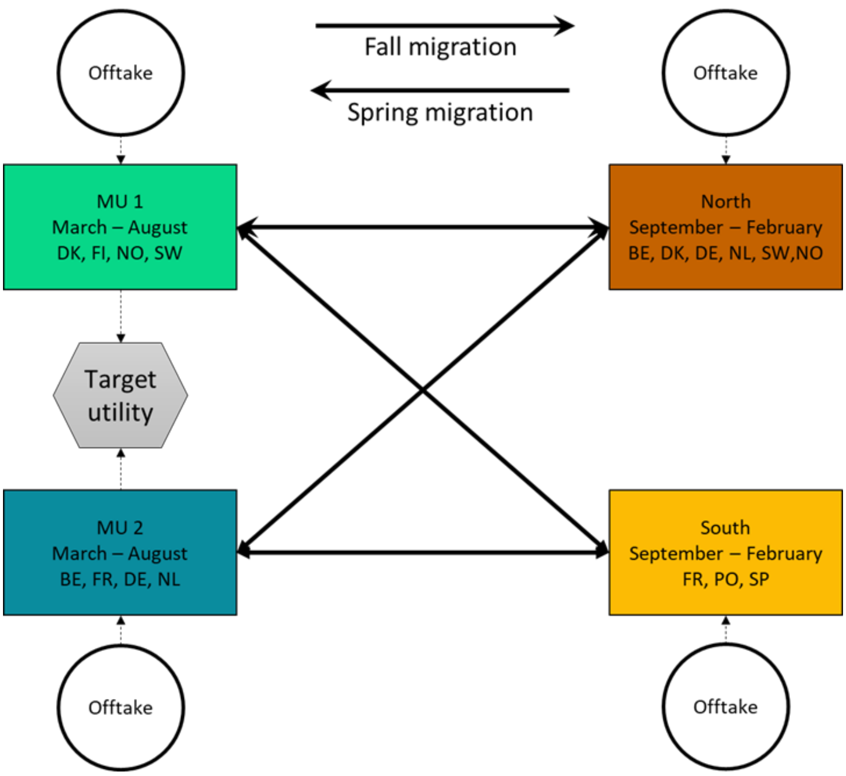

Figure 3.3-3. Diagrammatic representation of the model for the annual cycle of the NW/SW European population of Greylag Goose.

The model was parameterized using basic life history information and some limited empirical data (Appendix A.3). The model can be improved with a time-series of post-breeding population sizes in each MU, with the proportion of young in those counts, seasonal (March – August, September – February) offtake by country, and winter counts by country. The summer age ratios are particularly important in helping determine the number of breeding pairs, which is the criteria used in the MU-specific population targets. The biggest obstacle to model improvement and application, however, continues to be the acquisition of reliable empirical estimates of seasonal offtake.

b) Utility function

The effort to better coordinate the offtake of Greylag Geese involves specifying objectives and their relative importance in managing the abundance of Greylag Geese. Beyond an objective to maintain the population in a favourable conservation status, the objectives specified by the ISSMP are depicted in Figure 3.3-4. The ISSMP did not prioritize these objectives, however, and so the IWG was asked to specify their relative importance (also shown in Figure 3.3-4). These objectives and their weights were used to specify population targets of 70 and 80 thousand breeding pairs for MU1 and MU2, respectively (Johnson et al. 2021).

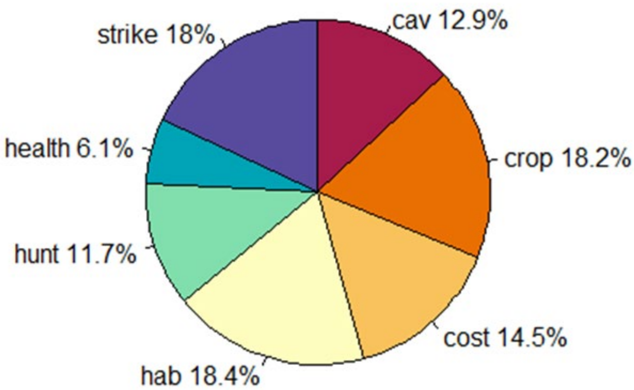

Figure 3.3-4. Relative importance of seven objectives for managing the offtake of the NW/SW European population of Greylag Geese. Management objectives are to maximize cultural and aesthetic values (cav), minimize agricultural damage (crop), minimize management costs to governments (cost), minimize deleterious impacts to habitats (hab), maximize satisfaction with the level of recreational hunting (hunt), minimize amenity fouling and disease transmission (health), and minimize bird strikes to aircraft (strike).

3.3.5 Population status

a) Abundance

The population size of the NW/SW European population of Greylag Goose is assessed twice a year, during winter and more recently during the post-breeding period in summer/early autumn. The winter abundance represents the total flyway population size, and the post-breeding abundance represents the size of each management unit.

Winter abundance is estimated using the International Waterbird Census (IWC), as well as values from special goose counts in Denmark and the Netherlands. Based on those sources, the estimated population size was 932,910 individuals in January 2024 (Figure 3.3-6), which indicates an increase of around 100,000 individuals compared to January 2023. As mentioned in Heldbjerg et al. (2021), estimates from Spain included a high degree of imputing due to data gaps during 2010-2013, which may have resulted in an overestimation of the actual population size by some 200,000 birds during those years. In recent years, Spanish data are not considered to be severely biased, yet we have chosen to keep both graphs (including and excluding Spain) in Figure 3.3-6. The imputed IWC value for January 2024 indicates that around 15,000 Greylag Geese wintered in Spain this year.

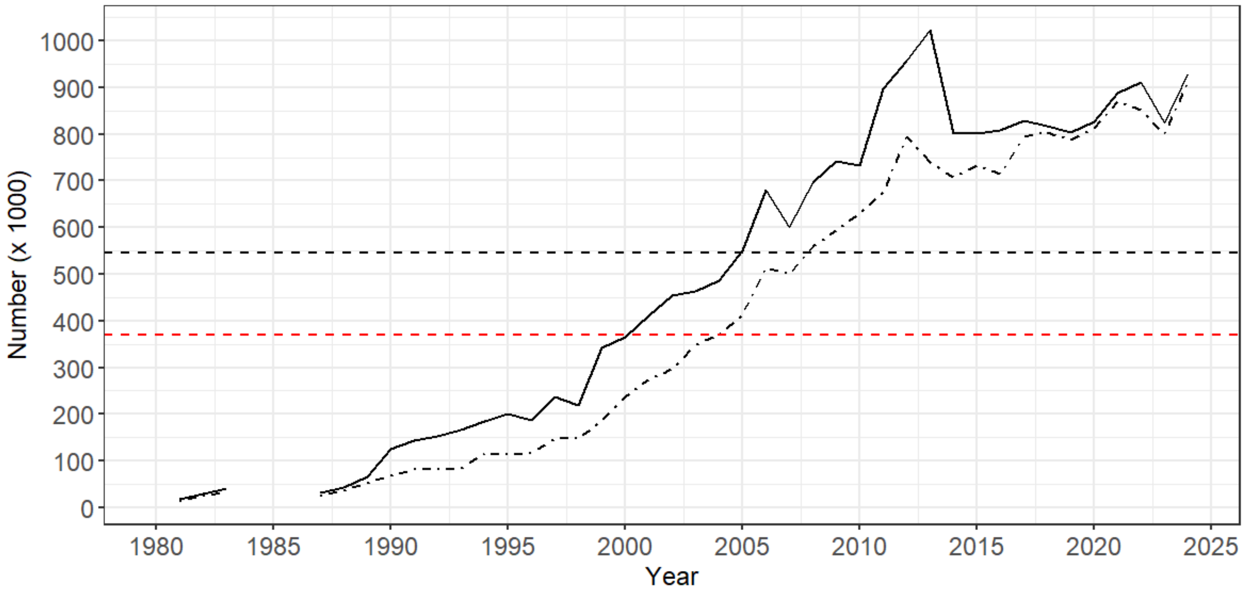

Figure 3.3-6. Development of the size (number of individuals) of the NW/SW European mid-winter population of Greylag Goose based on IWC imputed values from 1980-2024, including (solid line) and excluding (dot-dashed line) estimates from Spain. The dashed black line represents the target for the wintering population, and the red dashed line represents the wintering FRP.

Post-breeding abundance estimates are achieved through a combination of long-running and recently established national initiatives. For MU1, annual post-breeding counts have been carried out in Denmark and Sweden during September for decades (Nielsen et al. 2023, Haas et al. 2023). In 2022, Denmark organized an August count to provide a better estimate for the national population size (Jensen et al. 2023), after which the national September count was moved to August and will be carried out every second year from 2023. Birds in Finland have also been counted annually during 2021-2024, but as these birds are assumed to be included in the Swedish September count, they are currently not added to the annual total for MU1. In Norway, counts were carried out at selected sites in August 2022, and a model-based estimate for the population size was subsequently produced, including also previous counts at selected sites, data from the Norwegian breeding bird monitoring scheme, and national hunting bag statistics (see Doc. AEWA/EGMIWG/9.10). For MU2, counts are carried out and available from parts of Germany (Nordrhein-Westfalen, Niedersachsen and Schleswig-Holstein), The Netherlands and Belgium (Niedersächsische Sommer-Gänsezählung 2022, Koffijberg & Kowallik 2022, Wolff et al. 2023). Numbers from France and Spain are currently regarded as non-essential due to small breeding populations. However, the number of breeding pairs is estimated every six years in France.

Counts from the post-breeding period produced a minimum of 540,115 individuals in 2022 for MU1, with counts in Denmark and Sweden producing similar results in the following year(s). In 2024, 734,480 birds were reported for MU2 (no data available from France, and from Germany data are only available from Nordrhein-Westfalen, i.e., only one of 16 Bundesländer) (Figure 3.3-7).

In 2024, we investigated how the number of breeding pairs in the spring might be calculated from post-breeding censuses for the two management units of the NW/SW European Population of Greylag Goose (see Doc. AEWA/EGMIWG/9.10 with further details provided in Johnson et al. 2024). Although our methods only provide a rough approximation for the number of breeding pairs because empirical data are insufficient to do otherwise, such calculations will help evaluate progress in terms of reaching the agreed targets of 70,000 pairs in MU1 and 80,000 pairs in MU2.

The most recent year of complete data is 2022. For MU1, for a post-breeding population of 540,115 (Sweden, Finland, Denmark, and Norway) the estimated number of breeding pairs was 132,142 (113,293 – 150,852). Around the middle of the last decade, the number of breeding pairs (all countries) in MU 1 was estimated at 84,000 (S. Nagy, personal communication). For MU2, we used a 2022 post-breeding population of 748,110 (Netherlands, Belgium and Nordrhein-Westfalen, Niedersachsen, and Schleswig-Holstein, Germany) and a spring population in France of 8,323. Be aware that this is an underestimate of the total population size in MU2 as data are only available from three German federal states. The estimated number of breeding pairs was 180,268 (143,486 – 200,600)[1]. Around the middle of the last decade, the number of breeding pairs (all countries) in MU 2 was estimated at 139,400 (S. Nagy, personal communication).

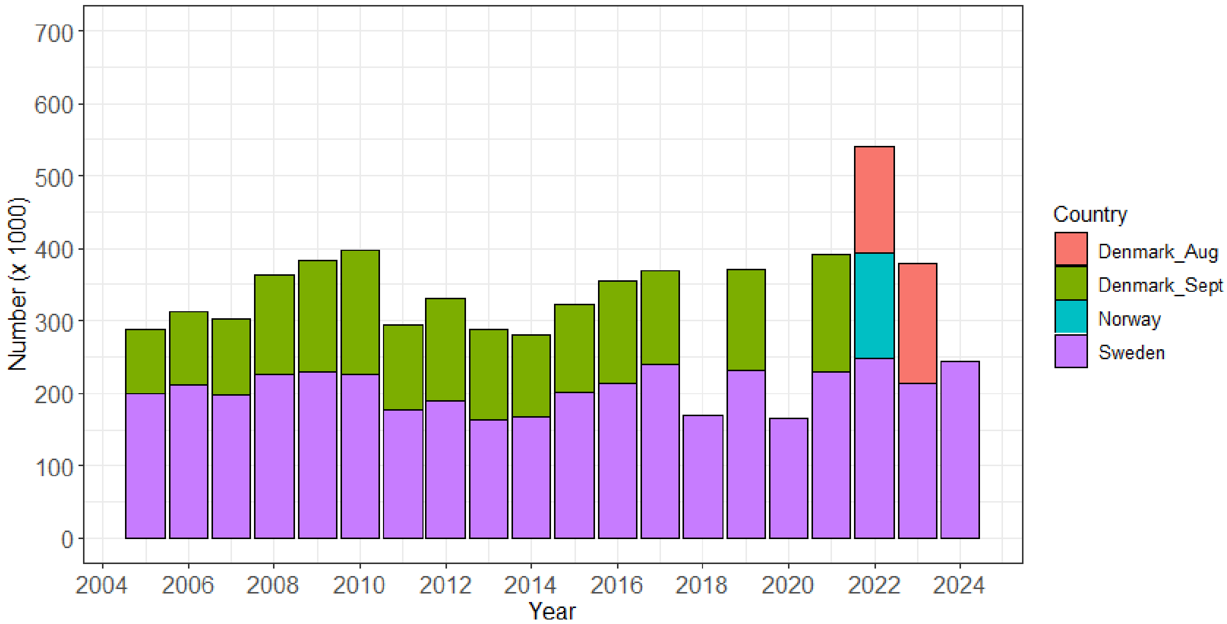

Figure 3.3-7. Number of Greylag Geese counted during the post-breeding counts in MU1 Range States, consisting of available data from Denmark (September 2005-2021, August 2022-2023), Sweden (September 2005-2024), and Norway (2022). Birds breeding in Finland are assumed to be included in the Swedish count.

[1] Note that this estimate has been updated in 2025 based on revised summer counts from France and Germany.

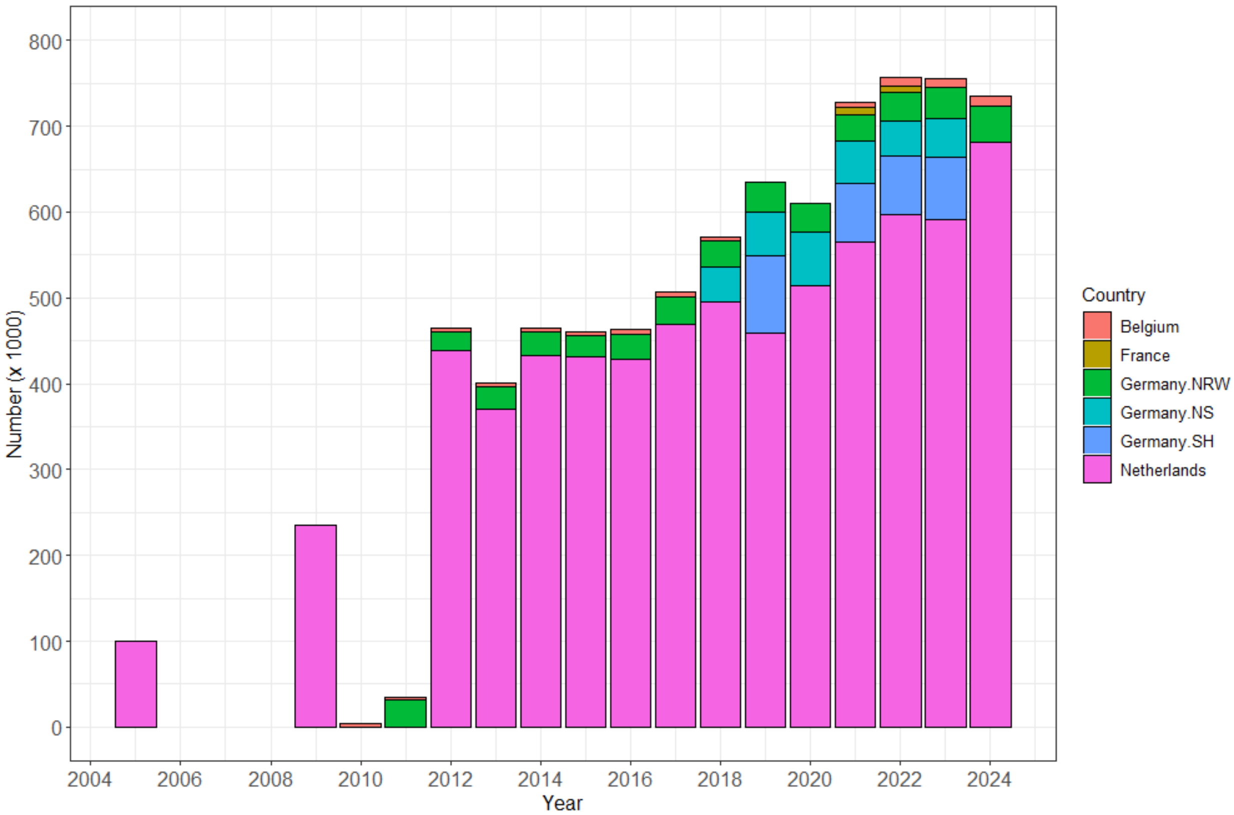

Figure 3.3-8. Number of Greylag Geese counted during the post-breeding counts in MU2 Range States, consisting of available data from Belgium (2010-2018 and 2021-2023), the Netherlands (July 2005, 2009, 2012-2024), Germany (Nordrhein-Westfalen July 2011-2024, Niedersachsen July 2018-2023, Schleswig-Holstein June/September 2019, 2021-2023), and France (2021-2022).

b) Survival and mortality

I) Offtake at population level

Hunting bag estimates are available from all range states and sum to 179,021 for the 2023/2024 season. Derogation data from 2023 are available from all range states where derogations have taken place, except Germany, and indicate that 252,374 geese were killed under derogation (including lethal scaring permitted at municipality level in Norway, following Norwegian game legislation). Thus, data suggest a minimum offtake of 425,393 Greylag Geese in 2023/2024 (Figure 3.3-9), indicating that offtake remains relatively stable across the Range States. Given an estimated summer population of around 1.3 million birds in recent years, and an estimated winter population size of 932,910 individuals in January 2024 (see above), with no indication of a declining trend, there is however reason to believe that offtake data are still biased high. We will continue to investigate this bias further in the coming years, with support from the relevant range states.

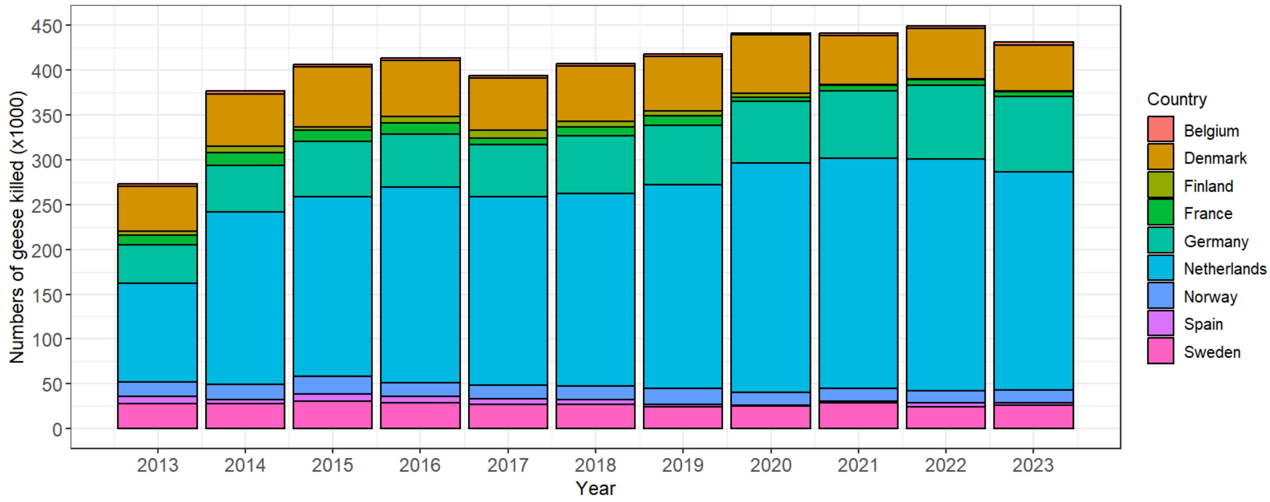

Figure 3.3-9. Total number of Greylag Geese killed under derogation (per calendar year 2013-2023) and hunting (per season from 2013/2014-2023/2024). Derogation data from Germany for 2023 are missing, as are hunting bag data from outside Andalusia, Spain. Derogation numbers from Norway are estimates, based on information from county governors and municipalities.

II) Survival

No updated monitoring results available.

III) Crippling

During June 2019-2022, 176 adult Greylag Geese were caught at three Swedish moulting sites and x-rayed to examine crippling rate (Månsson et al. 2024). Across the three regions (Södermanland, Örebro, and Gävleborg) a crippling rate of 21.0 % was found. Crippling rate varied between catch sites, from 11.7 % in Gävleborg (Huddiksval) to 26.4 % in Örebro (Örebro). These results are comparable to previously published records from Sweden and the Netherlands (see Johnson et al. 2024).

c) Reproduction

In MU1, age counts have been carried out in two Range States in 2024. Thus, new information is available from one region in Norway (Vestfold County in the Oslofjord Area) and a range of sites in Sweden. In Vestfold County, juvenile percentages have ranged between 27.5 and 36.5% during the years 2020-2024, with the most recent estimate being 27.8% (data from Tombre et al. 2020, 2021, 2023, 2024). In Sweden, the juvenile percentage reached a peak in 2024 at 25.0% (Haas et al. in prep.), indicating an unusually productive breeding season following a couple of years with juvenile proportions of 5.0-7.5% (Haas et al. 2023).

For MU2, extensive age counts are available from the Netherlands (Hornman et al. 2024, Sovon Vogelonderzoek Nederland) and North Rhine Westphalia in Germany (Koffijberg and Kowallik 2020, 2022, 2023, 2024). After an initial peak in the Netherlands in the late 1990s, the proportion of juveniles declined markedly and has stabilized at around 17% during the last decade in both Germany and the Netherlands (Figure 3.3-10).

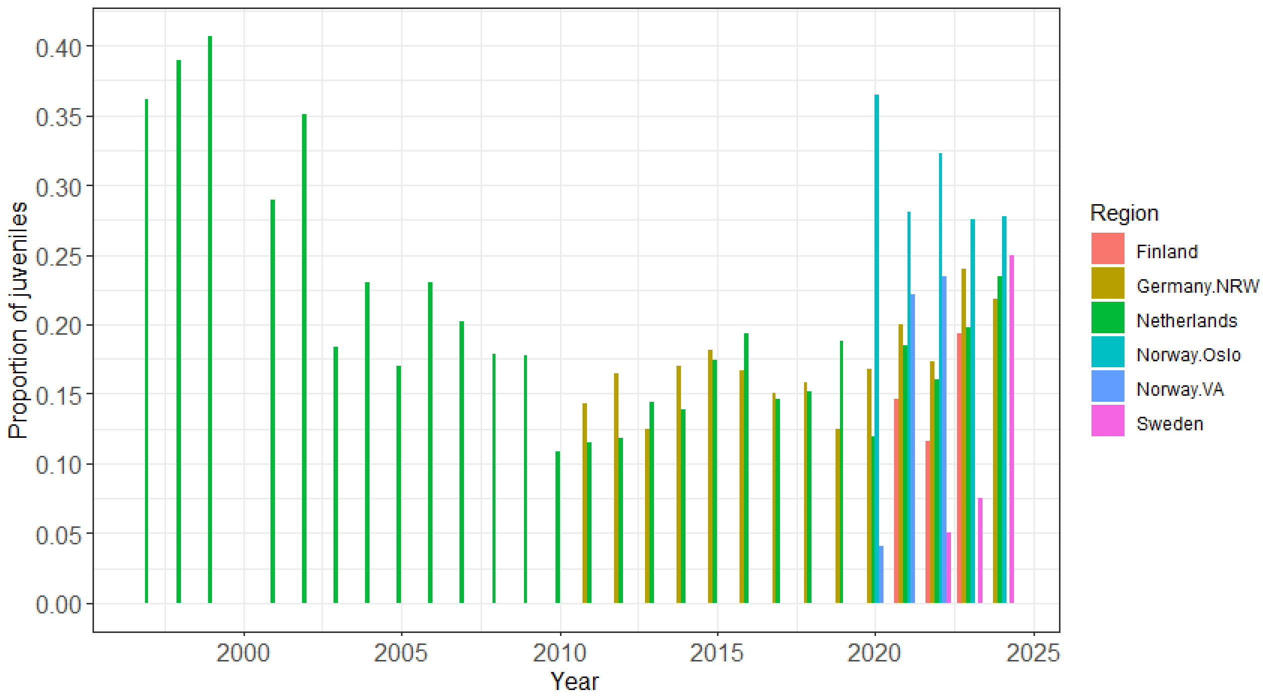

Figure 3.3-10. Proportion of juveniles in the NW/SW European population of Greylag Goose in five Range States: Norway (Vesterålen 2020-2022, Oslofjord Area 2020-2024), Finland (2022-2023), the Netherlands (1997-2024), Germany (North-Rhine Westphalia 2011-2024), and Sweden (2022-2024).

3.3.6 Management guidance

In 2023, using the preliminary population model, we simulated all permutations of offtake rates of 0.00 – 0.40 in increments of 0.02 for all seasons and areas (194,481 offtake scenarios). We retained all offtake strategies that had a high probability of meeting both MU targets by the time the ISSMP is due for revision in 2030.

The simulations of the preliminary model demonstrated that no unique level and distribution of offtake would meet MU population targets. Rather, alternative approaches to coordinating offtake must be evaluated ultimately not only in terms of their ability to meet population targets, but also in terms of cost, feasibility, and legal mandates. The ISSMP for the Greylag Goose (NW/SW European Population) clearly outlines the legal status of Greylag Geese and the implications for population management (see Annex 4 of the ISSMP). We urge range states to discuss practical considerations and constraints they may have in mitigating socio-economic conflicts and in managing sport hunting so that trade-offs and limitations associated with efforts to coordinate offtake can be better understood by the EGM IWG.

The 50 offtake strategies with high probability of meeting the MU targets are of two basic types: (a) those with relatively high spring/summer derogation and low winter offtake, and (b) those with low spring/summer derogation and relatively high winter offtake (Figure 3.3-10, Table 3.3-1). In June 2023, the IWG recommended that offtake be concentrated during the wintering period to the extent possible. Again in June 2024, the IWG agreed that all Range States will focus on offtake strategies that minimise the need for breeding season derogation.

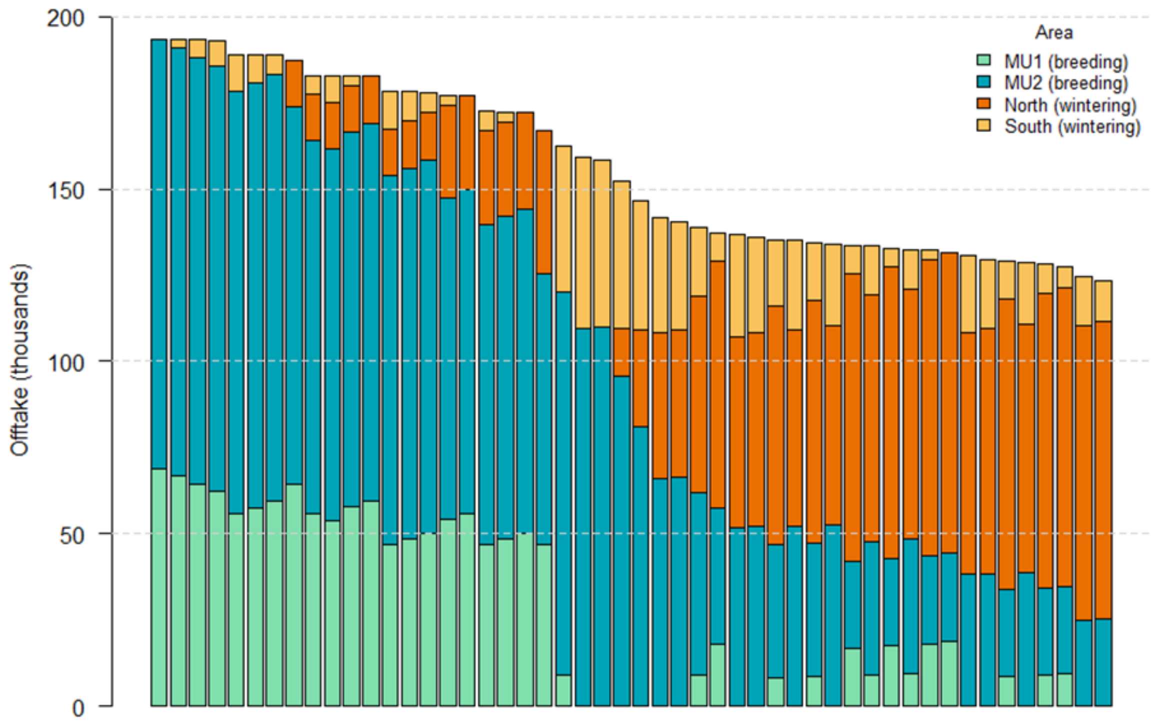

Figure 3.3-11. Fifty alternative offtake strategies for Greylag Geese with high probability of meeting the MU targets by 2030, ordered by decreasing level of total offtake. Values of offtake are the means over the timeframe. Colours correspond to those used in Figures 3.3-2 and 3.3-3.

Comparing the mean levels of offtake for the two sets of management strategies (a and b) with the most recent estimates of offtake implies either that the flyway population is underestimated by a factor of three or the flyway population is declining by about 20% per year, neither of which seem likely (Table 3.3-1). Thus, contemporary estimates of offtake continue to appear biased high, perhaps extremely so.

Table 3.3-1. Mean levels of offtake (in thousands) for the two sets of management strategies (a) those with relatively high spring/summer derogation and low winter offtake, and (b) those with low spring/summer derogation and relatively high winter offtake, as well as the most recent estimates of offtake (spring-summer of 2020 to spring-summer of 2021).

Area & season	(a) Mean offtake	(b) Mean offtake	Most recent estimates of offtake (spring-summer of 2020 to spring-summer of 2021)
MU1 – spring/summer	49	6	4.5
MU2 – spring/summer	109	43	142
subtotal	***158***	***49***	***146.5***
North – fall/winter	12	67	298
South – fall/winter	10	18	6.2
subtotal	***22***	***85***	***304.2***
Total offtake	***180***	***134***	***450.7***

To reconcile discrepancies between reported levels of offtake and those needed to meet population targets, the following data are needed in descending order of priority:

1. Reliable offtake estimates: by country and biannual period (spring-summer: March-August and fall-winter: September-February) for the most recent five calendar years.
2. Summer or early autumn abundance: by country for those conducting such surveys; all years in which they are available.
3. Post-breeding age ratios: all years and countries where available; should include counts of young and total sample size. Data should be provided at the lowest level available (e.g., by flock or location).
4. Winter counts: all years and countries where available.

3.4 Russia/Germany and Netherlands population of Barnacle Goose *Branta leucopsis*

This chapter provides an assessment of the population status of the Russia/Germany & Netherlands population, covering all three management units (see below). It aims to assess the cumulative impact of derogation (and hunting, where legally allowed) on the status of the flyway population and the three individual management units (MUs) and provides a guidance for management in 2025/26 and thereafter, covering for instance coordination of derogation measures among countries within one MU. In line with the framework set out in the AFMP (Nagy et al., 2021), the assessment is based on an Integrated Population Model (IPM). This model was initially developed for the Russian breeding population (MU1) only and presented during IWG5 in 2020 (Baveco et al. in Nagy et al. 2021). In 2022, it was extended to the Baltic and North Sea breeding birds and then used in a first full assessment of the population status in 2005-2021 (Jensen et al. 2022). During IWG7 in 2022, it was decided to use the model framework of the IPM for an annual update, making use of the newest available monitoring data. In autumn 2022, the IPM was further refined with input from a review made by the EGMP Data Centre and the Norwegian Institute for Nature Research (F. Johnson, K. Layton-Matthews).

3.4.1 Range states and management units

The range states for the Russia/Germany & Netherlands population of Barnacle Goose include Russia, Finland, Estonia, Sweden, Norway, Denmark, Germany, the Netherlands and Belgium. Among these range states, three management units have been delineated, covering the (arctic) Russian breeding population (MU1, migratory), the Baltic breeding population in Finland, Sweden, Estonia, Norway and Denmark (MU2, migratory) and the North Sea breeding population in Germany, the Netherlands and Belgium (MU3, sedentary) (Figure 3.4-1). Formally, the Norwegian population in MU2 (now expanding from original breeding sites in the greater Oslofjord region) and the Belgian population in MU3 are not covered by the AFMP, as these populations have not been recognized as naturally occurring by the respective country administrations. Still, these birds (altogether < 5,000 individuals and less than 1% of the flyway population) mix with the other birds in winter, so they are included in the monitoring setup and in the input data for the IPM.

During winter, birds from all management units mix in Sweden, Denmark, Germany, the Netherlands and Belgium. All these countries organize the traditional midwinter count (part of the International Waterbird Census) with usually a good coverage of wintering sites of Barnacle Geese. At present, the Netherlands and Germany are the most important wintering countries, supporting on average about 48% and 30% of the flyway population respectively (derived from census data collected in January 2023 and 2024).

3.4.2 Population FRPs and targets

The FRPs for the breeding season are 113,000 pairs for MU1, 12,000 pairs for MU2 and 12,000 pairs for MU3 (Nagy et al. 2021). The FRP for the entire population has been set at 380,000 individuals in winter, reflecting the flyway population size in 2000, when AEWA came into force (Nagy et al. 2021). As Barnacle Goose is an Annex 1 species of the EU Birds Directive, the AFMP does not aim to maintain the population at or reach a pre-defined target level. Management is carried out by each single EU Member State under the conditions for derogation, lined out in Art. 9 of the EU Birds Directive. Birds in Norway (not an EU Member State) have a similar protective status according to Annex II of the Bern Convention, including derogation-like measures to prevent crop damage (in this case granted by the municipalities) if other measures of prevention have failed. Hunting (harvest) is only carried out outside the EU, mainly on the breeding grounds in Russia.

3.4.3 Management strategies

The AFMP aims to prevent the population or any of its MUs from declining below the specified FRPs (Nagy et al. 2021). Hence, the FRPs represent the lower limits of the legally acceptable population sizes, but as such do not reflect true targets for population size. Monitoring of the population size and offtake and predictive modelling (IPM) of the cumulative impact of national derogation measures and hunting (where it is legally allowed) is used to inform national decision-making during the IWG-meetings to ensure this. The cumulative impact of derogation and hunting on the development of the population is assessed periodically, along with the likelihood of serious damage to agriculture and risk to air safety and to other flora and fauna (including the Arctic ecosystems) and the non-lethal measures taken to prevent damage/risk, as well as the effectiveness of these.

Within this framework, it has also been agreed to coordinate monitoring of the population and offtake under derogations and hunting when the size of a population (in individual MUs or the entire population) is below 200% of the FRP, as a precautionary measure. This includes monitoring of population size, offtake, prediction of population development (by the IPM), and coordination of offtake and conservation measures when necessary. A protocol for this coordination has been subject to discussions in the Task Force for the Russia/Germany and Netherlands population of Barnacle Goose (see doc. AEWA/EGMIWG/7.14 from EGM IWG7 in 2022). So far, it has only been applied in MU3 to avoid the population falling below FRP.

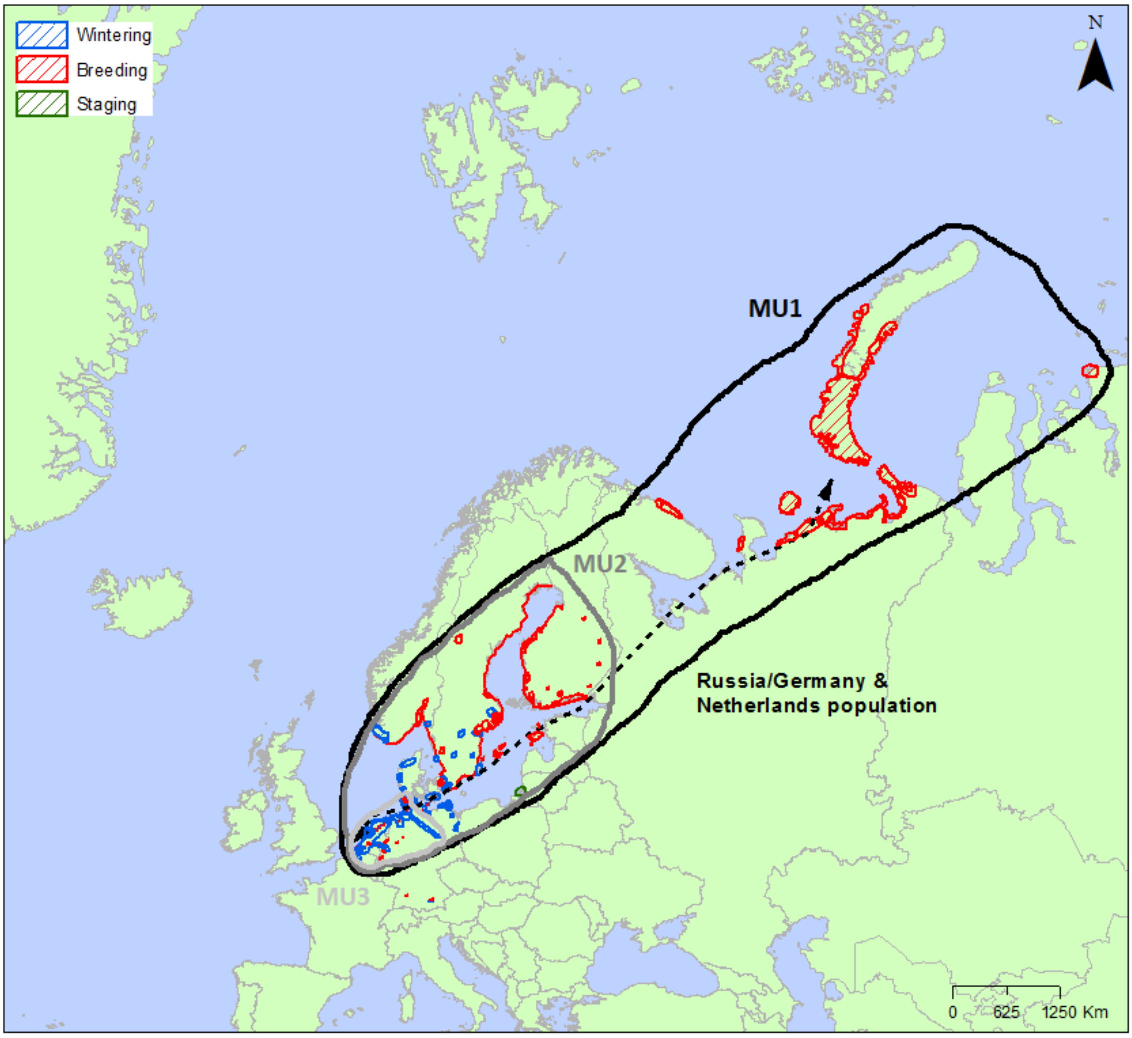

Figure 3.4-1. Management units of the Russia/Germany & Netherlands population of Barnacle Goose.

3.4.4 Assessment protocol

The assessment of the status of the Russia/Germany and Netherlands population is carried out using an Integrated Population Model (IPM). Input for the model was derived from monitoring data on abundance, productivity and offtake under derogation, both for summer and winter situations (see Appendix A.4 for coverage in each country and the EGMP Database for overview of data used). The way the IPM framework accounts for the impact of offtake in the respective management units is shown in Figure 3.4-2. Monitoring data on abundance and productivity have been included up to January 2024 (winter flyway size) and summer 2023 (numbers per MU). For derogation data the last year taken into account was 2023. In case of missing abundance data or incomplete time series, annual growth rates or estimates have been used to estimate the missing count information (see Gitlab EGMP for a full overview of input and output data). This was the case for parts of Germany in January 2024 (data not published yet) and for Sweden in January 2021 and 2022 (data missing due to very low coverage).

Because summer counts are completely missing prior to 2005, results of the assessment shown in this chapter solely refer to the period 2005-2023. An overview of the longer time series is included in the EGMP Database and the annual status report from 2021 (Heldbjerg et al. 2021). This is especially relevant for productivity, which has declined in the Russian population on a long term, but less so when considered from 2005 onwards. Like in the status report 2024, September counts have been used as a proxy for the Swedish summer population. This count is carried out mid-September, before migratory birds from MU1 have arrived (F. Haas, pers. communication). Moreover, exchange with the Finnish summer population is considered low, as the Finnish count is done only two weeks earlier than the Swedish count. Nevertheless, this issue needs further investigation and preferably confirmation by tracking or ringing data. A complete count in summer, covering all relevant parts of Sweden, is still considered unfeasible, so using the September count instead is regarded the best alternative option at present. In earlier assessments, the Swedish data were largely interpolated from few (old) available data points in the summer period, which was considered a less optimal strategy compared to the use of September count data. Also, gaps in time series for Danish summer counts are interpolated from periodical counts available.

Following a review by the EGMP in autumn 2022, the IPM was adapted in several ways. A simplification resulted from equating survival from natural mortality in the summer to that in the winter period. A reanalysis was performed of within-year variation in juvenile counts, and different approaches in defining the associated priors were tested. An approach for evaluating the goodness of fit, based on post-predictive checks, has been implemented as well, following the approach taken in the Pink-footed Goose IPM (Johnson et al. 2022).

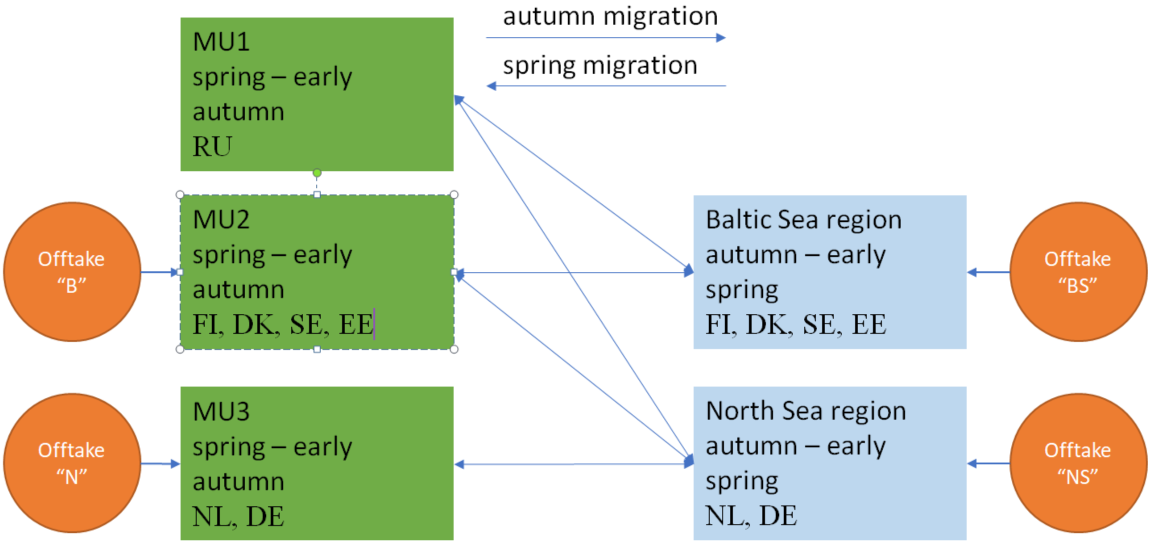

Figure 3.4-2. Overview of the offtake of Barnacle Geese in the different regions experienced by the birds belonging to the different MUs of the Russia/Germany and Netherlands population. Local breeding populations (green boxes) in the Baltic Sea and the North Sea areas experience offtake around the breeding period ("B" and "N" respectively). Outside this period (blue boxes), birds of all three MUs experience offtake in their staging and wintering areas ("BS" and "NS" respectively). The scheme is simplified, as in the model and data the first set is split in offtake before and after July 15, and the second in offtake before and after January 15. Half-yearly survival is effectuated directly before and after offtake in staging and wintering areas ("BS" and "NS"). Offtake in Russia is unknown.

3.4.5 Status

a) Abundance

Posterior estimates from the IPM indicate a flyway population size of about 1.6 million individuals (rounded) in January 2024 (Figure 3.4-3). Results from the IPM and from the field counts correspond well. After being stable at a level of around 1.4 million individuals, the flyway population size seems to have increased again in the past two seasons. Note in this context that estimates for the German winter population in 2023 have now been replaced with true counts (which turned out to be higher than those estimated before). On a longer term, there is a clear increase as well (see Heldbjerg et al., 2021) but the rate of increase has levelled off in the past decade.

The estimated population size in January 2024 is four times the FRP (100% and 200% levels shown by the dashed lines in Figure 3.4-3). Census data indicate that in January 2024 wintering numbers in the Netherlands were unusually high (876,000 – highest winter number recorded so far), in contrast with the numbers recorded in January 2023, which were the lowest since 2010. Higher numbers in the Netherlands corresponded to lower numbers in the northeastern part of the flyway (notably in Sweden), perhaps due to short cold-spells and subsequent movements occurring in this period.

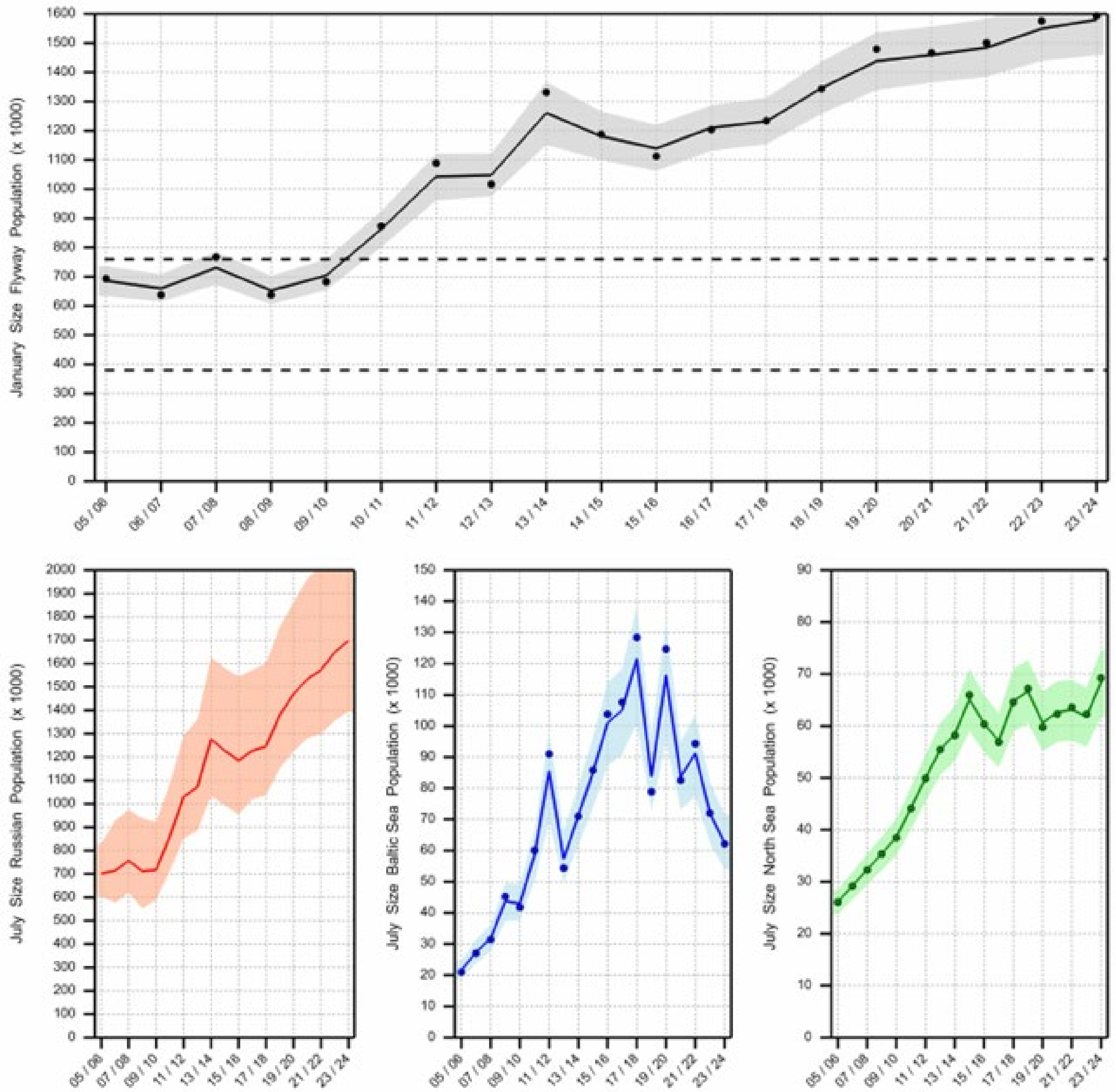

Figure 3.4-3. Top panel: January total flyway population counts (dots) of the Russia/Germany and Netherlands population of Barnacle Goose, posterior means based on the IPM (solid line), 95% credible intervals (shaded area) and FRP as well as 200% of the FRP (dashed lines). Bottom panels: July population sizes of the three MU-populations along with posterior means and 95% credible intervals. Left (in red) MU1, centre (in blue) MU2, right (in green) MU3. Note the different scales on the y-axes. Note that July counts of the Russian population are not available and are estimated as latent variables within the IPM framework (and come with large 95% credibility intervals).

Based on the posterior abundance estimates for July, the Russian population (MU1) is by far the largest of all MUs, amounting to approx. 1.7 million individuals (rounded) in 2024, whereas the Baltic populations in MU2 and North Sea populations in MU3 are much smaller: 62,000 and 68,000 individuals respectively (Figure 3.4-3). Note that these numbers are not directly comparable to those from January (and especially the estimate for MU1 also comes with large credibility intervals as they represent only estimates, due to natural and additive mortality (by offtake) occurring between July and January). These estimates do indicate that the trend in the large Russian MU1-population is the major driver for the increase in the total flyway population mentioned above. The Baltic MU2-population has continued to decline, whereas the North Sea MU3-population has been fluctuating around 63,000 individuals during the past decade (albeit the latest estimate being the highest of the time series). Census data from both Sweden (September, -36% compared to 2023) and Finland (August, -11%) showed declines in 2024, but no recent census results were available for Denmark, which has a large summer population as well (next census is planned for summer 2025). So, caution must be taken when assessing the size of the Baltic population during summer.

Converted into breeding pairs, the posterior estimate for the size of the breeding population in the Russian MU1 in 2024 was 591,000 breeding pairs, thus exceeding FRP and also exceeding the 200% threshold level by a large margin (Figure 3.4-4). The Baltic MU2-population is well above the FRP as well (an estimated 22,000 breeding pairs in 2024) but has now fallen below the 200% threshold. The North Sea MU3-population was estimated at 18,000 breeding pairs, so not far from its FRP (but clearly above, lower limit of 95% credibility interval just touching FRP) and still well below the 200% threshold of the FRP (Figure 3.4-4).

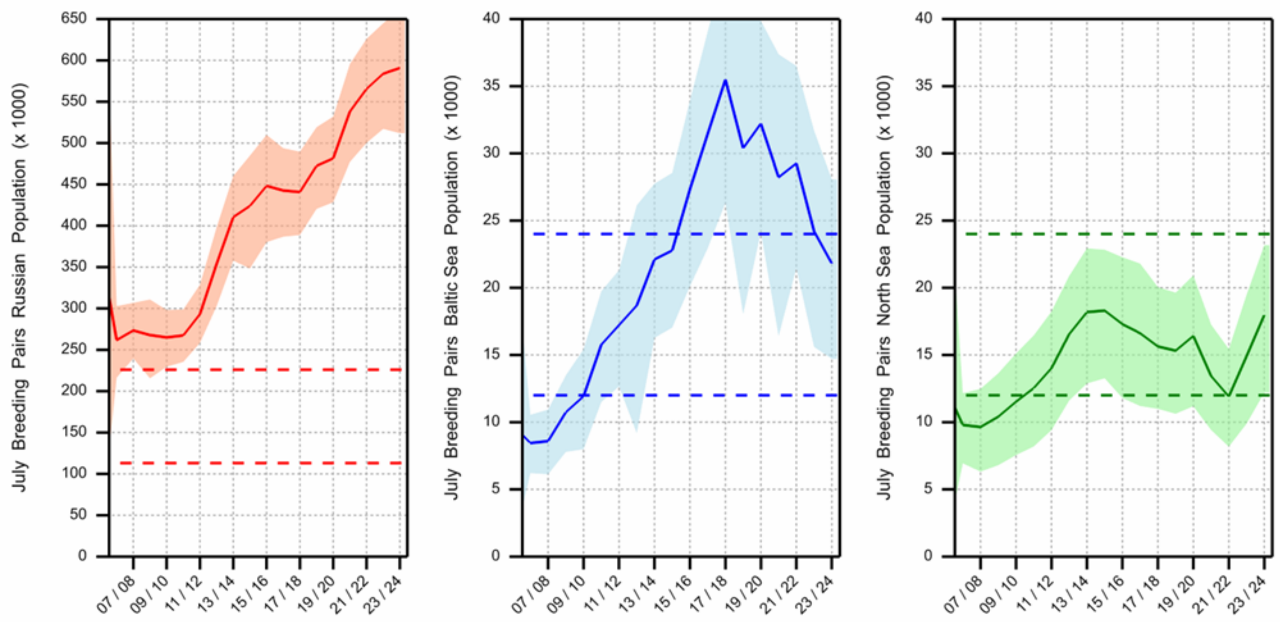

Figure 3.4-4. Posterior means (solid line) and 95% posterior intervals (shaded areas) for the number of breeding pairs in July for the three MU-populations of the Russia/Germany and Netherlands population of Barnacle Goose, derived from the IPM. Dashed lines are the FRP as well as 200% of the FRP. Left (in red) MU1, centre (in blue) MU2, right (in green) MU3. In the IPM framework, the number of breeding pairs has been set as the number of individuals of 2 years and older, divided by 2. Note the different scales on the y-axes between MU1 and MU2/3.

b) Mortality and offtake

Survival rates derived from the IPM, and combined for summer and winter, show that adults have much higher survival rates than juveniles (Figure 3.4-5, note that last year of the time series is based on incomplete data). In all cases, the posterior credible intervals for juvenile survival are much wider than those for adult survival and annual variation is more pronounced. For the Russian MU1-population, natural survival for juveniles is relatively low in some of the years, but this is according to expectation as natural survival for this MU-population includes unknown offtake in Russia (where it is a huntable species). In addition, the Russian population is fully migratory and (natural) losses among juveniles are likely to occur during autumn migration.

For the migratory Baltic MU2-population, juvenile survival is in the same order of magnitude as for MU1 but has declined over time (albeit with large fluctuations). For the mainly sedentary North Sea population natural survival of juveniles has increased until 2020 but then dropped to similar levels as those estimated for the other two MUs. Adult survival is highest for the Russian and North Sea populations and shows more pronounced fluctuations in the Baltic population (with an overall lower average).

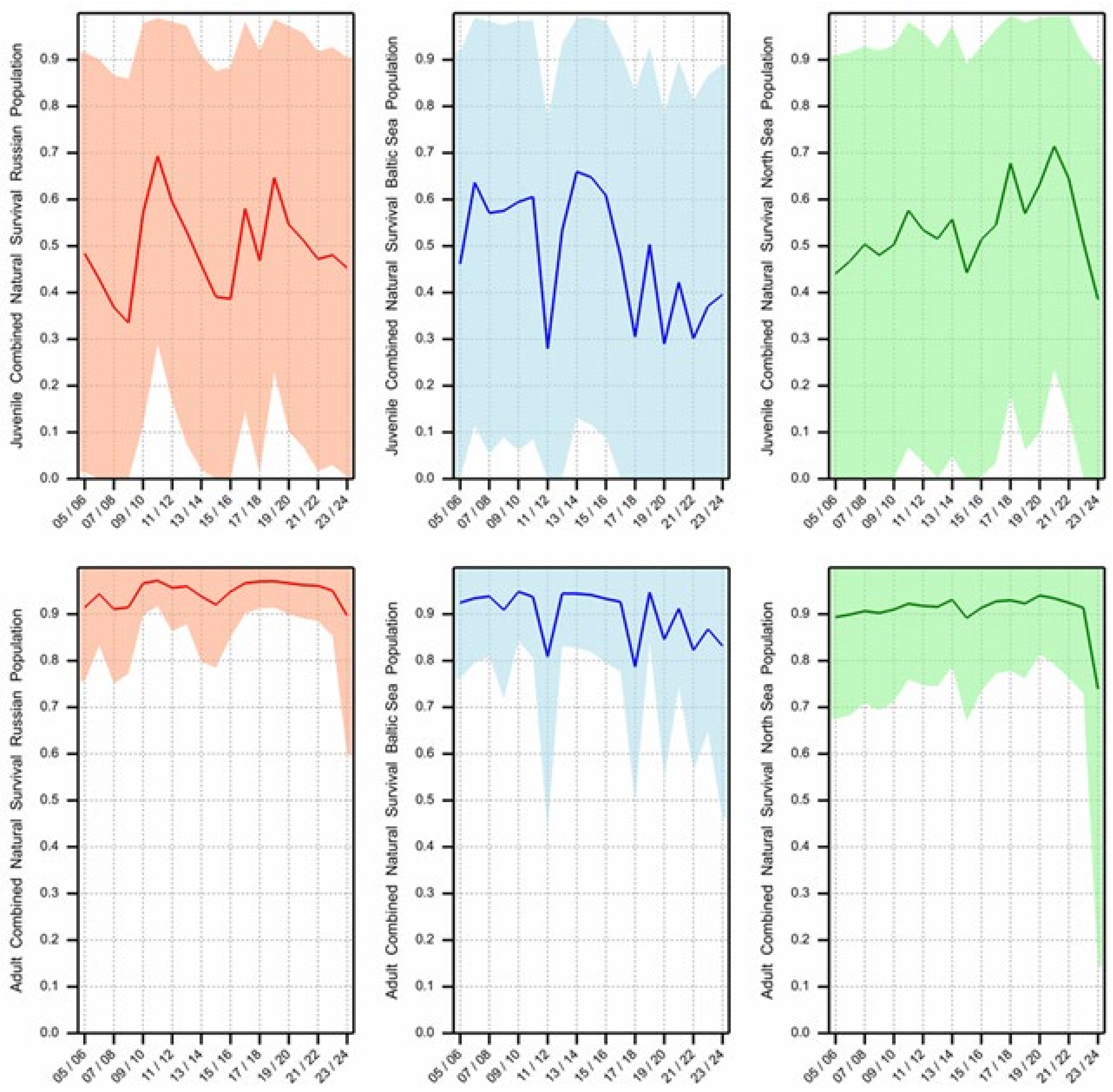

Figure 3.4-5. Posterior means and 95% intervals for combined, i.e., summer and winter, juvenile (upper panel) and adult (lower panel) natural survival for the three MU-populations of the Russia/Germany and Netherlands population of Barnacle Goose. Left (in red) MU1, centre (in blue) MU2, right (in green) MU3. Note that this includes unknown offtake for the Russian population in Russia.

Combined offtake rates have increased over time for all MUs, in EU-countries reflecting increased levels of derogation. For the populations of MU1 and MU2, offtake rates were on average 3% and 7% for adults, and 6% and 10% for juveniles, respectively, for the five most recent years (Figure 3.4-6). Whilst offtake rates in the Russian MU1-population remain at about the same (low) level, the offtake rates in the Baltic MU2-population have increased recently. Here, it should be noted that offtake in the Baltic population may be biased somewhat, as numbers are divided among presumed MU1-birds and presumed MU2-birds. These cannot be distinguished for most of the year and part of the derogations assigned to MU2 may actually represent MU1-birds. Combined derogation offtake rates for the North Sea population have increased steeply after 2013, when coordinated management was taken up by the provinces in the Netherlands, including shooting and roundingup during wing-moult in early summer. As a result, combined offtake rates even exceeded 30% in 2020/21. Following the outcome of the EGMP-assessment in 2022, showing that numbers in the MU3-population were approaching FRP, management efforts in the Netherlands were reduced and derogation figures went down following guidance given by the IWG.

In 2023, offtake in the Netherlands amounted to 22,782 individuals, slightly more than in 2022 (20,874) but considerably less than the level of offtake in 2019-2020 (on average 46,000 individuals). Overall offtake by derogations in EU-countries in 2023 was at least 46,924 individuals, of which the Netherlands (49%) and Denmark (35%) took the largest share (Figure 3.4-7). Like in the previous report, data for Estonia were missing (i.e. not submitted to or available via the EU-portal), but they accounted for only 3% of total derogations in the EU in earlier years so likely do not affect the overall figures given above. In MU2, especially an increase in derogation effort in Sweden is apparent (Figure 3.4-7).

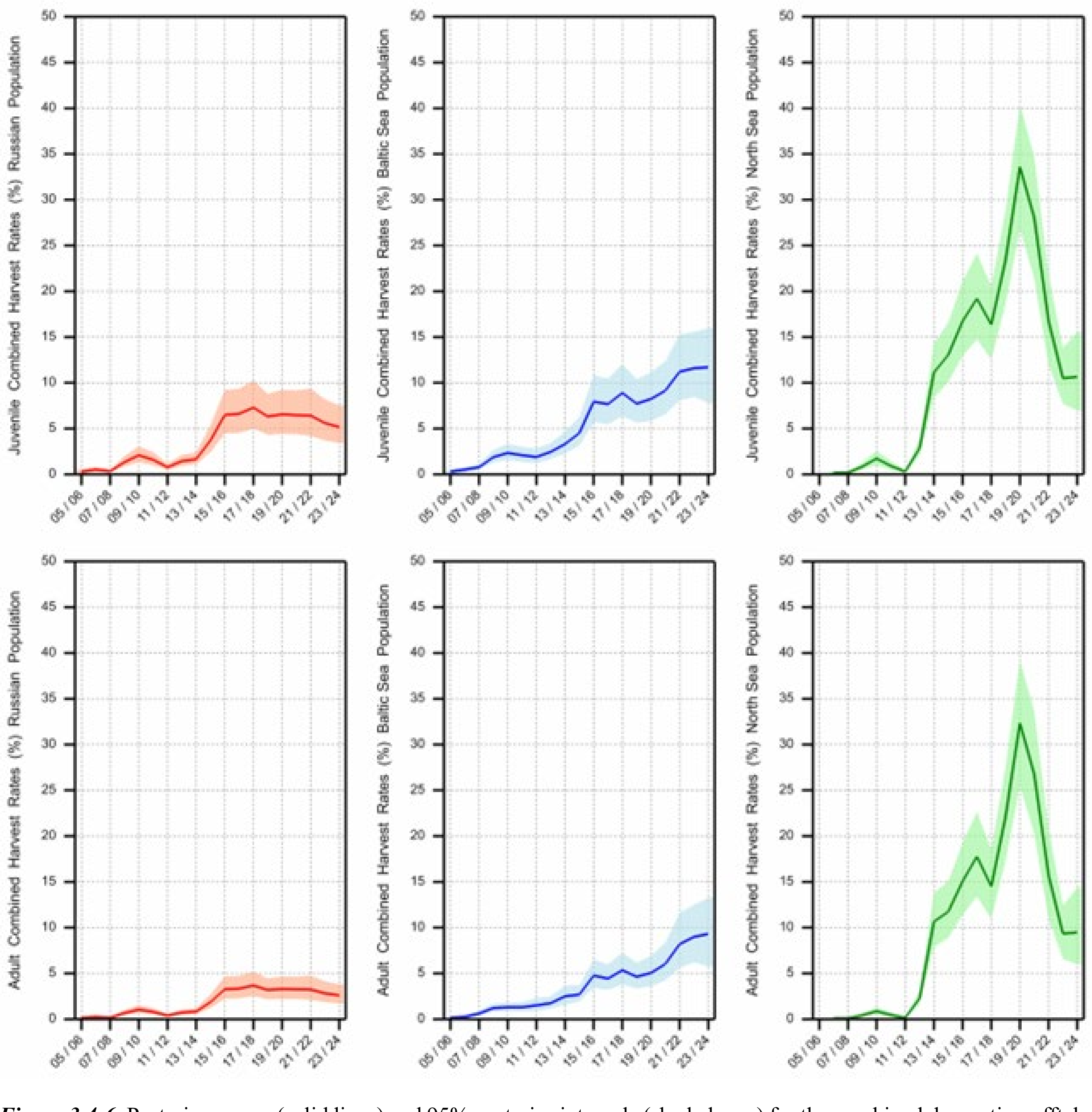

Figure 3.4-6. Posterior means (solid lines) and 95% posterior intervals (shaded area) for the combined derogation offtake rates of juveniles (top panels) and adults (bottom panels) for the three MU-populations of the Russia/Germany and Netherlands population of Barnacle Goose. Left (in red) MU1, centre (in blue) MU2, right (in green) MU3.

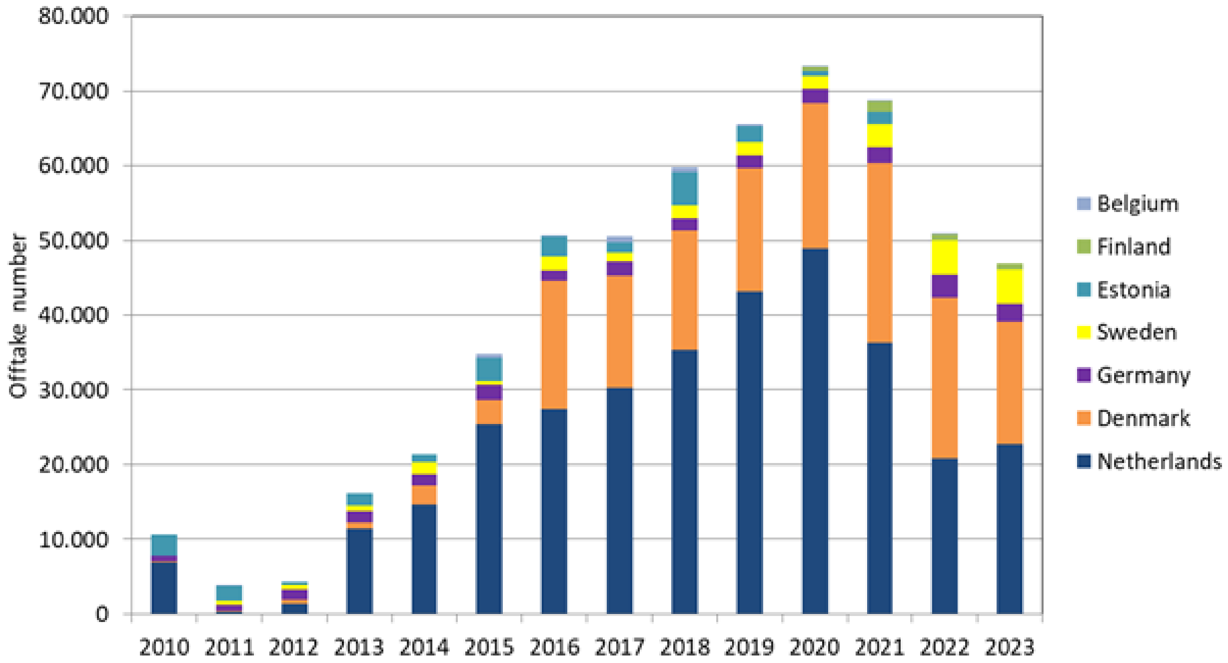

Figure 3.4-7. Number of Barnacle Geese killed under derogation in EU countries during 2010-2023. Data retrieved from national agencies (the Netherlands, Germany, Denmark) or the data repository at Eionet. Note that for Estonia, data were missing for 2022-2023 and for Belgium in 2023.

c) Reproduction

The percentage of juveniles in autumn flocks, reflecting productivity in MU1 and MU2 (however, according to abundance, it will mainly reflect productivity in MU1), is recorded mainly in the Netherlands and shows a high degree of variation (Figure 3.4-8). Field data from autumn 2023 suggested increased productivity, but according to the IPM-estimates there was little difference compared to previous seasons. Results from the IPM also consistently show a higher level of productivity than the data collected in the field, although in all years field results are within the 95% posterior credible intervals of the IPM estimates. Since autumn 2022, collection of age-ratio data in the field was advanced to October-November (instead of November-December), to avoid potential issues with identification of age groups in the field. Note that on a longer term (i.e. from the mid-1970s onwards), productivity in Arctic Barnacle Geese has declined, and the amplitude in high and low years is nowadays much less (see Heldbjerg et al. 2021).

At the MU-level, there are no field data from the Russian population in MU1 (in summer), but IPM results predict juvenile percentages as high as 28% in some years, and without a clear trend (Figure 3.4-8, lower panel), similar to assessments in autumn (see above). In the Baltic MU2-population productivity shows large fluctuations with a tendency to decline. The trend in field data and IPM results are partly very different. As shown for autumn counts at flyway level, field data for MU2 show consistently (in MU2 even more so) lower juvenile percentages than the IPM estimates, many even outside the 95% posterior credible intervals. This is not an identification issue as has been hypothesized earlier for the situation in autumn but is likely associated with the nature of the monitoring data used. The field data from MU2 is mainly based on assessments made in the Helsinki region in Finland, which according to the local experts may be not fully representative as this population has been established already for a long time and has shown some saturation because of local density-dependent effects (M. Mikkola-Roos & A. Lehikoinen, pers communication) while other areas that were colonized later on may show higher productivity. Hence, it may not reflect a representative sample, even more so as data from the large Swedish population is completely lacking and there are no data from Denmark either. In MU3 also field assessments and IPM estimates deviate in most years whilst IPM-estimates show a tendency to increase (but associated with large 95% credibility intervals).

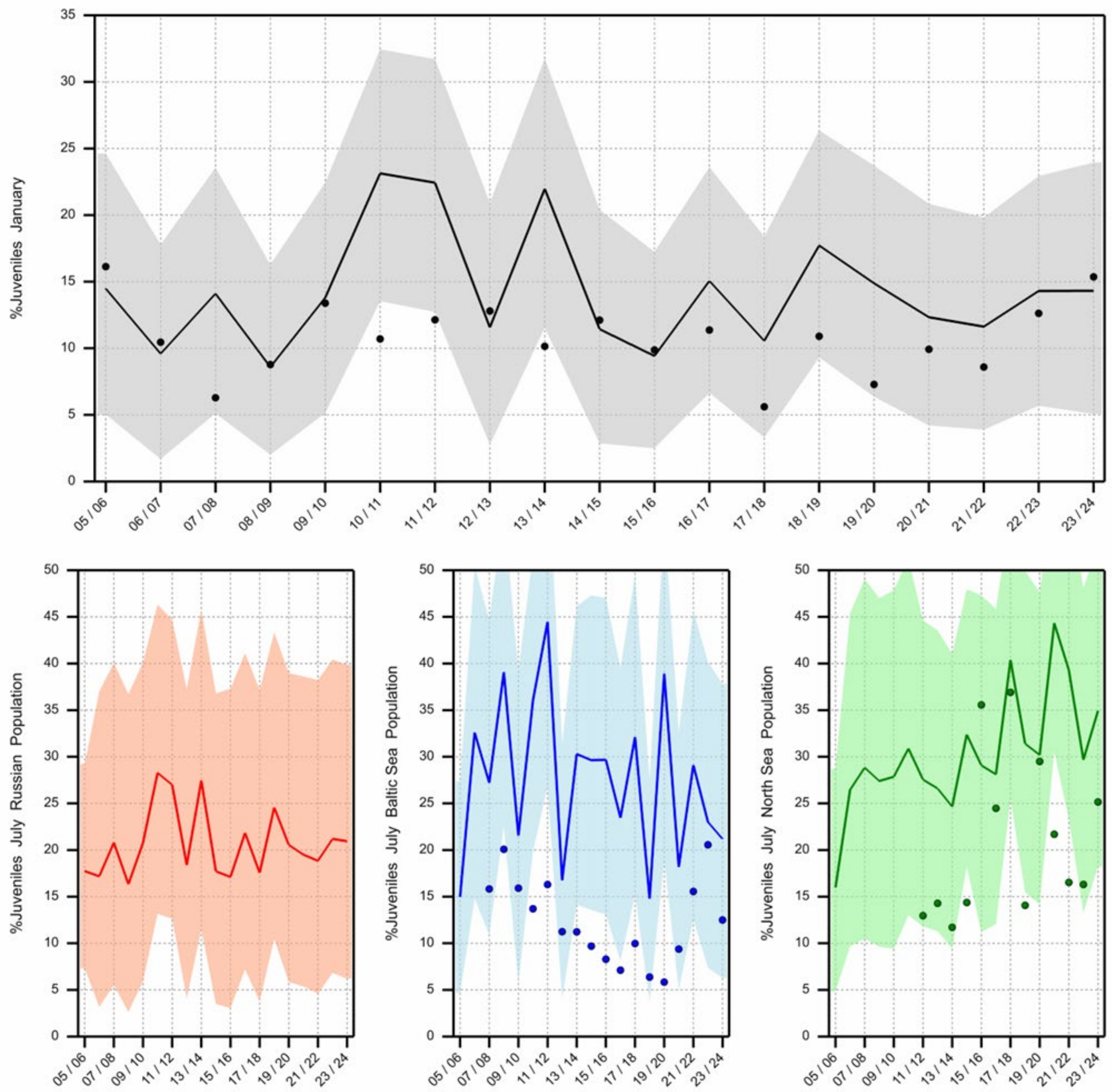

Figure 3.4-8. Top panel: Observed autumn percentage of juveniles (dots) in the Russia/Germany and Netherlands population of Barnacle Goose, posterior means (solid line) and 95% posterior intervals (shaded area). Bottom panels: Observed summer percentage of juveniles in the three MU-populations, along with posterior means and 95% posterior intervals. Left (red) MU1, centre (blue) MU2, right (green) MU3. Note that in MU1 there are no field data to compare with the IPM estimates (they are included in the assessments in autumn, given in the top panel).

3.4.6 Management guidance

The overall results of this year's assessment are broadly similar to those for 2024. The MU3-population of Barnacle Geese in Belgium, the Netherlands and Germany should still be subject to a coordinated derogation approach, in line with the 200% threshold set in the AFMP. The latest model output points at a population level which is above the size of the FRP (Figure 3.4-4). At present derogations affecting MU3 are only granted in the Netherlands. Derogations in Schleswig-Holstein in Germany are likely affecting MU2 and (even more so) MU1-populations only, given the time of the year in which they are undertaken (according to new legislation from October-February). In the model this is however not possible, as in this period offtake is assumed to affect all three MU, proportional to their numbers. Offtake rates on MU2 will therefore be slightly overestimated. It remains unknown to what extent large-scale clutch management in Schleswig-Holstein affects total numbers in July. In Niedersachsen, no derogations take place, and Belgium considers its small breeding population as non-naturally occurring (Nagy et al. 2021, F. Verhagen, pers. communication), so stays out of this coordination. In the Netherlands, a coordinated approach among the provinces (which are each responsible for their own goose management) has been installed in order to facilitate implementation of the AFMP and avoid numbers falling below the FRP.

Worth noticing is the fact that the current IPM-estimates indicate that the Baltic MU2 population has now also dropped below the 200% threshold level and thus will require coordination among range states (notably Denmark, Sweden, Finland), as far as measures affecting local breeding populations are undertaken or planned. Based on derogation data collected so far, offtake in these countries likely affect mainly the Russian MU1-population, but there is a need to investigate a more data-based division of offtake under derogations in these countries (perhaps differentiating among regions or time of the year), to evaluate to what extent the different MUs might be affected. By doing so, the assigned offtake to MU2 is perhaps lower and should actually be added to that from MU1.

Regarding the Russian MU1-population, the results indicate that this population is increasing and its current population level way beyond the 200% threshold. Breeding opportunities in the Russian Arctic are also assumed to expand, as shown by Lameris et al. (2023) for Novaya Zemlya, as a result of climate change.

There is no indication that highly pathogenic avian influenza (HPAI) has resulted in considerable declines, as was initially observed in the Svalbard population of Barnacle Goose. Caliendo et al. (2024) estimated that in 2020/21 and 2021/22 up to 4.8% and 7.4% of the Barnacle Goose present in the Netherlands died of avian influenza. During 2024/25, at least in the Netherlands, higher mortality was again observed among wintering birds, but involving apparently fewer birds than during 2020-2022.

In terms of monitoring data for the IPM, there are some issues, especially regarding data in the summer period. Larger gaps specifically occur in the Baltic MU2. Finland is the only country in which comprehensive (late) summer counts have been established since 2008. For Sweden, where summer census data were lacking for nearly the entire period of interest, we have now used results from the mid-September count instead. This count is carried out before migratory birds from the Arctic MU1 arrive, and it is only two weeks after the summer count in Finland (which takes place by the end of August). It is assumed that in this short period, transition rates between the two countries are low, but this assumption should preferably be underpinned by data from resightings of ringed birds or tracking data. Moreover, given the large fluctuations in the count results for September in Sweden (and the rather low number in autumn 2023), it is recommended to check if the coverage of the counts does affect the final results, or what other explanations could be found for this pattern (e.g. earlier emigration to Denmark or other countries further south). This is especially important, as the current data suggests that the numbers in MU2 are below 200% of the FRP. So far, data has only periodically been collected in the Oslofjord area in Norway and in Denmark and it is recommended to continue these periodical counts (in Denmark, future counts will be carried out in August, next count scheduled for 2025). In MU3, it would be highly desirable to include up-to-date counts from Schleswig-Holstein and Niedersachsen (now partly available), along with a more timely assessment and publication of these data.

Furthermore, seasonal assignment of offtake and assignment to the respective MUs still involve a lot of assumptions and expert judgement, as most data are only available as a total figure for the entire calendar year and assignment to MU-level is challenging. Currently, the Netherlands is the only country with a monthly data resolution, allowing us to make more precise assignment of derogation figures to each respective MU (notably segregating migratory and sedentary populations to a large extent). Also data from Denmark partly allow this. Improved assignment to MUs for derogations in especially Sweden would improve the use of derogation data and allow more precise offtake estimates for individual MUs (specifically segregating among MU1 and MU2). This does not necessarily have to be monthly data, as long it will be possible to improve assumptions about the MUs affected by the derogations issued, either by the period derogations were undertaken or the sites or regions where it was carried out.

Regarding productivity data, it is recommended to achieve a more representative sample from the entire MU2-population (now data based mainly on Helsinki region in Finland). This would mean an extension of counts outside the Helsinki region and start of surveys in Sweden and preferably also Denmark. Swedish surveys could eventually be combined with the September count (as juveniles are still relatively easy to identify by that time), but can also be done earlier, in late summer or early September. It is also assumed that by September flocks of breeders and non-breeders are occurring more mixed than during summer, thus delivering more representative estimates. Earlier in summer, breeders and non-breeders likely occur more segregated, as is observed in the Netherlands and Germany. Collection of a representative sample then may be more challenging.

Winter abundance is generally well covered, albeit some missing data (Sweden 2021-2022 and part of Germany 2024) had to be interpolated from previous counts. Regarding January-data, a more up-to-date assessment of census data from Schleswig-Holstein in Germany would allow to include final figures to be used in this status report.

3.5 E. Greenland/Scotland and Ireland population of Barnacle Goose *Branta leucopsis*

3.5.1 Range states and management units

The Range States for the *E. Greenland/Scotland & Ireland population of Barnacle Goose* include Greenland, Iceland, Republic of Ireland and United Kingdom (Figure 3.5-1). The population is managed as one Management Unit (MU) (Jensen et al. 2018; Nagy, Heldbjerg, Jensen, Johnson, Madsen, Meyers, et al. 2021).

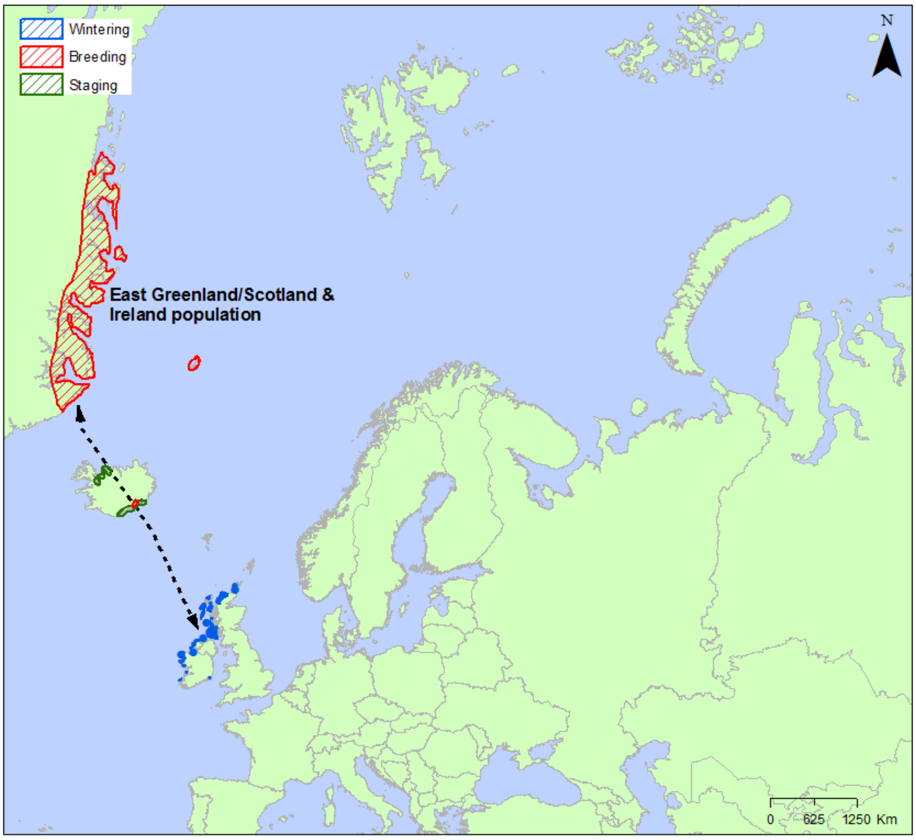

Figure 3.5-1. Annual distribution and migration routes for the E. Greenland/Scotland & Ireland population of Barnacle Geese, including breeding (red), staging (green) and wintering (blue) areas.

3.5.2 Population FRPs and targets

The FRP for the breeding season is 19,400 pairs (Nagy et al. 2021). The FRP for the entire population has been set at 54,000 wintering individuals. Being an Annex 1 species of the EU Birds Directive, the AFMP does not aim to maintain the population at a certain target level. In EU countries (Ireland) and the UK management is carried out under the conditions for derogation, outlined in Art. 9 of the EU Birds Directive. Furthermore, the species is strictly protected under the Bern Convention. There are open hunting seasons for the species in Iceland (which has entered a reservation in respect of the Bern Convention's Appendix II listing of Barnacle Geese) and Greenland.

3.5.3 Management strategies

The AFMP aims to prevent the population declining below the defined FRPs (Nagy et al. 2021). Thus, the FRPs represent the lower limit of the legally acceptable population size but does not reflect targets for population reduction. Monitoring of the population size and harvest, and predictive modelling of the cumulative impact of national derogation measures and hunting are used to inform national decision-making to ensure the population remains above the FRPs. The cumulative impact of derogation and hunting and the non-lethal measures taken to prevent damage/risk on the population are assessed periodically, along with the likelihood of serious damage to agriculture and risk to air safety and to other flora and fauna (including the Arctic ecosystems), as well as the effectiveness of these.

Within this framework, it has also been agreed to coordinate monitoring of the population and offtake under derogations and hunting when the actual size of the populations is below 200% of the defined FRP. This includes prediction of population development, coordination of offtake and taking coordinated conservation measures, where necessary. Note, however, that the population size has perhaps never exceeded 200% of the FRP.

As the population is apparently approaching the FRP, it was agreed at IWG9 in June 2024 that Iceland and the United Kingdom should seek agreement on the maximum level of offtake to be permitted (if any) and the split between the two Range States and further develop and implement a coordination mechanism to ensure adherence to these limits. Iceland and the United Kingdom has informed the EGM IWG in writing on the agreed level of offtake for 2024, the agreed coordination mechanism, and reported on the implementation and adherence to the agreed level of offtake.

3.5.4 Assessment protocol

In 2020, NatureScot and the Department of Housing, Local Government and Heritage Ireland, funded the development of an integrated population model (IPM) for the purpose of better understanding the population dynamics of the flyway population of Greenland/Scotland and Ireland barnacle geese and in order to inform the management of offtake for the species.

We refer to McIntosh et al. (2023) for the following description of the IPM, which is a pre-breeding census model with an annual time-step and anniversary date in March. Annual change in March abundance is described as:

$$N_{t+1} = N_t\theta \begin{Bmatrix} \left(1-h_t^i\right)\left(\left(1-p_t^{Islay}\right)+\ p_t^{Islay}\left(1-h_t^s\right)\right)+ \\ r_t\left(1-v^i h_t^i\right)\left(\left(1-p_t^{Islay}\right)+\ p_t^{Islay}\left(1-v^s h_t^s\right)\right) \end{Bmatrix}$$

where N_t is the March population size at time t, q is the constant rate of natural survival, p_t^{Islay} is the proportion of the March flyway population on Islay at time t, h_t^i is the annual harvest rate in Iceland, h_t^s is the annual harvest rate in Scotland, v^i is the differential vulnerability of juveniles in Iceland, v^s is the differential vulnerability in Scotland, and r_t is the pre-season age ratio (juvenile: adult ratio at the start of the hunting season).

To model annual change in March abundance we assumed that: a) harvest occurs sequentially (first in Iceland, then in Scotland), b) differential vulnerability of juveniles in Scotland is constant throughout the winter (Calvert et al. 2017), c) natural mortality is distributed evenly throughout the year (Gauthier et al. 2001). Lastly, we assumed that shooting mortality is additive to natural mortality as observed in numerous other goose populations (Gauthier et al., 2001; Sedinger et al., 2007; Cooch et al., 2014; Koons et al., 2014).

We assume six months of natural mortality to predict pre-hunting population size:

$$N_t^F = N_{A,t}^S\theta^{6/12} + N_{A,t}^S\theta^{6/12}r_t$$

where N_t^F is the autumn population size and $N_{A,t}^S$ is the adult spring population size.

Harvest occurs first in Iceland (H^I) in the early autumn:

$$H_t^I = N_{A,t}^S \theta^{6/12} h_t^i (1 + r_t v^i)$$

To estimate Scottish harvest (H^S) we assume an additional month of natural mortality and that individuals survive harvest in Iceland. Winter derogation shooting occurs predominantly on Islay, therefore only Islay-wintering birds experience Scottish shooting mortality.

Number surviving Iceland harvest is:

$$(N_t^F - H_t^I)\theta^{1/12} = N_{A,t}^S \theta^{7/12}(1 - h_t^i) + N_{A,t}^S \theta^{7/12} r_t (1 - v^i h_t^i)$$

Scottish harvest (H^S) is then

$$H_t^S = N_{A,t}^S \theta^{7/12} \left\{ \left(p_t^{Islay} \left((1 - h_t^i) h_t^s \right) \right) + r_t \left(p_t^{Islay} \left((1 - v^i h_t^i) v^s h_t^s \right) \right) \right\}$$

We estimated annual harvest rates for different age classes.

Adults (h_t^A):

$$h_t^A = h_t^i + \theta^{1/12} \left(p_t^{Islay} \left((1 - h_t^i) h_t^s \right) \right)$$

Juveniles (h_t^J):

$$h_t^J = v^i h_t^i + \theta^{1/12} \left(p_t^{Islay} \left((1 - v^i h_t^i) v^s h_t^s \right) \right)$$

Annual survival rate (s_t) is derived from apparent natural survival (q) and harvest mortality (h_t). Due to an absence of data on unretrieved harvest, crippling losses (unobserved harvest mortality) are implicitly included in the estimate of natural mortality. Adult survival rate is:

$$s_t^A = \theta(1 - h_t^A)$$

and juvenile survival rate is:

$$s_t^J = \theta(1 - h_t^J)$$

Raw data and the results of the 2025 update of the IPM are available from the EGMP Data Centre.

3.5.5 Status

a) Abundance

After a peak population of 80,000 in 2006 and in 2012, posterior estimates of flyway abundance declined to 62,438 (52,845 – 72,985) in March 2025 (Figure 3.5-2). For much of the period of record, abundance on Islay exceeded that in all other wintering areas, but that pattern has been reversed since 2018.

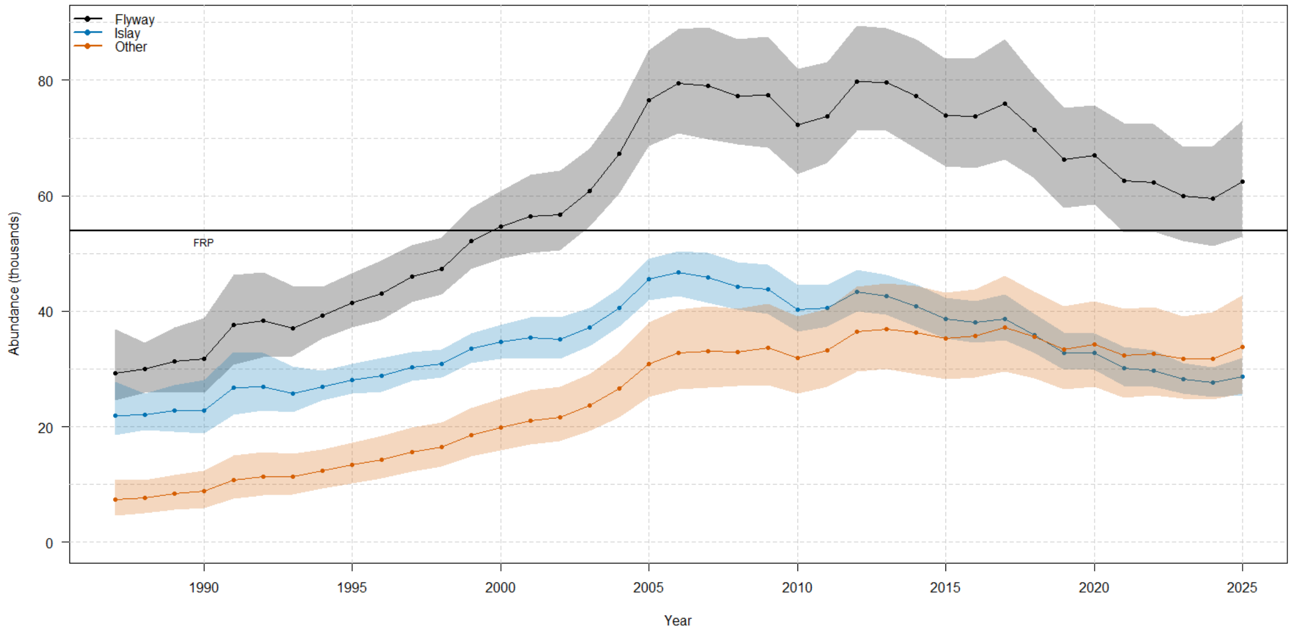

Figure 3.5-2. Development of the March population size of E. Greenland/Scotland & Ireland Barnacle Geese as based on the IPM. The FRP = 54 thousand. Shading represents the 95% credible intervals.

b) Mortality and offtake

Natural survival (i.e., 1 – the natural mortality rate) was relatively high and stable until 2007 when it became more variable, with unusually low natural survival during 2007 – 2009, in 2017, and during 2020 – 2021 (Figure 3.5-3). The latter period of low survival might be attributed to an outbreak of avian influenza, but it is difficult to say whether survival was in fact lower than is typical because of the wide credible intervals.

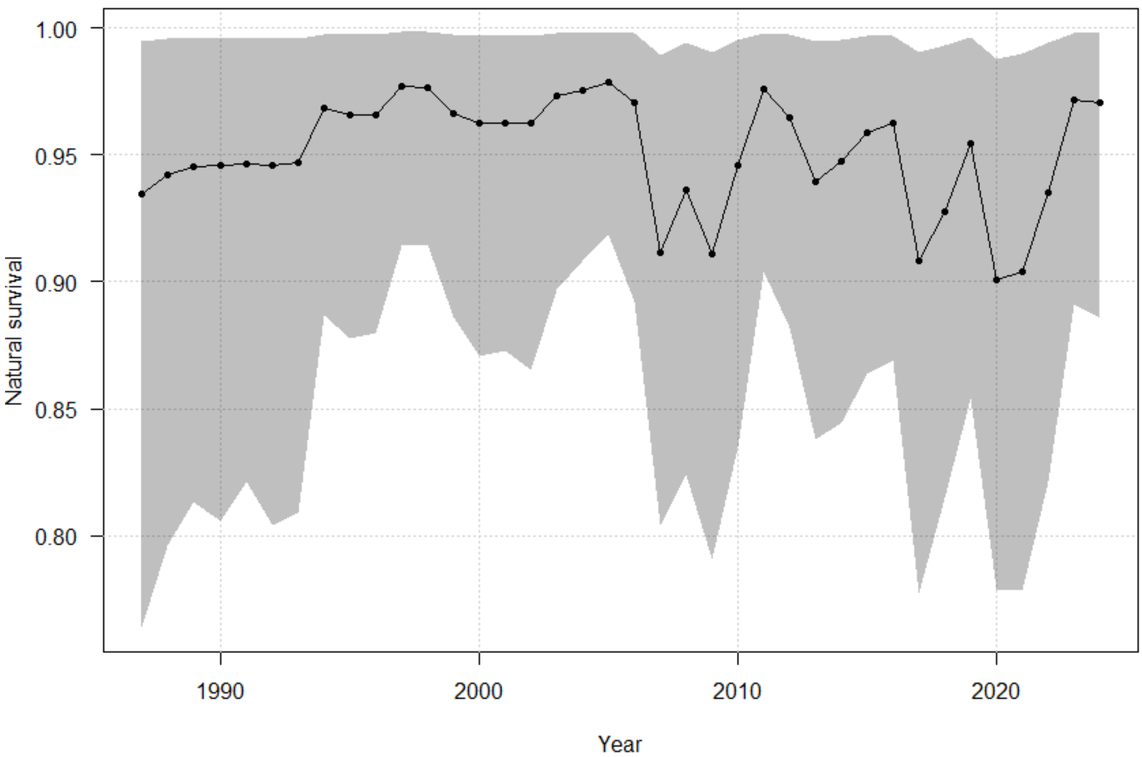

Figure 3.5-3. Natural survival rates (i.e., 1 – the natural mortality rate) of E. Greenland/Scotland & Ireland Barnacle Geese as based on the IPM. Shading represents the 95% credible intervals.

The total harvest rate of adults has increased over the period of record, from around 0.01 to a peak of 0.05 (0.04 – 0.07) in 2017 (Figure 3.5-4). Thereafter, harvest rate declined to 0.03 (0.02 – 0.04) in 2024. Annual survival rate of adults (including both harvest and natural mortality) declined at the same time harvest rates were increasing, suggesting that harvest may have contributed to the decline in flyway abundance (although other factors cannot be ruled out).

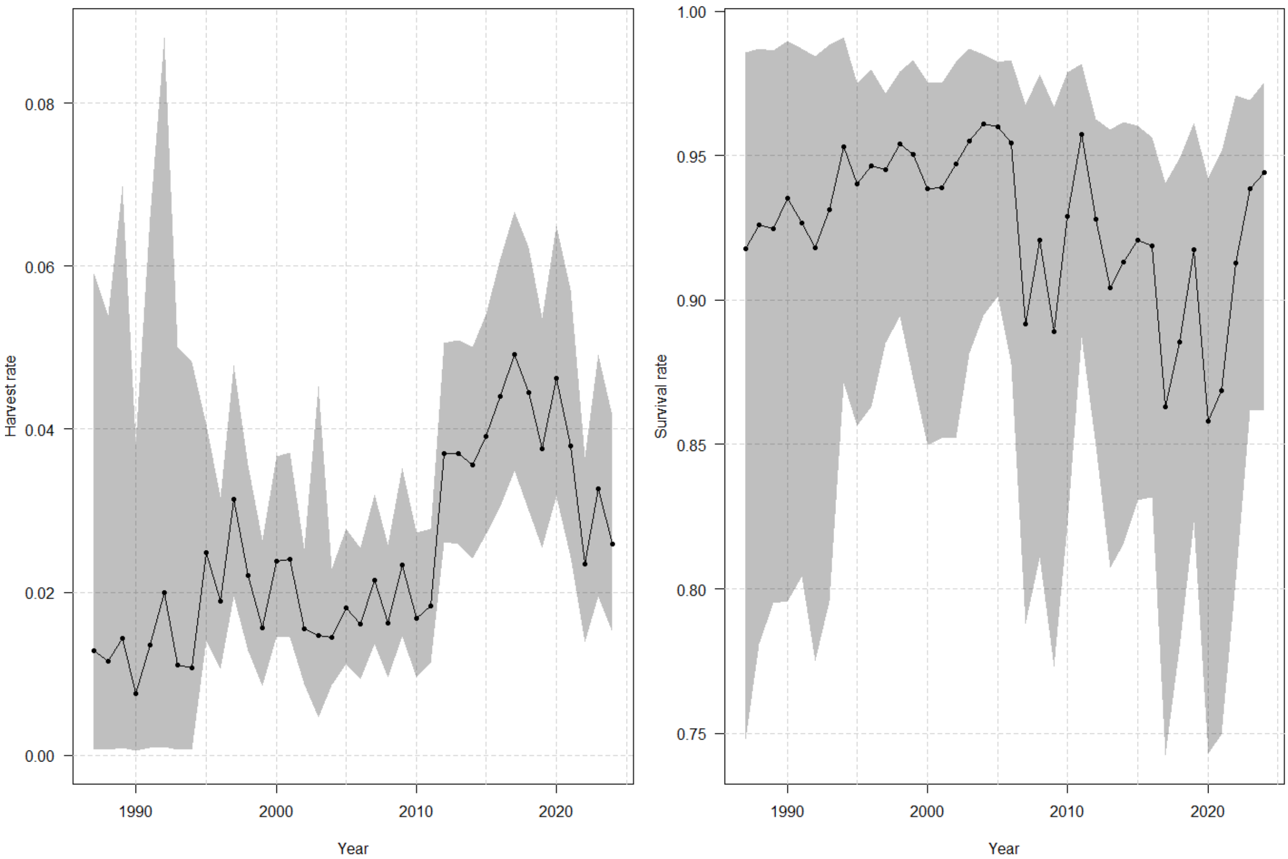

Figure 3.5-4. Adult harvest rates (left) and annual survival rates (right) of E. Greenland/Scotland & Ireland Barnacle Geese as based on the IPM. Shading represents the 95% credible intervals.

Recreational harvest (and overall harvest rate) in Iceland has generally increased over the period of record (Figure 3.5-5, Figure 3.5-6), and the 2024 estimated harvest in Iceland was 2,686 (1,824 – 3,789) individuals. In Scotland, derogations increased starting in 2012 in response to a plan to limit agricultural conflicts but has now been reduced to near zero in response to avian influenza and the observed population decline. The 2024 estimated harvest in Scotland was 58 (2 – 319) individuals.

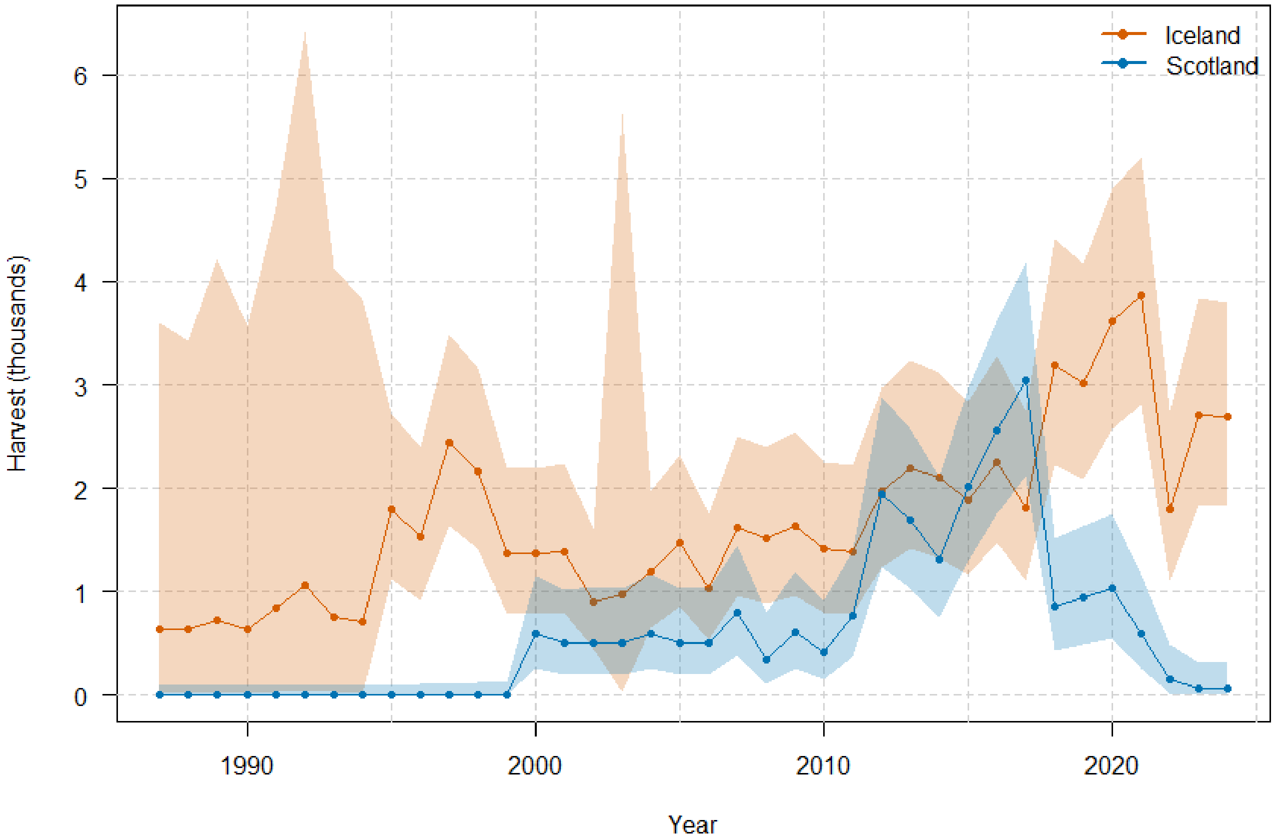

Figure 3.5-5. Offtake of E. Greenland/Scotland & Ireland Barnacle Geese as based on the IPM. Shading represents the 95% credible intervals.

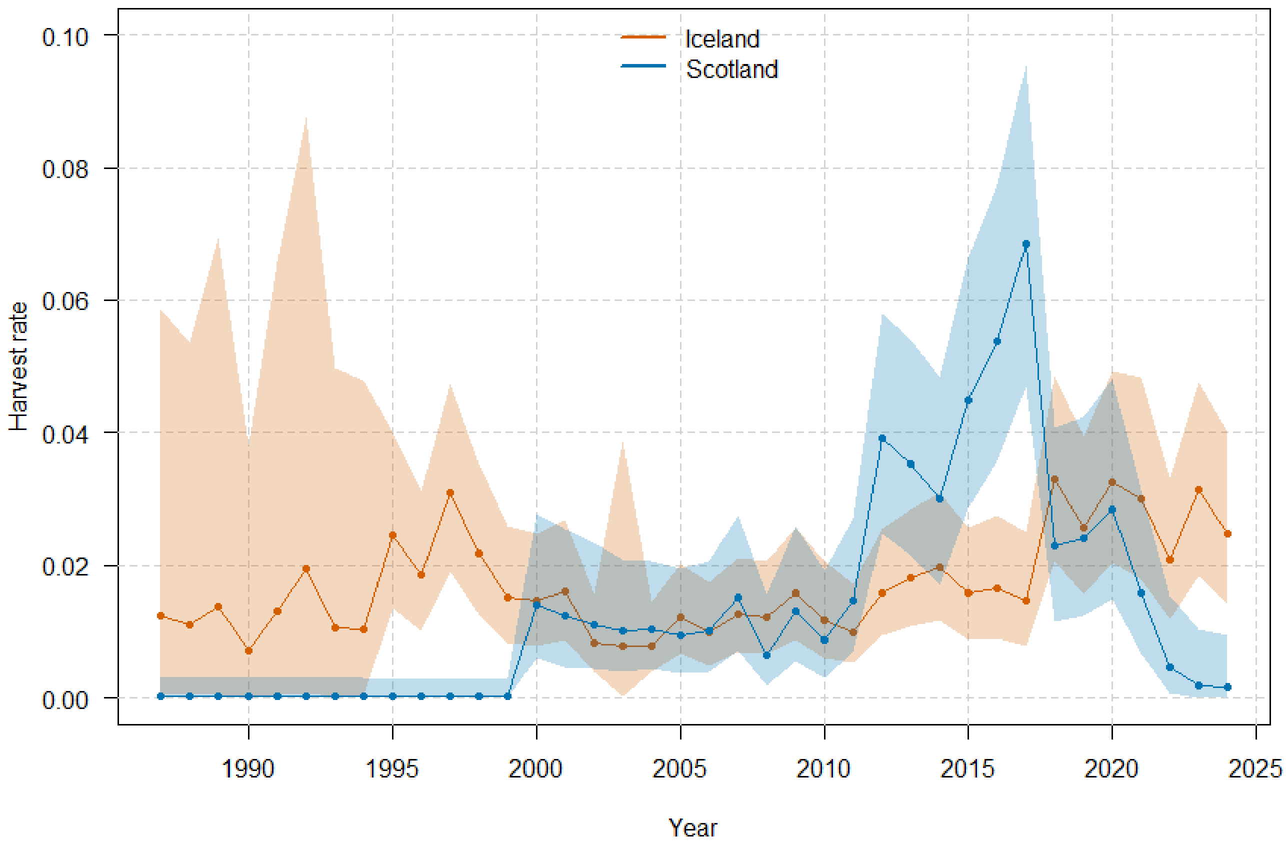

Figure 3.5-6. Harvest rates (including derogations) of E. Greenland/Scotland & Ireland Barnacle Geese as based on the IPM. Shading represents the 95% credible intervals.

c) Reproduction

The post-breeding age ratio has been moderately variable over time, although perhaps somewhat lower since 2006 than previously (Figure 3.5-7). It is possible that this variability in reproduction, along with the lower annual survival rates in more recent years, could have contributed to the more recent decline in Flyway (Figure 3.5-4).

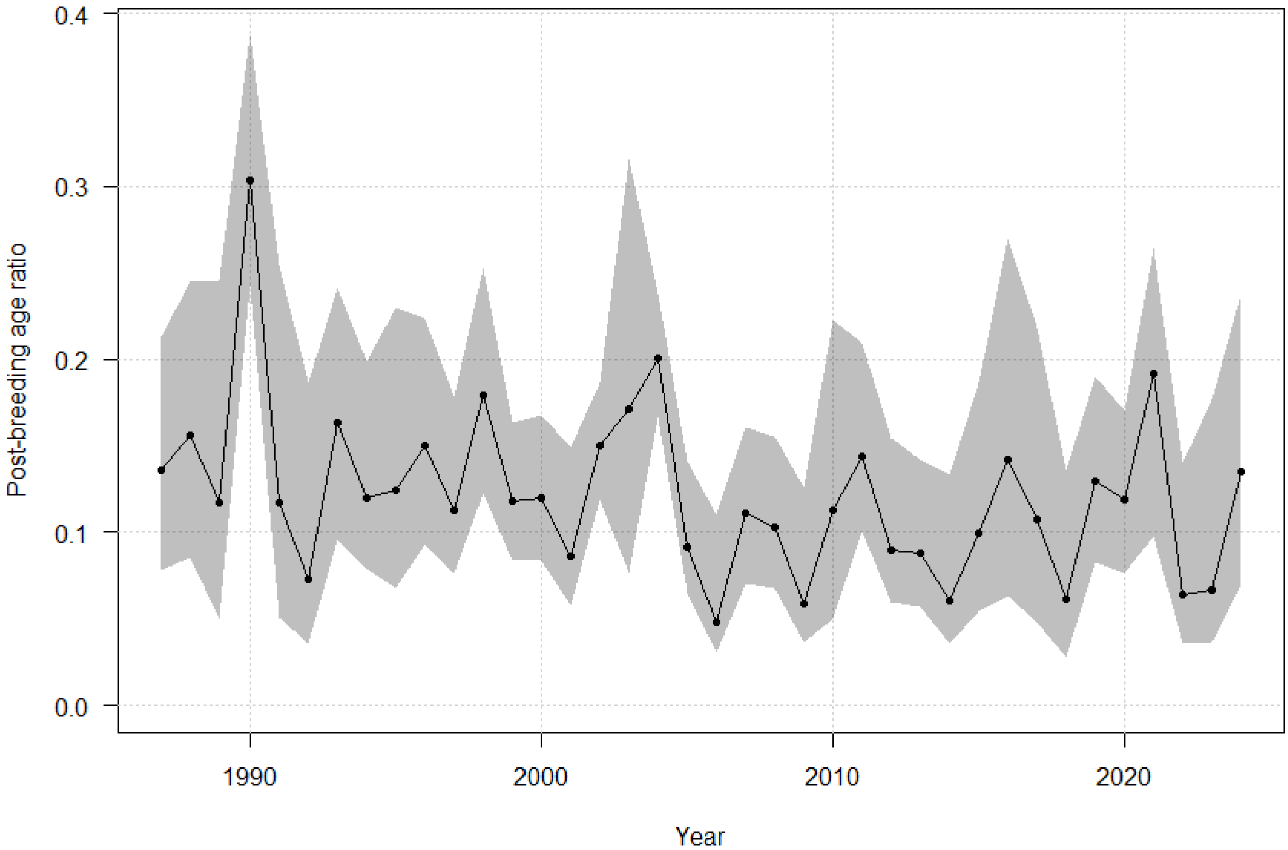

Figure 3.5-7. Post-breeding age ratio of E. Greenland/Scotland & Ireland Barnacle Geese as based on the IPM. Shading represents the 95% credible intervals.

3.5.6 Management guidance

It appears that a contribution of factors, possibly including decreased productivity, as well as increased harvest and natural mortality rates, may have been responsible for the decline in flyway abundance over the last decade. Given the harvest rates in 2024, estimates from the IPM give a 4% probability that the March 2025 population is below the FRP of 54,000. Because of the proximity of the population to the FRP over the past several years, the Adaptive Flyway Management Plan requires tighter coordination of offtake between Iceland and Scotland to ensure the population does not fall below the FRP.

Table 3.5-1 provides a range of scenarios of varying levels of offtake applied to varying spring population sizes to determine the probability (based on the IPM) of the population falling below the FRP the following year. Thus, this table expresses the risk of falling below the FRP for a range of population sizes and levels of offtake *for any given year*. Once an acceptable risk level is established, the table can provide the **maximum** acceptable offtake for any population size. Probabilities account for uncertainty in natural mortality and reproductive rates, as well as for sampling error in estimated population size. Probabilities are updated each time the IPM is updated.

Table. 3.5-1. Approximate probability that the following year's population size of Greenland Barnacle Geese is lower than the FRP of 54k for varying levels of population size and offtake in any given year. The table does not refer to any particular year. March population sizes (in thousands [k]) for any focal year (t) are provided in the leftmost column and varying offtake levels (in thousands [k]) are represented in the top row. Values in each coloured cell represent the probability that the population size in the following year (i.e., t + 1 will be below the FRP, P(Nt+1<54k)). Colour scale represents increasing level of risk, where warmer colours indicate higher probabilities that the population will fall below the FRP.

March	Offtake (k)																								
pop (k)	**0**	**0,25**	**0,5**	**0,75**	**1**	**1,25**	**1,5**	**1,75**	**2**	**2,25**	**2,5**	**2,75**	**3**	**3,25**	**3,5**	**3,75**	**4**	**4,25**	**4,5**	**4,75**	**5**	**5,25**	**5,5**	**5,75**	**6**
54	0,29	0,30	0,31	0,33	0,35	0,36	0,39	0,40	0,42	0,43	0,44	0,46	0,48	0,50	0,51	0,53	0,54	0,56	0,57	0,59	0,60	0,62	0,63	0,64	0,66
55	0,23	0,25	0,26	0,27	0,28	0,30	0,31	0,33	0,34	0,36	0,38	0,39	0,42	0,42	0,44	0,46	0,47	0,49	0,51	0,52	0,53	0,55	0,56	0,58	0,60
56	0,19	0,19	0,21	0,22	0,23	0,25	0,27	0,28	0,29	0,30	0,32	0,33	0,35	0,37	0,37	0,39	0,41	0,42	0,44	0,46	0,47	0,49	0,50	0,51	0,53
57	0,15	0,15	0,17	0,18	0,19	0,20	0,21	0,22	0,23	0,25	0,26	0,27	0,29	0,30	0,31	0,32	0,34	0,36	0,37	0,38	0,39	0,42	0,44	0,45	0,47
58	0,11	0,12	0,13	0,14	0,15	0,15	0,17	0,18	0,19	0,20	0,21	0,22	0,23	0,25	0,26	0,28	0,29	0,30	0,31	0,33	0,35	0,36	0,38	0,39	0,40
59	0,08	0,09	0,09	0,10	0,11	0,12	0,13	0,13	0,15	0,16	0,17	0,17	0,19	0,20	0,22	0,22	0,23	0,24	0,26	0,27	0,29	0,30	0,31	0,32	0,34
60	0,06	0,07	0,07	0,08	0,08	0,09	0,10	0,11	0,11	0,12	0,13	0,14	0,15	0,16	0,17	0,18	0,19	0,20	0,22	0,23	0,24	0,25	0,26	0,27	0,28
61	0,05	0,05	0,06	0,06	0,07	0,07	0,08	0,08	0,09	0,10	0,10	0,11	0,12	0,13	0,13	0,14	0,15	0,16	0,17	0,18	0,19	0,20	0,22	0,23	0,23
62	0,03	0,04	0,04	0,05	0,05	0,05	0,06	0,06	0,06	0,07	0,07	0,08	0,09	0,10	0,10	0,11	0,12	0,13	0,14	0,15	0,15	0,16	0,17	0,18	0,19
63	0,02	0,02	0,03	0,03	0,03	0,04	0,04	0,04	0,05	0,05	0,06	0,06	0,07	0,07	0,08	0,09	0,09	0,10	0,11	0,11	0,12	0,13	0,14	0,15	0,16
64	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,04	0,04	0,04	0,05	0,05	0,05	0,06	0,07	0,07	0,08	0,08	0,08	0,10	0,10	0,11	0,11	0,13

Appendix A – Data overview

A.1. Pink-footed Goose – Svalbard population

Table A.1. Overview of available monitoring data for the Svalbard population of Pink-footed Goose. X data collected (nearly) annually and reported to EGMP, x data collected (nearly) annually, (x) data collected in part of the country and/or not annually, - no data collected or reported to the EGMP, * 0 or not relevant range state in this respect.

	NO	SE	FI	DK	NL	BE
Population count in Autumn	X	X	X	X	X	X
Population count in Spring	X	X	X	X	*	*
Productivity	X	X	*	X	-	X
Hunting bag (or derogation)	X	X	*	X	*	*
Wings	-	(x)	*	X	*	*
Crippling	(x)	*	*	-	*	*
Temperature on Svalbard	X	*	*	*	*	*

A.2. Taiga Bean Goose

Table A.2a. Overview of available monitoring data in the Finland and NW Russia/Sweden, Denmark and Germany Taiga Bean Goose population. X data collected (nearly) annually and reported to EGMP, x data collected (nearly) annually, (x) data collected in part of the country and/or not annually, - no data collected or reported to the EGMP, * 0 or not relevant range state in this respect.

	NO	SE	FI	DK	DE	NL	LV	PL	UA	RU
Population counts in Autumn	-	X	X	X	*	*	-	-	-	-
Population counts in mid-winter	*	X	*	X	-	*	-	-	-	-
Population counts in Spring	X	X	X	X	-	X	(x)	-	-	-
Productivity	*	X	-	-	-	-	-	-	-	-
Hunting bag	*	*	X	X	-	*	(x)	-	-	(x)
Derogation	-	X	X	*	-	X	(x)	-	-	-
Heads/Wings	*	(x)	(x)	(x)	-	-	(x)	-	-	(x)

Table A.2b. Overview of available monitoring data in the Scandinavia/Denmark and UK Taiga Bean Goose population. X data collected (nearly) annually and reported to EGMP, - no data collected or reported to the EGMP.

	UK	DK
Population counts in mid-winter	X	X
Productivity	X	-

A.3. Greylag Goose – NW/SW European population

Table A.3.1 Overview of available monitoring data in the NW/SW European Greylag Goose population.
Grey cells mark data for MU1 and blue cells for MU2.
X = data collected annually/regularly and reported to EGMP, x = data collected annually/regularly, (x) = data collected in part of the country and/or not annually, - = no data collected or reported to the EGMP, * = 0 or not relevant range state in this respect.

	NO	SE	FI	DK	DE	NL	BE	FR	ES
Population counts in January (received through IWC)	X	X	*	X	(x)[1]	X	X	X	(x)[2]
Summer count	(x)[3]	X[4]	X[5]	X[6]	(x)[7]	X	X	(x)[8]	*
Productivity	(x)[9]	X	(x)[10]	-	(x)[11]	X	-	-	-
Hunting bag	X	X	X	X	x[12]	*	X	X[13]	(x)[14]
Split hunting data into March-Aug and Sep-Feb	(x)[15]	(x)[16]	(x)[17]	(x)[18]	-	*	(x)[19]	X	X
Derogation	(x)[20]	X	X	X	(x)[21]	X	X	*	*
Split derogation data into March-Aug and Sep-Feb	(x)[22]	(x)[23]	(x)[24]	X	-	X	(x)[24]	*	*
Crippling rate		(x)[25]				(x)[25]			

1) Available from IWC most years, but the coverage is unknown.
2) Available from IWC most years, but the coverage is limited.
3) Country-wide estimate from 2022 has been made available. Future count/estimate interval unknown.
4) September count is used. Coverage could be improved, and counts do not account for hunting and migration.
5) To estimate population size, organized counts have been carried out in 2022 and 2023. GPS-tracking has been used to distinguish between birds from the C and NW/SW European populations.
6) Counted every two years in August.
7) Available from Nordrhein-Westfalen (since 2011) and Niedersachsen (2018-2023). Data from Schleswig-Holstein is available for June and September 2018-2023.
8) Available every 6 years from 2022.
9) Available from Vesterålen (2020-2022) and Oslofjord-area (2020-2024).
10) Data available from 2022 and 2023.
11) Available from Nordrhein-Westfalen.
12) Data Source: Datenspeicher Jagd Eberswalde, Thünen-Institut.
13) Method unknown.
14) Available from Andalusia.
15) Hunting season 21.07-23.12. Assume all hunting takes place Sep-Feb.
16) Open hunting season 11.08-31.01. Assume all hunting takes place Sep-Feb. Conditional hunting season: all year, but assume all takes place between March-Aug.
17) Hunting season 10.08-31.12. Assume all hunting takes place Sep-Feb.
18) Hunting season 01.08-31.01. Assume all hunting takes place Sep-Feb.
19) Hunting season 15.07-31.01, but 15.07-14.08 and 01.10-31.01 constrained to prevent (crop) damage in the absence of other satisfying solutions. Open hunting season 15.08-30.09. Assume all hunting takes place Sep-Feb.
20) No routine data collection, but few individuals (~1200).
21) Available in most years.
22) All year, assume all derogation takes place between March-Aug.
23) Derogation period: 01.01-09.08, the majority takes place in July-Aug. Assume all derogation takes place between March-Aug.
24) Assume all derogation takes place between March-Aug.

25) Not collected annually, and only for part of the flyway.

Table A.3.2 Overview of model parameters and their source

Parameter	Description	Value	Source
Φ	annual survival in absence of hunting	0.88	allometric relationship (Johnson et al. 2012)
ϕ(0.90)	annual survival of young from MU1	0.79	loosely based on Pistorius et al. (2006) and Schneider & Bacon (2022)
α	rate of production of young by birds aged 3+	0.46	derived using ϕ and population growth rate of 1.014 from EGMP Population Status and Offtake Assessment Report (2022)
ψ_1	proportion of MU1 birds wintering in the North	0.67	based on marking data (Leo Bacon, pers. comm.)
ψ_2	proportion of MU2 birds wintering in the North	0.95	based on marking data (Leo Bacon, pers. comm.)
π_1, π_2	fidelity of MU1 and MU2 birds	1.0	Schneider & Bacon (2022), recognizing that lack of fidelity is typically temporary
$\begin{bmatrix} n_{1,1} \\ n_{2,1} \\ n_{3,1} \\ n_{1,2} \\ n_{2,2} \\ n_{3,2} \end{bmatrix}$	initial population sizes (in thousands) in fall 2022, where the first subscript denotes age and the second denotes MU	$\begin{bmatrix} 72.2 \\ 56.4 \\ 201.1 \\ 120.3 \\ 94.0 \\ 334.9 \end{bmatrix}$	derived based on estimates of breeding pairs in 2018 (Szabolcs Nagy, pers. comm.) and the stable age distribution of the matrix model in the absence of harvest
h_{ijk}	rate of offtake of age *i*, season *j*, and area *k*	0.0 to 0.4 in increments of 0.02	simulated to project population sizes in 2030
v_s	differential vulnerability of young in summer	1.0	assumed given no selectivity in summer derogations
v_w	differential vulnerability of young in winter	2.0	assumed to be similar to pink-footed geese (Johnson et al. 2020)

A.4. Barnacle Goose – Russia/Germany and Netherlands population

Table A.4. Overview of available monitoring data in the Russia/Germany and Netherlands Barnacle Goose population. X data collected at national level/annually, (x) data collected but not annually and/or not at national level, - data currently not collected, * not relevant range state in this respect.

	RU	FI	EE	SE	NO	DK	DE	NL	BE	Remark
January census	*	*	*	X	*	X	X[1]	X	X	
Summer census	-	X	-	X[2]	(x)	(x)	(x)	X	(x)	
Productivity, MU1 and MU2	*	*	*	-	*	-	X	X	-	Autumn, Oct-Dec
Productivity, MU2	*	(x)	-	-	(x)	-	*	*	*	Summer, Jul-Aug
Productivity, MU3	*	*	*	*	*	*	(x)[4]	X	-	Summer, Jul
Offtake, hunting	-	*	*	*	*	*	*	*	*	In EU-countries only derogations
Offtake, derogations	*	X	X	X	X[3]	X	X	X	X	Mostly annual totals (apart from monthly data in NL), more detailed data requested especially from DK and SE in order to improve estimates for individual MUs.

[1] Note that Germany only submits data once every six years (latest full dataset up to 2016, next 2026), and recent years are based on published data only.
[2] For Sweden, the national count in mid-September is used as a proxy for numbers in summer.
[3] Norway is not an EU Member State but applies similar rules when it comes to management of Barnacle Goose, although derogations are for scaring purposes only.
[4] Only available from North-Rhine Westphalia.

A.5. Barnacle Goose – East Greenland/Scotland and Ireland population

Table A.5. Overview of available monitoring data in the East Greenland/Scotland and Ireland Barnacle Goose population.
X data collected (nearly) annually and reported to EGMP, x data collected (nearly) annually, (x) data collected in part of the country and/or not annually, - no data collected or reported to the EGMP, * 0 or not relevant range state in this respect.

	UK	Ireland	Iceland	Greenland
Flyway total every 3 years	X	X	*	*
Islay March count - annual	X	*	*	*
Other totals in Scotland - annual	X	*	*	*
Breeding bird count in Iceland every 3 year	*	*	X	*
Offtake	X	X	X	- / (x)
Productivity	X	-	-	-
Wings	X	*	X	*
Survival	-	-	-	-

References

UNEP/AEWA Secretariat. 2022. Agreement text and the Annexes to the Agreement as amended by MOP8. Budapest, Hungary. Available online: https://www.unep-aewa.org/sites/default/files/publication/aewa_agreement_text_2023-2025_mop8.pdf

Aubry, P., M. Guillemain, G. H. Jensen, M. Sorrenti, and D. Scallan. 2020. 'Moving from intentions to actions for collecting hunting bag statistics at the European scale: some methodological insights'. European Journal of Wildlife Research, 66,70 (2020), https://doi.org/10.1007/s10344-020-01400-2

Bairlein, F., J. Dierschke, V. Dierschke, V. Salewski, O. Geiter, K. Hüppop, U. Köppen, and W. Fiedler. 2014. 'Atlas des Vogelzuges. Ringfunde deutscher Brut- und Gastvögel'. AULA-Verlag, Wiebelsheim.

Baveco, H., P. W. Goedhart, K. Koffijberg, H. van der Jeugd, L. de Vries, and R. Buij. 2021. 'Development of an integretaed population model for Barnacle Geese of the Russian management unit'. Progress Report prepared by the Dutch working group on Barnacle Goose in collaboration with the EGMP Data Centre.' in S. Nagy, H. Heldbjerg, G. H. Jensen, F. A. Johnson, J. Madsen, O. Therkildsen, E. Meyers and S. Dereliev (eds.), Netherlands Population of the Barnacle Goose (*Branta leucopsis*). AEWA EGMP Programme No. 3. Bonn, Germany.

Caliendo, V., E. Kleyheeg, N. Beerens, C.J. Camphuysen, K., R. Cazemier, A.R.W. Elbers, R.A.M Foucher, L. Kelder, T. Kuiken, M. Leopold, R. Slaterus, M.A.H. Spierenburg, H. van der Jeugd, H. Verdaat, and J.M. Rijks. 2024. 'Effect of 2020–21 and 2021–22 Highly Pathogenic Avian Influenza H5 Epidemics on Wild Birds, the Netherlands'. Emerging Infectious Diseases, 30(1), 50-57. https://doi.org/10.3201/eid3001.230970.

Calvert, A. M., Alisauskas, R. T., & White, G. C. 2017. Annual survival and seasonal hunting mortality of midcontinent snow geese. The Journal of Wildlife Management, 81(6), 1009–1020.

Clausen, K.K., T.E. Holm, L. Haugaard and J. Madsen. 2017. 'Crippling ratio: A novel approach to assess hunting-induced wounding of wild animals'. Ecological Indicators, 80: 242-46, https://doi.org/10.1016/j.ecolind.2017.05.044

Cooch, E. G., Guillemain, M., Boomer, G. S., Lebreton, J., & Nichols, J. D. 2014. The effects of harvest on waterfowl populations. Wild, 4, 220–276.

EU. 2020. 'Composite European Commission Report on Derogations according to article 9 of Directive 2009/147/EC on the Conservation of Wild Birds.'

Fox, A.D. & J.O. Leafloor. (eds.) 2018. 'A global audit of the status and trends of Arctic and Northern Hemisphere goose populations'. Conservation of Arctic Flora and Fauna International Secretariat: Akureyri, Iceland.

Fryxell, J. M., A. R. E. Sinclair, and G. Caughley. 2014. 'Wildlife Ecology, Conservation, and Management'. Wiley.

Gauthier, G., R. Pradel, S. Menu, J.-D. Lebreton. 2001. 'Seasonal survival of Greater Snow Geese and effect of hunting under dependence in sighting probability'. Ecology, 82(11): 3105–3119, https://doi.org/10.1890/0012-9658(2001)082[3105:SSOGSG]2.0.CO;2

Gupte, P., K. Koffijberg, G. Mskens, M. Wikelski, and A. Klzsch. 2019. 'Family size dynamics in wintering geese'. Journal of Ornithology, 160: 363-75, https://doi.org/10.1007/s10336-018-1613-5

Haas, F., H. Kampe-Persson & L. Nilsson. 2023. 'Inventering av höstrastande och övervintrande gäss i Sverige – årsrapport för 2022'. Biologiska institutionen, Lunds universitet.

Heldbjerg, H., F. A. Johnson, K. Koffijberg, R. McKenzie, S. Nagy, G. H. Jensen and J. Madsen. 2021. 'Population Status and Assessment Report 2021'. AEWA EGMP Technical Report No. 19. Bonn, Germany.

Hornman, M., M. Kavelaars, K. Koffijberg, F. Hustings, E. van Winden, P. van Els and R. Kleefstra. 2021. 'Watervogels in Nederland in 2018/2019'. Sovon rapport 2021/01, RWS-rapport BM 21.08. Sovon Vogelonderzoek Nederland, Nijmegen.

Hornman M., Koffijberg K., van Oostveen C., van Winden E., Louwe Kooijmans J., Kleefstra R. and Soldaat L. 2024. Watervogels in Nederland in 2022/2023. Sovon-rapport 2024/96, RWS-rapport BM 24.39. Sovon Vogelonderzoek Nederland, Nijmegen. https://stats.sovon.nl/pub/publicatie/22231

Jensen, G.H., H. Heldbjerg, I.H. Sørensen, P. Clausen and C.L. Pedersen. 2023. 'Summer count of Greylag Geese in Denmark 2022'. Aarhus University, DCE - Danish Centre for Environment and Energy, 27 s. – Scientific briefing no. 2023|1

Jensen, G.H., F.A. Johnson and J. Madsen. 2023. 'Sources of variation in estimating breeding success of migratory birds from autumn counts'. *Ecologica Solutions and Evidence* 4(1):e12212, https://doi.org/10.1002/2688-8319.12212

Jensen, G.H., F.A. Johnson, H. Baveco, K. Koffijberg, P.W. Goedhart, R. McKenzie and J. Madsen. 2022. 'Population Status and Assessment Report 2022'. AEWA EGMP Technical Report No. 20 Bonn, Germany

Jensen, G. H., J. Madsen, S. Nagy, and M. Lewis. 2018. 'AEWA International Single Species Management Plan for the Barnacle Goose (Branta leucopsis) - Russia/Germany & Netherlands population, East Greenland/Scotland & Ireland population, Svalbard/South-west Scotland population'. AEWA Technical Series No. 70. Bonn.

Johnson, F. A., G. S. Zimmerman, G. H. Jensen, K. K. Clausen, M. Frederiksen, and J. Madsen. 2020. 'Using integrated population models for insights into monitoring programs: An application using pink-footed geese', *Ecological Modelling* 415, https://doi.org/10.1016/j.ecolmodel.2019.108869 .

Johnson, F., H. Heldbjerg, and S. Mntyniemi. 2020. 'An integrated population model for the central management unit of taiga bean geese': Final project report. Avalable at: https://egmp.aewa.info/sites/default/files/download/population_status_reports/egmp_final_project_report_tbg_complete.pdf

Johnson, F. A., H. Heldbjerg, S. Nagy, and J. Madsen. 2021. 'Setting population-size targets for geese causing socio-economic conflicts'. *Ambio* 51:209–225, https://doi.org/10.1007/s13280-021-01539-5

Johnson, F.A., I.H. Sørensen, H. Baveco, K. Koffijberg, R.R. Germain, and J. Madsen. 2024. Population Status and Assessment Report 2024. EGMP Technical Report No. 22. Bonn, Germany.

Johnson, F.A., J. Madsen, K. K. Clausen, M. Frederiksen and G.H. Jensen. 2022. 'Assessing the value of monitoring to biological inference and expected management performance for a European goose population'. Journal of Applied Ecology 60(1):132-145, https://doi.org/10.1111/1365-2664.14313

Johnson, F. A., and K. Koffijberg. 2021. 'Biased monitoring data and an info-gap model for regulating the offtake of greylag geese in Europe'. Wildlife Biology, 1:wlb.00803, https://doi.org/10.2981/wlb.00803

Johnson, F. A., M. A. H. Walters, and G. S. Boomer. 2012. 'Allowable levels of take for the trade in Nearctic songbirds'. *Ecological Applications* 22:1114–1130, https://doi.org/10.1890/11-1164.1

Kéry, M., J. Madsen, and J. D. Lebreton. 2006. 'Survival of Svalbard pink-footed geese Anser brachyrhynchus in relation to winter climate, density and land-use', Journal of Animal Ecology, 75: 1172-81, https://doi.org/10.1111/j.1365-2656.2006.01140.x

Koffijberg, K. 2022. 'Bruterfolgsmonitoring bei Gänsen und Schwänen: Bestimmung von Alt- und Jungvögeln'. Version 15.10.2022. Dachverband Deutscher Avifaunisten, https://austausch.dda-web.de/s/Bestimmung-GuS-Jungvoegel.

Koffijberg, K., and C. Kowallik. 2020. 'Ergebnisse der Gänsezählungen in Nordrhein-Westfalen im Juli 2018, 2019 und 2020'. NWO Monitoringbericht 2020/02. Nordrhein-Westfälischen-Ornithologengesellschaft. Available online: http://www.nw-ornithologen.de/images/textfiles/monitoring_downloads/Sommergaense_2018-2020.pdf

Koffijberg, K. and C. Kowallik. 2022. 'Ergebnisse der Gänsezählungen in Nordrhein-Westfalen im Juli 2021 und 2022'. NWO-Monitoringbericht 2022/02, Voerde/Duisburg.

Koffijberg, K., and C. Kowallik. 2023. 'Ergebnisse der Gänsezählungen in Nordrhein-Westfalen im Juli 2023'. NWO Monitoringbericht 2023/01. Nordrhein-Westfälischen-Ornithologengesellschaft. Available online: https://www.nw-ornithologen.de/images/textfiles/monitoring_downloads/Sommergaense_2023.pdf.

Koffijberg, K. & C. Kowallik (2024): Ergebnisse der Gänsezählungen in Nordrhein-Westfalen im Juli 2024. NWO-Monitoringbericht 2024/01, Voerde/Duisburg. https://www.nw-ornithologen.de/images/textfiles/monitoring_downloads/Sommergaense_2024.pdf

Koons, D. N., Rockwell, R. F., & Aubry, L. M. 2014. Effects of exploitation on an overabundant species: The lesser snow goose predicament. Journal of Animal Ecology, 83(2), 365–374.

Lameris, T.K., O.B. Pokrovskaya, A.V. Kondratyev, Y.A. Anisimov, N.H. Buitendijk, P.M. Glazov, H.P. van der Jeugd, C. Kampichler, H. Kruckenberg, K.E. Litvin, J.A. Loshchagina, S. Moonen, G.J.D. Müskens, B.A. Nolet, K.H.T. Schreven, H. Sierdsema, E.M. Zaynagutdinova & M.P. Boom. 2023. 'Barnacle geese Branta leucopsis breeding on Novaya Zemlya: current distribution and population size estimated from tracking data'. Polar Biology 46, 67–76. https://doi.org/10.1007/s00300-022-03110-8

Madsen, J., G. Cracknell & A.D. Fox (editors). 1999. ‘Goose Populations of the Western Palearctic: A Review of Status and Distribution’. National Environmental Research Institute, Denmark and Wetlands International, Wageningen, The Netherlands. Wetlands International Publication Vol. 48.

Madsen, J., Schreven, K. H. T., Jensen, G. H., Johnson, F. A., Nilsson, L., Nolet, B. A., & J. Pessa. 2023. ‘Rapid formation of new migration route and breeding area by Arctic geese’. Current Biology, 33(6), 1162-1170.e4. https://doi.org/10.1016/j.cub.2023.01.065

Marescot, L., G. Chapron, I. Chads, P. L. Fackler, C. Duchamp, E. Marboutin, and O. Gimenez. 2013. 'Complex decisions made simple: a primer on stochastic dynamic programming', *Methods in Ecology and Evolution*, 4: 872-84, https://doi.org/10.1111/2041-210X.12082

Marjakangas, A., M. Alhainen, A. D. Fox, T. Heinicke, J. Madsen, L. Nilsson, and S. Rozenfeld. 2015. ‘International Single Species Action Plan for the Conservation of the Taiga Bean Goose (Anser fabalis fabalis)’. AEWA Technical Series No. 56. Bonn, Germany.

McIntosh, A. L. S., S. Bearhop, G. M. Hilton, J. M. Shaw, and F. A. Johnson. 2023. Modelling harvest of Greenland barnacle geese and its implications in mitigating human-wildlife conflict. Journal of Applied Ecology 60:764–777.

Månsson, J., N. Liljebäck, R. Buij, S. Moonen, and J. Elmberg (2024). Regional differences in crippling rate in greylag geese *Anser anser*. Wildlife Biology (early view). https://doi.org/10.1002/wlb3.01356.

Nagy, S., H. Heldbjerg, G. H. Jensen, F. A. Johnson, J. Madsen, E. Meyers, and S. Dereliev. 2021. ‘Adaptive Flyway Management Programme East Greenland/Scotland & Ireland Population of the Barnacle Goose (Branta leucopsis)’. AEWA EGMP Programme No. 2. Bonn, Germany.

Nagy, S., H. Heldbjerg, G. H. Jensen, F. A. Johnson, J. Madsen, O. Therkildsen, E. Meyers and S. Dereliev, 2021. ‘Adaptive Flyway Management Programme for Russia/Germany & Netherlands Population of the Barnacle Goose (Branta leucopsis)’. AEWA EGMP Programme No. 3. Bonn, Germany."

Nagy, S., H. Heldbjerg, G. H. Jensen, F. A. Johnson, and J. Madsen. 2021. 'Adaptive Flyway Management Programme for the Greylag Goose Anser anser, NW Europe/SW Europe population.' AEWA EGMP Programme No. 1. Bonn, Germany.

Niedersächsische Sommer-Gänsezählung 2022. https://www.nlwkn.niedersachsen.de/startseite/naturschutz/staatliche_vogelschutzwarte/aktuelles_zu_vogelarten/monitoring_von_gastvogeln/sommer_gansezahlung/5-niedersaechsische-sommer-gaensezaehlung-2022-212718.html

Nielsen, R.D., Holm, T.E., Clausen, P., Bregnballe, T., Clausen, K.K., Petersen, I.K., Sterup, J., Balsby, T.J.S., Pedersen, C.L., Dalby, L., Mikkelsen, P., Mellerup, K.A. & Bladt J. 2023. ‘Fugle 2020-2021. NOVANA’. Aarhus Universitet, DCE – Nationalt Center for Miljø og Energi. Videnskabelig rapport fra DCE - Nationalt Center for Miljø og Energi nr. 531. http://novana.au.dk/fugle/

Noer, H., J. Madsen, and P. Hartmann. 2007. 'Reducing wounding of game by shotgun hunting: Effects of a Danish action plan on pink-footed geese', Journal of Applied Ecology, 44: 653-62, https://doi.org/10.1111/j.1365-2664.2007.01293.x

Onkelinx, T., K. Devos, and P. Quataert. 2017. 'Working with population totals in the presence of missing data. Comparing imputation methods in terms of bias and precision', Journal of Ornithology, 158, 603-615, https://doi.org/10.1007/s10336-016-1404-9

Pistorius, P.A, A. Follestad and F.E. Taylor. 2006. ‘Declining winter survival and fitness implications associated with latitudinal distribution in Norwegian Greylag Geese Anser anser’. Ibis 148(1):114-125, https://doi.org/10.1111/j.1474-919X.2006.00498.x

Rozenfeld, S.B., E. G. Strelnikov and S.V. Volkov. 2024. ‘Migration routes and key stopovers of Anser fabalis fabalis (Anseriformes): Critical protection gaps’. Nature Conservation Research 9(4): 80–92. https://dx.doi.org/10.24189/ncr.2024.033

Schaub, M., and F. Abadi. 2011. 'Integrated population models: a novel analysis framework for deeper insights into population dynamics'. Journal of Ornithology, 152(Suppl 1):227-37, https://doi.org/10.1007/s10336-010-0632-7

Schneider, E., and L. Bacon. 2022. Etude démographique des oies cendrées sur la voie de migration européenne NO/SO. 2e année de Master Ecologie-Ethologie, 2021-2022. Université Jean Monnet, Saint-Etienne.

Schreven, K. H. T., J. Madsen & B.A. Nolet, 2024. ‘Effects of capture and GPS-tagging in spring on migration timing and reproduction in Pink-footed geese Anser brachyrhynchus’. Animal Biotelemetry, 12(1), Article 10. https://doi.org/10.1186/s40317-024-00365-2

Sedinger, J. S., Nicolai, C. A., Lensink, C. J. Wentworth, C., & B. Conant. 2007. 'Black Brant harvest, density dependence, and survival: A record of population dynamics'. Journal of Wildlife Management, 71(2), 496–506.

Sumaila, U. R., & C. Walters. 2005. 'Intergenerational discounting: a new intuitive approach'. Ecological Economics, 52(2):135-42, https://doi.org/10.1016/j.ecolecon.2003.11.012

Tombre, I. M. , G. E. B. Andersen, T. Axelsen, V. Kristiansen, and L. Rasmussen. 2020. 'Gjess i Ytre Oslofjord og Telemark. Antall og ungeproduksjon i 2020 for grågås og hvitkinngås'. NINA Report, 33. Norwegian Institute for Nature Research.

Tombre, I.M., G. E. B. Andersen, T. Axelsen, V. Kristiansen, L. Rasmussen, and J. Torp. 2021. 'Gåseforekomster i Vestfold og Telemark og Østfold-området i 2021'. NINA Report. Norwegian Institute for Nature Research.

Tombre, I.M., G.E.B. Andersen, V. Kristiansen & T. Axelsen. 2023. Gåseregistreringer i Vestfold og Telemark 2023. NINA Rapport 2398. Norwegian Institute for Nature Research.

Tombre, I.M., G.E.B. Andersen, T. Axelsen, V. Kristiansen & R.B. Solhaug. 2024. Gåseregistreringer i Vestfold, Telemark og Østfold i 2024. NINA Rapport 2540. Norwegian Institute for Nature Research. http://hdl.handle.net/11250/3169241

van der Jeugd, H. 2003. 'Survival and dispersal in a newly-founded temperate Barnacle Goose Branta leucopsis population', Wildfowl *63:72-89*.

van Roomen, M., Citegetse, G., Crowe, O., Dodman, T., Hagemeijer, W., Meise, K., & Schekkerman, H. (eds.). 2025. East Atlantic Flyway Assessment 2023. The status of coastal waterbird populations and their sites. Wadden Sea Flyway Initiative p/a CWSS, Wilhelmshaven, Germany, Wetlands International, Wageningen, The Netherlands, BirdLife International, Cambridge, United Kingdom. https://doi.org/10.5281/zenodo.15355686

Wolff S., B. Koop, H.-J. Augst, K.Günther and Uwe Helbing. 2023. 'Rastbestände von Weißwangen- und Graugänsen 2022'. In: Jahresbericht 2023 Zur biologischen Vielfalt. Jagd und Artenschutz, Schleswig-Holstein. https://www.schleswig-holstein.de/DE/fachinhalte/A/artenschutz/Downloads/jahresbericht2023.pdf?__blob=publicationFile&v=6.

AEWA European Goose Management Platform

AEWA

UNEP/AEWA Secretariat
UN Campus
Platz der Vereinten Nationen 1
53113 Bonn
Germany
Tel.: +49 (0) 228 815 2413
Fax: +49 (0) 228 815 2450
aewa.secretariat@unep-aewa.org
www.unep-aewa.org