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**AEWA EUROPEAN GOOSE MANAGEMENT PLATFORM**

AEWA European Goose Management Platform

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# EGMP POPULATION STATUS AND OFFTAKE ASSESSMENT REPORT 2023

*Prepared by the EGMP Data Centre with contributions from the International Modelling Consortium*

**Summary**

This report provides the 2023 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*

Beginning in May 2022, the population estimate was 61,222 (52,757 – 72,806). In November 2022, the population size was estimated as 65,600 (55,403 – 79,682). The May 2023 population estimate was 62,822 (51,080 – 74,352), which is similar to the May 2022 estimate. May population size appears to have declined since implementation of the adaptive harvest management program in 2013. We note, however, that the last several years of May population estimates from the IPM are highly uncertain. It appears that the November count has become increasingly biased high because of increased numbers of Barnacle Geese in the counting areas, making accurate identification at a distance difficult. Also, it appears that Pink-footed Geese have become more dispersed on the staging grounds in Trøndelag, Norway in May, exacerbating the likelihood of a low count. In the coming year, the Data Centre hopes to better understand the magnitude of bias in the biannual counts by exploring the use of GPS-tagged birds to estimate detection probabilities. Monitoring issues aside, the harvest quota for the 2023/2024 hunting season, based on the estimated population size of approximately 62,800 and 9 days above freezing in Svalbard in May 2023, is 7,300. Harvest quotas for Norway and Denmark this year are 2,190 and 5,110, respectively. We emphasize, however, that we can only say with 80% certainty that the total quota lies between 0 and 15,650. We also point out that the harvest has decreased rather dramatically in Denmark during the last two years for reasons that are unclear. Consequently, the total harvest during the last two years averaged only 9,577 (*se* = 154), well within the 80% credible interval of the allowable harvest for 2023. The harvests in Norway and Denmark during the last two years averaged 2,470 (*se* = 181) and 7,072 (*se* = 83), respectively. Finally, we note that 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. Therefore, the Data Centre will need to explore how to explicitly account for this lack of precise control over harvests.

*Taiga Bean Goose*

The four Management Units (MU) for Taiga Bean Geese have been redefined as populations: 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 Eastern 1 MU is now the West Siberia/Poland and Germany population. Birds belonging to the Eastern 2 MU are now regarded as a different subspecies of Bean Geese. In the former Western MU, the January count in 2023 was quite low (631 birds), but there were difficulties experienced in the count, particularly in the UK. There is no information on the status and demography of the Eastern population beyond what was reported in the 2021 Population Status and Assessment Report. In the former Central MU, the March 2023 population estimate was 66,166 (62,078 – 70,985), which is similar to the March 2022 estimate of 65,428 (61,302 – 69,993). Of particular concern to harvest management is that the current estimate of the carrying capacity ($K$) for the breeding population is 70,194 birds (64,552 – 79,735), which is essentially the same as the population target of 70,000. We emphasize that if the spring population were at the estimated carrying capacity of $K$ = 70,194 birds, there would be *no* harvestable surplus (i.e., any level of harvest would lead to a decline in equilibrium population size). This situation serves as a cautionary note about establishing population targets for huntable species in the absence of accounting for the population's biological potential. A total harvest of 1,000 birds during the next two years is projected to maintain the population near its current level (on average). Due to hunting restrictions in the range states, the harvest has only averaged 153 birds (sd = 71) during the last two years.

*Greylag Goose – NW/SW European population*

In 2023, the goal was to move from the rather crude information-gap decision model at population level to a dynamic and model-based management at MU level. Considerable progress has been made in this effort, including the development of a flyway population model and a utility model used to evaluate various offtake strategies in terms of their ability to meet population targets. However, MU or population level management is still not possible for a number of reasons; 1) the post-breeding population sizes for the two MUs as well as

the winter population size cannot be updated due to missing data, 2) there is evidence that the offtake data are biased high, perhaps extremely so, and 3) there are multiple offtake strategies (in terms of level and distribution) indicate a high probability of meeting both MU targets; thus offtake strategies must additionally be evaluated in terms of cost, feasibility, and legal mandates (which is outside the scope of the work done by the EGMP Data Centre).

*Barnacle Goose – Russia/Germany and Netherlands population*
This report provides an intermediate offtake assessment of all management units (MUs) in the Russian/Germany and Netherlands population for the period 2005/06-2021/22. The estimated flyway population size is about 1.4 million individuals in midwinter 2020/21 and 2021/22, thus 3.7 times the FRP. Converted into breeding pairs, Russian MU1 and Baltic MU2 are beyond the 200% threshold level set above the FRP, and for the North Sea MU3, numbers are below this 200% threshold, and about the size of FRP. Thus, derogation effort targeting the breeding population should be undertaken with caution (not relevant for Belgium as the breeding population here is considered non-naturally occurring). At present this is only applicable to the Netherlands, where derogations mainly take place in summer, but if significant derogation activities are planned in Germany, there should be coordination in place between the two countries. Furthermore, as in the Netherlands derogation is the responsibility of the provincial administrations, a coordinated approach is needed here as well (and is in development). Numbers in MU1 and MU2 are still above the 200% threshold set in the AFMP and their future developments give no concern for similar management adaptations as suggested for the MU3-North Sea population.

*Barnacle Goose – Greenland/Scotland and Ireland population*
The first assessment of the status of the population was supposed to take place in 2023. However, due to a failure to report all data by the deadline and a lack of guidance from the Task Force on projection scenarios for coordinated offtake between Scotland & Iceland (due to lack of data and understanding of avian influenza impacts), it has not been possible to conduct an assessment. Instead, the available raw data is presented. In 2023, population size is only available from winter counts on Islay, the most important wintering site in the UK, where 24,656 birds were counted in February. A total of 1,627 Barnacle Geese were killed in Scotland and Iceland. Derogation shooting was suspended in Scotland during most of the season as the result of a significant avian influenza (AI) outbreak. Until we receive all the data from the international census carried out in late February, it is not possible to estimate the impact of AI.

**Action requested from the EGM IWG8:**

The EGM IWG8 is requested to take note of the Population Status and Offtake Assessment report and provide further guidance to the Secretariat and Data Centre.

## Preface

This report provides the 2023 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.

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## Acknowledgement

There are many individuals involved in the data contribution in each country and those listed in the EGMP Database may be the ones who have delivered the data to the EGMP, but not necessarily the ones responsible for the actual data collection in the range states. We would therefore like to thank the network of national coordinators and all volunteers and agencies who contributed to the population counts, the hunters and wildlife councils who delivered data to different schemes across the range of these populations, and for providing wings of shot birds (see EGMP Database for further details and full acknowledgements). Furthermore, we also wish to thank the EGMP Task Forces and the EGMP Modelling consortium for helpful reviews of earlier drafts and the EGMP Range States that contributed to the annual budget of the EGMP Data Centre.

## Funding organisations

We are very grateful to:

- All EGMP Range States which have contributed with annual voluntary contributions to the EGMP Data Centre activities.
- NatureScot and the Norwegian Environment Agency for funding development of an impact model for the Greenland/Scotland and Ireland population as well as the Svalbard population of Barnacle Goose.
- Jægernes Naturfond in Denmark for funding development of a flyway-wide decision model for use in investigating population-management strategies for Greylag Geese, as well as Office Français de la Biodiversité (OFB) and the Dutch Ministry of Agriculture, Nature & Food Quality for funding projects focused on estimates of demographic parameters that will be used in the flyway model and for monitoring of crippling rate.
- A range of national initiatives to improve monitoring programs, particularly the development of monitoring programs to estimate the breeding population of Greylag Geese, in Denmark funded by the Danish Environmental Protection Agency, in Finland funded by the Finnish Wildlife Agency and

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the Finnish Ministry of Agriculture and Forestry, in Sweden funded by the Swedish Environmental Protection Agency, in Norway funded by the Norwegian Environmental Agency and in France by the National Office for Biodiversity and the Ligue pour la Protection des Oiseaux.

- NatureScot and the Department of Housing, Local Government and Heritage Ireland, for funding development of an integrated population model for the E. Greenland/Scotland & Ireland population of Barnacle Geese and the international census which took place in February 2023.
- The Ministry of Agriculture, Nature and Food Quality, the Provinces and BIJ12 in The Netherlands for funding development of an integrated population model for the Russian/Germany and Netherlands population of Barnacle Goose, developing a population model for Greylag Geese, and supporting the collection of monitoring data.
- The Finnish Wildlife Agency and Natural Resources Institute for funding development of an integrated population model for Taiga Bean Goose.

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## 1. Introduction

The first management plan to actively manage a migratory population of waterbirds in Europe was 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 extended to Taiga Bean Geese in 2015. 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 of AEWA 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 Eastern2 MU were listed as a population of Bean Goose (subspecies johanseni) in the AEWA Annexes (AEWA Agreement Text and Annexes 2022).

***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 | 2028 | 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 | 2028 | AFMP | 2020 | 2026 |
| E. Greenland/Scotland & Ireland population of Barnacle Goose | ISSMP | 2018 | 2028 | AFMP | 2020 | 2026 |
| Svalbard/SW Scotland population of Barnacle Goose | ISSMP | 2018 | 2028 | Not developed | - | - |

This report, together with the EGMP Database, replaces the individual population status and harvest assessment reports produced previously. 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 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 are available at: https://gitlab.com/aewa-egmp.

Information on indicators related to other aspect of the management plans, such as socioeconomic issues and ecosystem services provided by geese, are presented in the Adaptive Flyway Management Programmes (AFMPs) under Indicator factsheets and 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.*

A major component of the process for setting hunting regulations and assessing the impact of derogation consists of periodic monitoring and other data collection. Monitoring data refers to measures of abundance (counts or indices based on samples), data on productivity (counts of young and adults), 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 Russian Barnacle Goose population, and by NatureScot for the Greenland Barnacle Goose population. See Appendix A for coverage in each country and population and the EGMP Database for overview of data used.

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. This assessment process takes place every third year, and in the intervening years estimates of population abundance and other demographic information are presented.

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 Taiga Bean Goose (Central MU).

As the AFMP for the Svalbard/SW Scotland population of Barnacle Goose is still under development, no reporting is provided for this population.

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.

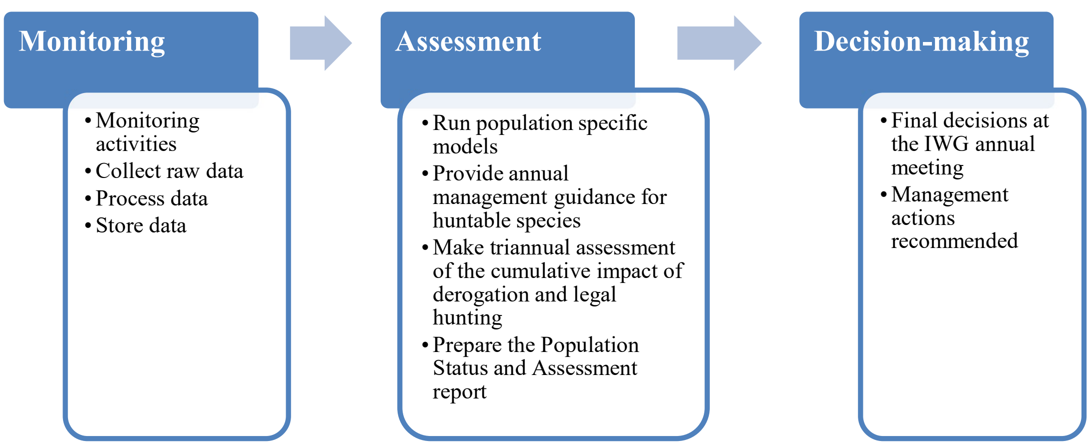



***Figure 1.1-1.*** The EGMP assessment process, including annual activities related to monitoring, assessment and decision-making.

## 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 that are part of the respective Eurasian flyways. These counts focus on counts in 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 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, Devos, and Quataert 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 (which coordinates the IWC survey, (van Roomen et al. 2018)).

In general, the January census provides the best available knowledge on the size of the total flyway population, as it has highest 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 occurs more or less at 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.

*Autumn census:* In continental Europe, special population counts have been made for all grey geese (*Anser sp.*) in November, as well as in September for Greylag Goose (Madsen, Cracknell, and Fox 1999). Some countries have added extra months, like Sweden where goose counts are performed in September-November and January each year, or 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.

*Spring census:* Counts during spring, just before the assessment process in May/June and before the next hunting season starts, 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 Taiga Bean Goose population, a count (in addition to the autumn count) is organized in late March/early April, when most of the population is gathered in Sweden and good coverage is possible. Spring census has recently been introduced to France to evaluate waterfowl and wader breeding populations sizes, including Greylag goose.

*Summer census:* For other 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. Timing of this kind of count varies from mid-July to early September, working on 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. 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, Finland, Sweden) it is a challenge to coordinate such a count 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.

*Common Breeding Bird Index:* The Common Breeding Bird Monitoring schemes provide a method to achieve information on the relative changes in breeding populations. The aim of these schemes is not to estimate the total number of breeding pairs (or breeding individuals), but instead to produce comparable national breeding bird indices from year to year, which are useful for the assessment of trends. These schemes are all based on fieldwork by a large number of volunteers and include all the common species, including breeding goose species. The scheme varies among countries, but all have standardized methodology, a formal design, are producing annual breeding bird indices which can be compared between countries and, when combined, deliver aggregated trends (Pecbms 2019). Information about each of the schemes can be found at www.pecbms.info.

All data were 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. 2022). Counts are usually done from October to late December, Greylag Goose is however already assessed during July or start August (preferably in combination with the summer census, s. above), as it otherwise is difficult to distinguish juveniles from adults. 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 behavior (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 some kind of harvest monitoring scheme; ranging from national harvest data recording, harvest data schemes at regional level/s or harvest data collection by wildfowling clubs shooting on foreshore land (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. In 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 the 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; (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 for 2021 taken from draft data available via the EU central data repository mentioned above.

*Wings and heads:* In Denmark, hunters may, on a voluntary basis, submit wings from shot geese to the Danish Wing Survey. 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 been invited to send a picture to the national hunting organisations for sub-species identification for estimating the proportion of Taiga Bean Goose among all bean geese.

*Crippling rate:* In several goose species, X-ray images have been used to assess the proportion with embedded shotgun pellets (Noer, Madsen, and Hartmann 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; Kery, Madsen, and Lebreton 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 Central MU of Taiga Bean Goose (Johnson, Heldbjerg, and Mntyniemi 2020), 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 modeling, 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 of 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

### 3.1.1. Range states and management units

This chapter compiles monitoring data on the population status of Svalbard Pink-footed Geese (*Anser brachyrhynchus*), as well as providing guidance for the upcoming hunting season (2023/2024). The range states for the Svalbard population of Pink-footed Goose 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, consisting of c. 4000 individuals and increasing partly due to immigration from the traditional flyway, qualifies as a separate biogeographic population according to AEWA definitions (Madsen et al. 2023). How this new population will be treated will be discussed as part of the evaluation process of the ISSMP in 2023-2025.

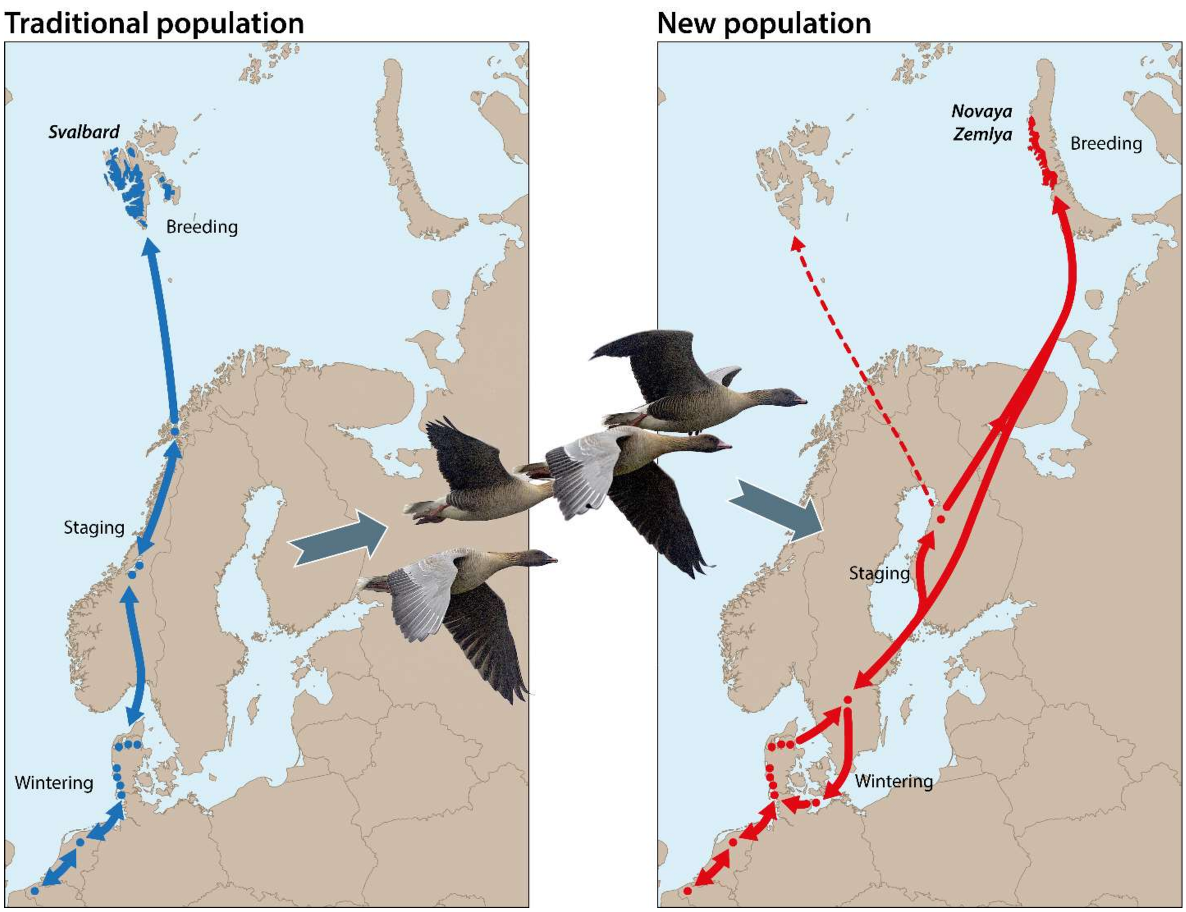



***Figure 3.1-1.*** Annual distribution and migration route of Svalbard Pink-footed Goose traditional population (left) as well as the new population (right) (Madsen et al. 2023).

### 3.1.2. Population FRP and target

No FRP has been set for Svalbard Pink-footed Geese. The population target is 60,000 individuals in spring to help reduce agricultural conflicts, particularly in Norway, as well as tundra degradation due to grazing 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. 2023). 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, $\theta_t$ 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 $\upsilon$ 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 $\gamma_t$ is the binomial probability of young, and:

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

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 modeled 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 $(a_\tau)$ and resource-dependent $(x_\tau)$ 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.

Data are available at EGMP (calm-dune-07f6d4603.azurestaticapps.net) and R code for running the IPM is provided at: https://gitlab.com/aewa-egmp/svalbard-population-of-pink-footed-goose. 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. The optimization code can be found at the same location as the IPM.

### 3.1.5. Status

*a) Abundance and trends*

We begin by discussing some monitoring issues that have come to light during this year's update of the IPM. Referring to Figure 3.1-2, we note that 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, as shown in Figure 3.1-3. 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 (Figure 3.1-3). 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. 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 has difficulty interpreting the decreasing May count and the increasing November count. Consequently, the last several years of May population estimates from the IPM are highly uncertain. The suspicion is that the November count has become increasingly biased high because of increased numbers of Barnacle Geese in the counting areas, making accurate identification at a distance difficult. Also, it appears that Pink-footed Geese have become more dispersed on the staging grounds in Trøndelag, Norway in May, exacerbating the likelihood of a low count. In the coming year, the Data Centre hopes to better understand the magnitude of bias in the biannual counts by exploring the use of GPS-tagged birds to estimate detection probabilities.

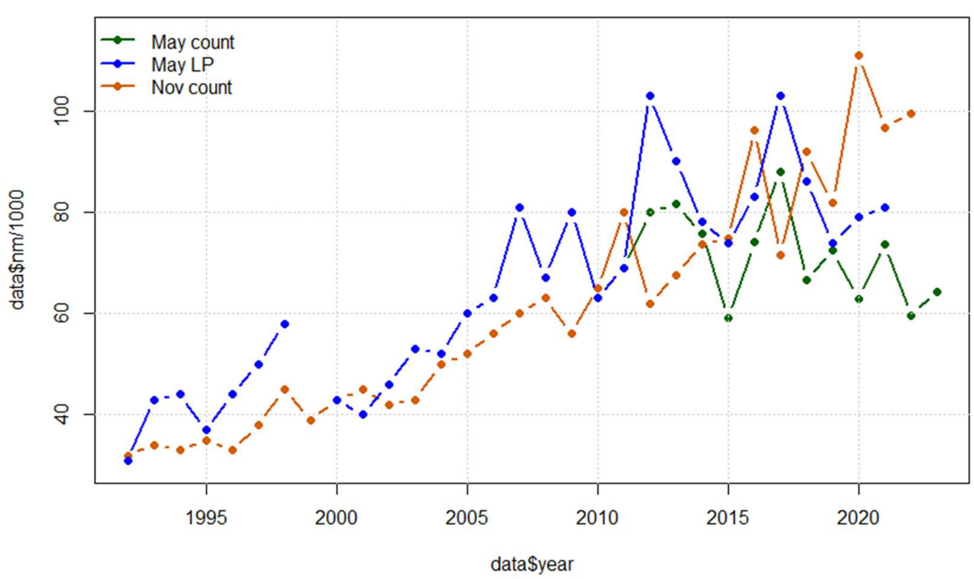



***Figure 3.1-2***. Biannual estimates of population size of Svalbard Pink-footed Geese based on counts and a Lincoln-Peterson (LP) estimator.

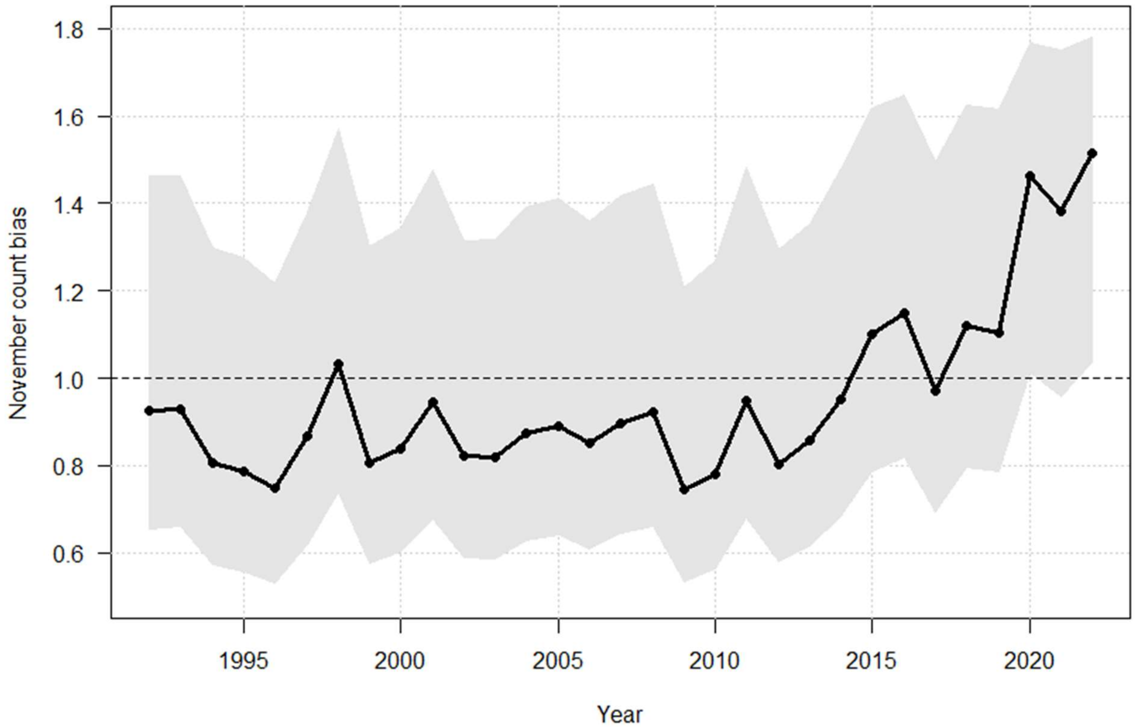



***Figure 3.1-3***. IPM-based estimates of the bias in November counts. Values <1 indicate a negative bias and those >1 indicate a positive bias.

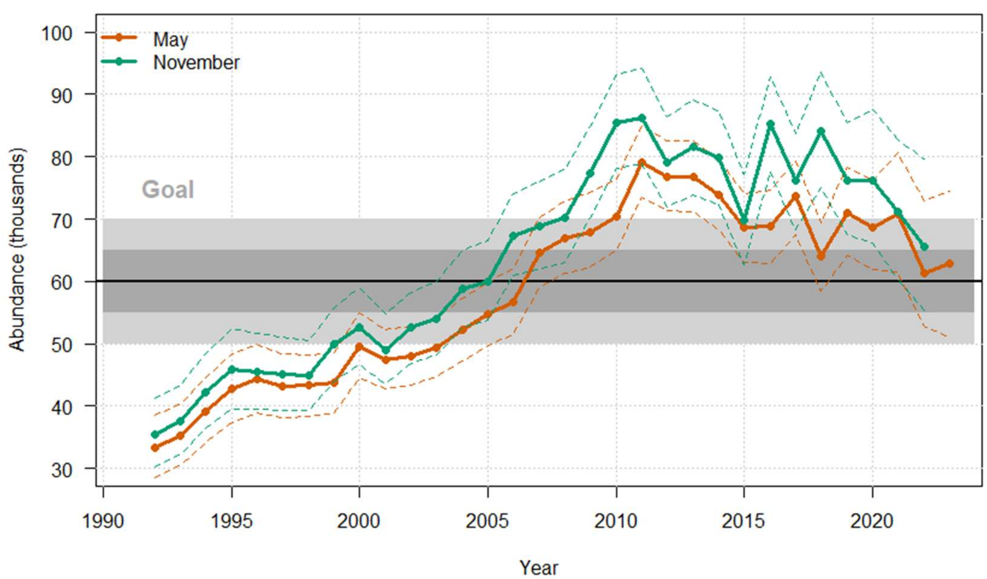



***Figure 3.1-4***. IPM-based estimates of abundance of Svalbard Pink-footed Geese in May and November, relative to the goal of 60,000 (95% credible intervals are indicated by the dashed lines). The dark grey band centered on the goal defines near-complete stakeholder satisfaction with population sizes,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

Without losing sight of the monitoring issues described above, posterior estimates of population size at two times of the year from the IPM are depicted in Figure 3.1-4. The reader is cautioned that historic estimates may differ from those presented previously (see Methods section 2.4). Beginning in May 2022, the population estimate was 61,222 (52,757 – 72,806). In November 2022, the population size was estimated as 65,600 (55,403 – 79,682). The May 2023 population estimate was 62,822 (51,080 – 74,352), which is similar to the May 2022 estimate. May population size appears to have declined since implementation of the adaptive harvest management program in 2013.

*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. Of note, however, is the decline in harvest and harvest rate during the last two years, especially in Denmark. 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).

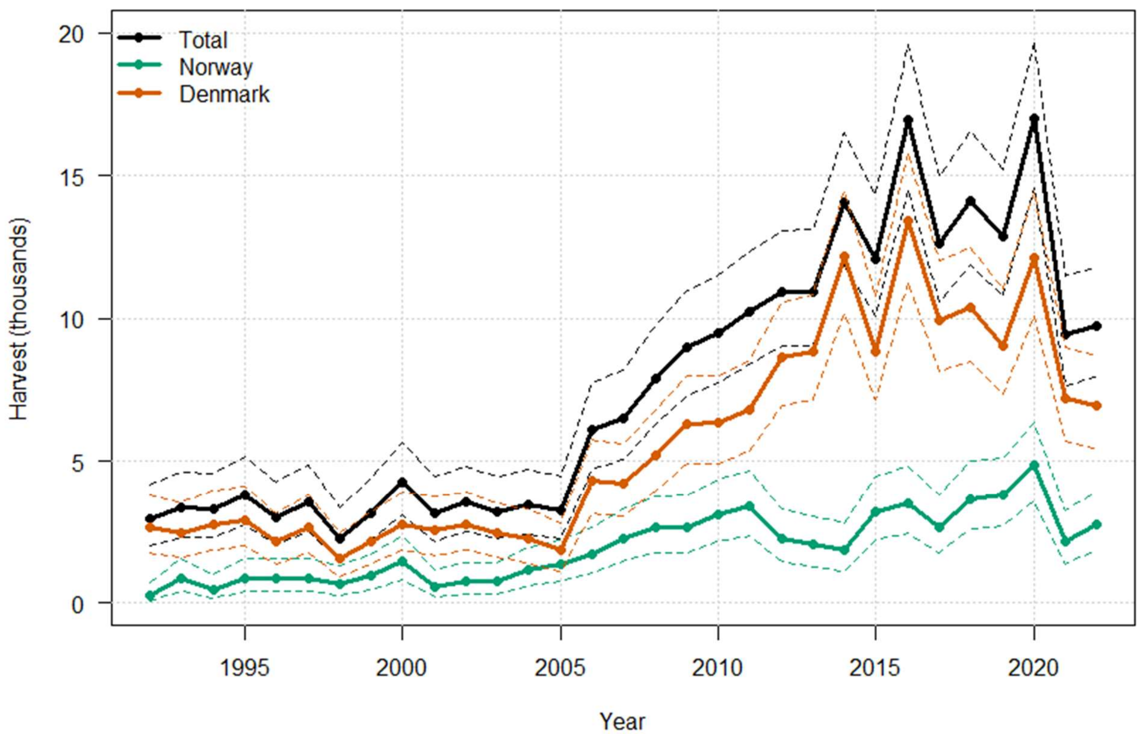



***Figure 3.1-5.*** IPM-based estimates of harvests of Svalbard Pink-footed Geese (95% credible intervals are indicated by the dashed lines).

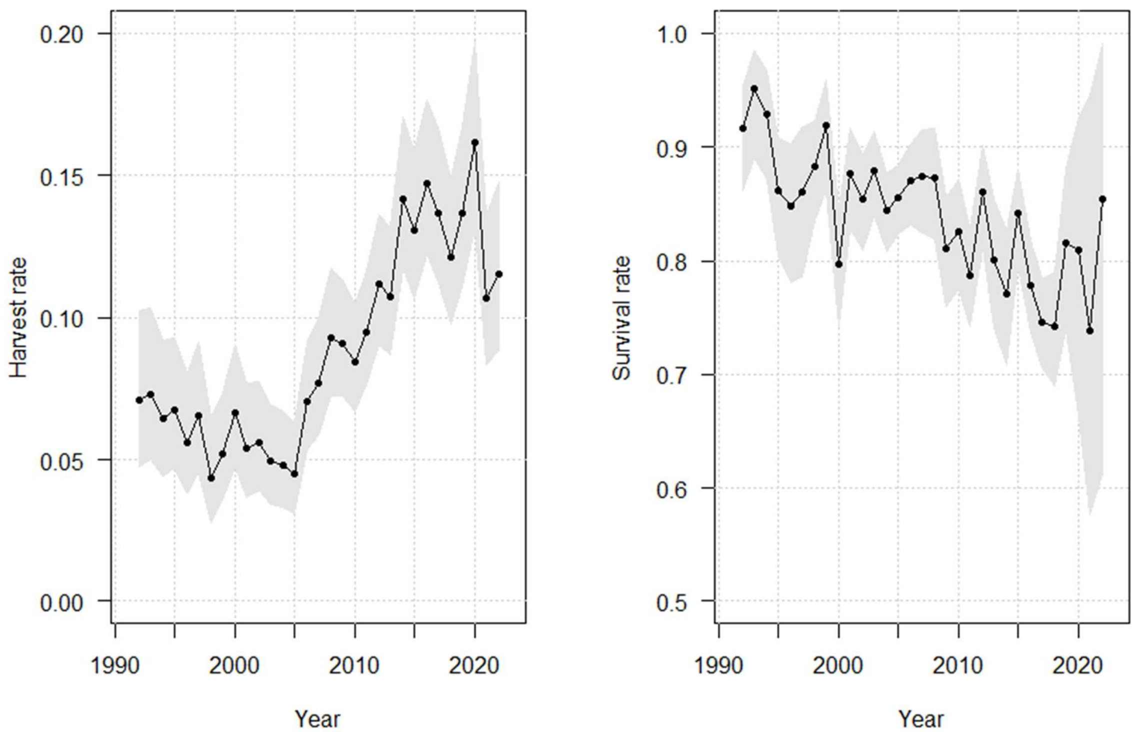



***Figure 3.1-6.*** IPM-based estimates of harvest and annual survival rates of adult Svalbard Pink-footed Geese (95% credible intervals are indicated by the shaded polygons).

*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 0.20 (*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 0.35 (0.30 – 0.40) in 2018 following a record 27 days above freezing in May in Svalbard. In contrast, the record low proportion of 0.14 (0.12 – 0.15) occurred in 1998, following 0 days above freezing in May in Svalbard. In 2022, the estimated post-breeding proportion of young was 0.21 (0.20 – 0.22), following 11 (near the long-term average of 9) days above freezing in May in Svalbard.

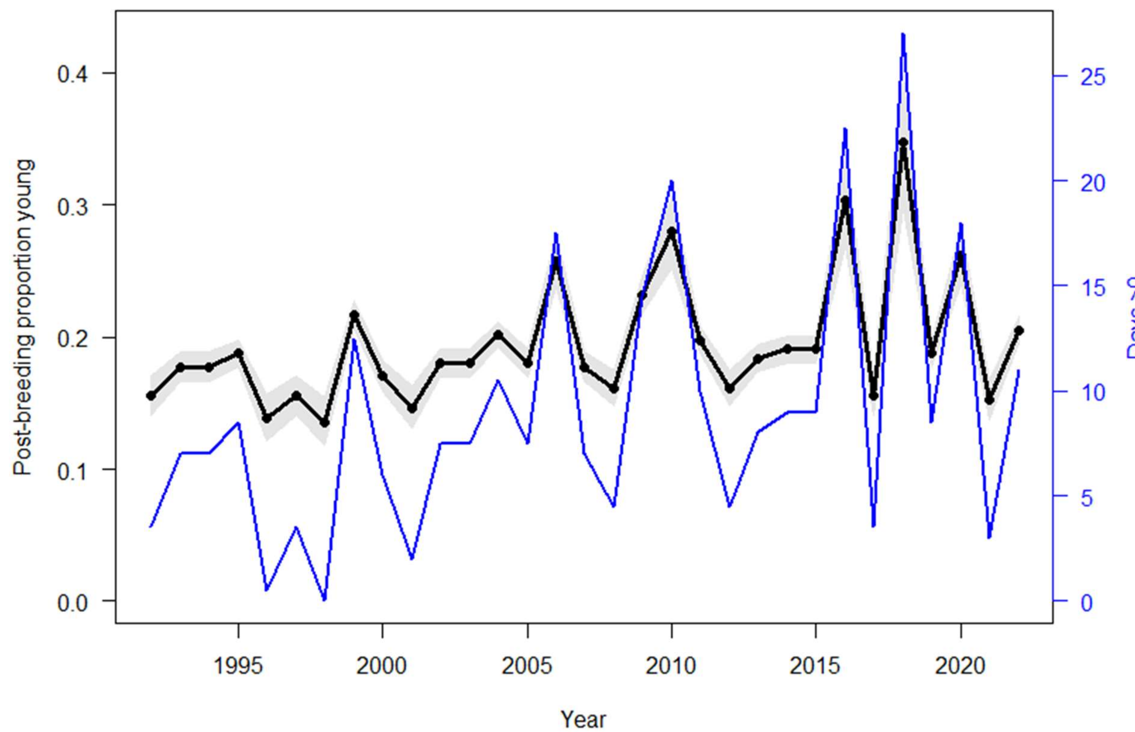



***Figure 3.1-6.*** IPM-based estimates of the post-breeding proportion of young for Svalbard Pink-footed Geese (95% credible intervals are indicated by shaded polygon). In blue are the number of days above freezing in May in Svalbard.

### 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 31,000 within the most desirable range of population sizes (i.e., 55,000–65,000) (Figure 3.1-7). 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 days above freezing, the harvest quota is 5,000. The management strategy in Figure 3.1.7 also depicts the evolution of May population size, days above freezing in May, and harvest quotas since implementation of AHM in 2013.

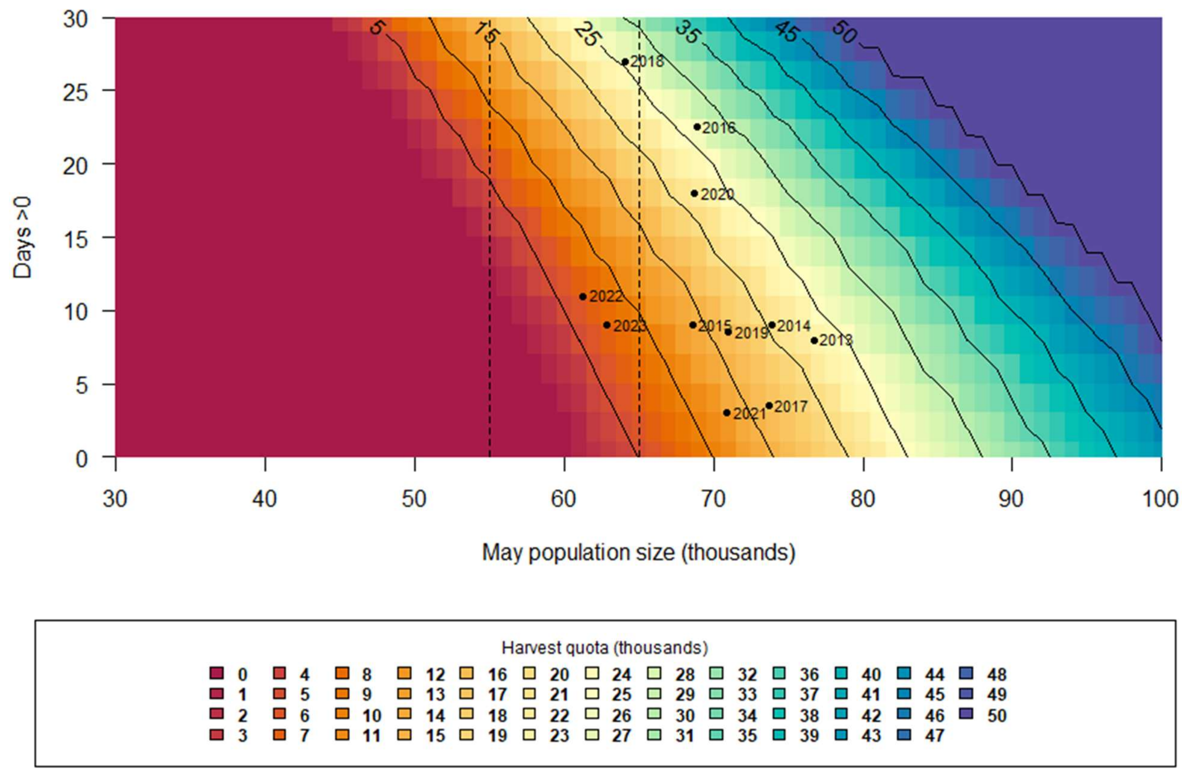



***Figure 3.1-7.*** Optimal harvest quotas for Svalbard Pink-footed Geese based on an IPM and an objective to maintain population size near 60,000. Days >0 represents the number of days above freezing in May in Svalbard. The vertical dashed lines depict near-complete stakeholder satisfaction with population sizes. Also depicted are population sizes and days above freezing for the years in which AHM has been in place (2013–2023).

The harvest quota for the 2023/2024 hunting season, based on the estimated population size of approximately 62,800 and 9 days above freezing in Svalbard in May 2023, is 7,300. We emphasize, however, that the May 2023 population estimate is highly uncertain for the reasons explained previously. In fact, we can only say with 80% certainty that the true quota lies between 0 and 15,650. If we were to require 95% certainty, the interval would be even wider. If we use the nominal quota of 7,300 and the agreed upon allocation of the quota (30% for Norway, 70% for Denmark), harvest quotas for Norway and Denmark this year are 2,190 and 5,110, respectively. For comparison, the realized harvest has averaged 12,630 (*se* = 1,416) during the last five years. We note, however, that harvest has decreased rather dramatically in Denmark during the last two years for reasons that are unclear. Consequently, the total harvest during the last two years averaged only 9,577 (*se* = 154), well within the 80% credible interval of the allowable harvest for 2023. The harvests in Norway and Denmark during the last two years averaged 2,470 (*se* = 181) and 7,072 (*se* = 83), respectively. Finally, we note that 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. Therefore, in the coming year, the Data Centre will explore how to explicitly account for this lack of precise control over realized harvests.

## 3.2 Taiga Bean Goose

### 3.2.1 Range states and management units

This chapter compiles monitoring data on the population status of the previous Western (now Scandinavia/Denmark and UK population) and Eastern1 Management Unit (MU) (now West Siberia/Poland and Germany) of Taiga Bean Goose for the season 2022/2023, as well as an assessment of the population development and management guidance for the previous Central Management Unit (now Finland and NW Russia/Sweden, Denmark and Germany population) for the coming hunting season (2023/2024). Birds belonging to the Eastern2 MU are now listed as a population of Bean Goose (subspecies *johanseni*) in the AEWA Annexes.

There are three recognized populations for Taiga Bean Geese:

- *Scandinavia/Denmark and UK population (former western MU):* 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 (former Central MU)*: 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 (former Eastern1 MU)*: Breeding in upper Pechora region and western parts of west Siberian lowlands of Russia, wintering mostly in North-east Germany and North-west Poland.

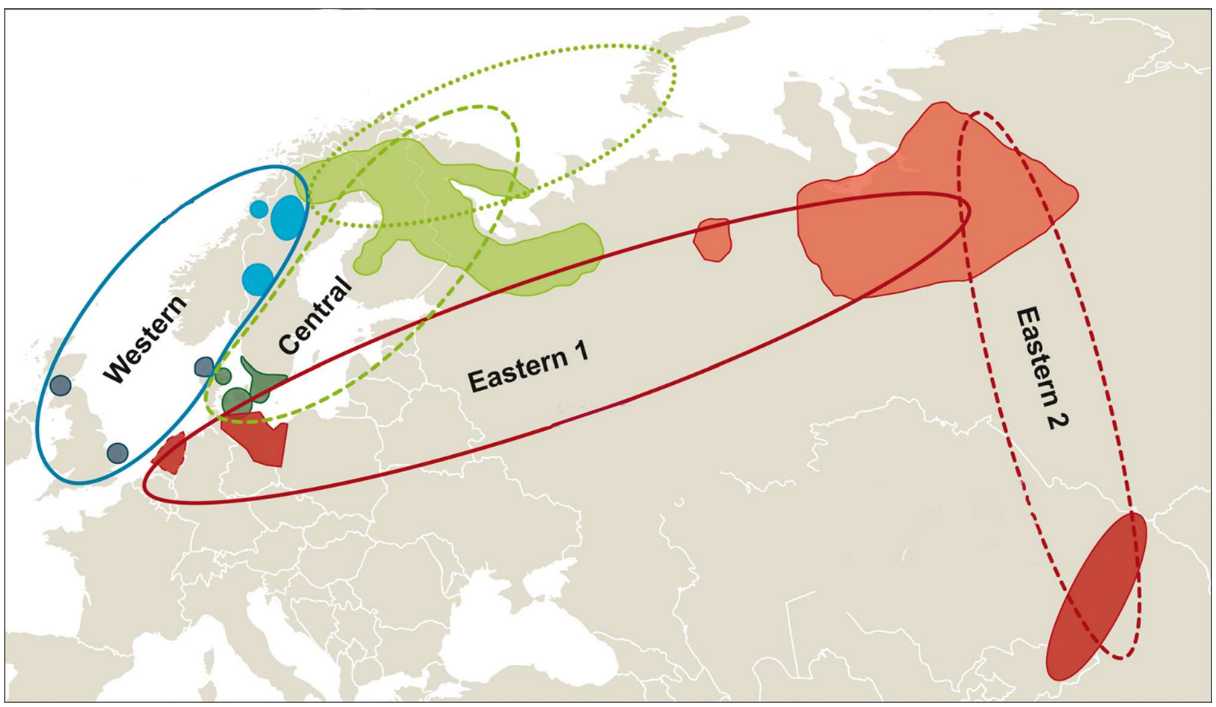



***Figure 3.2-1.*** The previous Western, Central and Eastern1 Management Units (now Scandinavia/Denmark and UK population, Finland and NW Russia/Sweden, Denmark and Germany population and West Siberia/Poland and Germany population, respectively) of Taiga Bean Goose (green dotted line indicates linkages between breeding areas in norther Fennoscandia and known moulting areas in Novaya Zemlya and the Kola Peninsula). Birds belonging to the Eastern2 MU are now 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 **FRP(s) and target(s) (if any)**

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 Western MU (now Scandinavia/Denmark and UK population), 60,000 – 80,000 individuals in the Central MU (now Finland and NW Russia/Sweden, Denmark and Germany population), and 100,000 individuals total in the Eastern 1 and Eastern 2 MUs, with stable or increasing trends in all (Marjakangas et al., 2015).

### 3.2.3 Management strategies

The abundance of Western MU (now Scandinavia/Denmark and UK population) 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 Eastern 1 MU (now West Siberia/Poland and Germany) are hunted in Belarus, Latvia, Russia and Poland, but the bag sizes in these 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 Central MU (now 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 by March 2025, while still providing limited hunting opportunity.

### 3.2.4 Assessment protocol

An annual stock assessment for the Central MU (now 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 the tundra subspecies (*A. f. rossiccus*) from count and harvest data. The IPM relies on harvest estimates (FI, SW, DK), and population counts in March (SW), October (SW), and January (SW, 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 March population size, $\psi$ is intrinsic survival from natural causes, $\gamma$ is the intrinsic rate of reproduction, $K$ is carrying capacity in the breeding season, $\theta$ 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:

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

in which we assume seven months of natural mortality, all of the 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 $\alpha$ represents the proportion of the Swedish harvest occurring prior to January (i.e., the regular hunting season).

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").

To evaluate the current, interim harvest strategy, we projected population size two years into the future using methods described by Kéry and Schaub (2012). In 2017, the European Goose Management Platform adopted a harvest strategy consisting of a 3% harvest rate to assist with recovery of the population, while providing limited opportunities for hunting. In 2020, the interim harvest strategy was revised to prescribe allowable harvests that would permit the population to reach its median population target of 70,000 by March 2025 (on average). Due to hunting restrictions in Finland, Sweden, and Denmark, the 2-year projection this year is based on a relatively low level of harvest – approximately 1,000 total birds. By agreement of the range states, the total harvest is to be allocated among Russia (15%), Finland (49%), Sweden (26%), and Denmark (10%). The Russian harvest is unknown, however, and in the IPM it is implicitly included as natural mortality. We thus re-normalized the remaining Range States' harvest allocation as 58% (580), 30% (300), and 12% (120) for Finland, Sweden, and Denmark, respectively.

We note that some historical data for Taiga Bean Geese have recently been updated or corrected. This includes counts in March (2019 – 2021) and October (2004 – 2006, 2016 – 2019) in Sweden, and January counts in Denmark (2007 – 2008). It also includes several years of Swedish (1996, 1998, 2006, 2016 – 2019) and Danish (1996, 1998, 2006, 2016 – 2019 and 2004 – 2006, 2011 – 2013, 2016 – 2020) harvest estimates. Note also that we have decided to use the maximum of the October or November count in Sweden as the best indicator of fall population size (the November count was the maximum of the two counts in 2004 – 2006, 2012, and 2021). We alert the reader that these revisions to the historical data have resulted in some changes to the past estimates of population abundance and demography. We also remind the reader that historic estimates can also change when the IPM is updated each year, absent any changes to the historical data (see Section 2.4). Finally, we note that Sweden has recently changed its methodology for estimating harvests (Lindstrom and Bergqvist 2020), and revisions to historical estimates are substantive. We have used those new estimates here as recommended by the Taiga Bean Goose Task Force. Current data and code for running the 2023 stock assessment can be found at: https://gitlab.com/aewa-egmp/taiga-bean-goose.

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

*a) Abundance*

The population size of the Western MU of Taiga Bean Goose is assessed primarily at the wintering grounds in Denmark, Scotland and England. An effort is also made in Norway during spring and summer at the breeding areas, both in terms of direct observation from a distance (Finnmark in Northern Norway) and the collection of droppings and feathers for DNA-analyses as a basis for individual identification in the region of Børgefjell in mid-Norway.

The count in Denmark in 2023 took place around the weekend of 14-15 January, where the usual main sites in Northwest Jutland were visited in Thy on 17 January and the Lundergård Mose area west of Pandrup on 15 January. The former area is known to be used as a stop-over by birds wintering in Norfolk and Slamannan, UK, whereas the latter has only been documented to be used by birds from Slamannan. The count resulted in an exceptionally low number of only 411 birds, all in Thy, while no birds could be found in the Pandrup area (Figure 3.2-2). Hence, 411 Taiga Been Geese but no Tundra Bean Geese were found in Western Management Unit parts of Denmark.

Bean Geese in Northwest Jutland are notoriously very difficult to locate, but the low numbers in 2023 may in fact reflect a genuine low number. This interpretation is to some extent supported by an extract of data from DOFbasen, the citizen science portal of BirdLife Denmark. In the database only 25 records and a maximum of 384 birds on a single site was reported from Thisted and Jammerbugt municipalities in the 2022-23 winter, which compares to 40-51 records and annual maximum flocks of 418-764 birds in the previous five wintering seasons. These two municipalities include the Western MU range for Bean Geese in Denmark.

In Scotland, it was not possible to get a good winter count due to a combination of the fragmentation of the 'flock' in difficult to view areas, winter weather and the presence of Pink-footed Geese in the same fields, leading to confusion and misidentification. Furthermore, on the day for the organized count January 15 tracking data showed an unknown number of birds had just departed for Denmark. It seems like departure dates are becoming earlier. Instead, the total is derived based on counts / estimated counts made in two locations within a short while (with no apparent interchange), resulting in c. 220 Taiga Bean Geese in Scotland (Figure 3.2-2).

No information has been received from England; however previous years counts have been less than 10 individuals.

It seems highly likely that, rather than representing a decline in overall population size, the low numbers (total of 631) detected in 2022-23 winter are due to shifts in wintering distribution which have been indicated by results from tracking studies, whereby these birds remain higher upstream in the flyway corridor in response to milder conditions. Likewise – the Taiga Bean Geese in the Central population also had its lowest number on record in Denmark since counts started in the early 1980s.

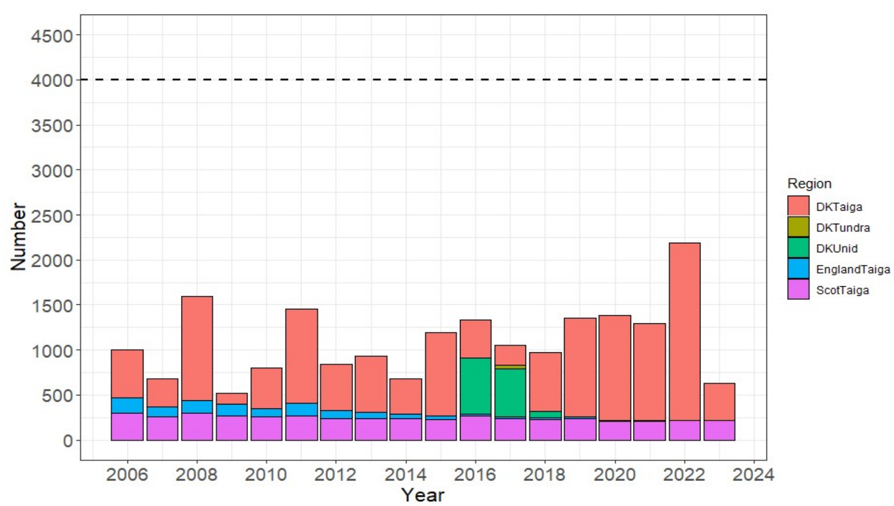



***Figure 3.2-2.*** Population size of the Western MU (Scandinavia/Denmark and UK population) of Taiga Bean Goose during mid-winter since 2006 in the UK and since 2016 in Denmark. The number of Tundra Bean Geese and unidentified Bean Geese are included for Denmark. Data is missing from England in winter 2022/2023 (= year 2023). The dashed black line represents the target for the wintering population.

*b) Mortality*

No survival information exists for the Western MU (Scandinavia/Denmark and UK population) of Taiga Bean Goose. It is protected from hunting.

*c) Reproduction*

The age count occurred in Scotland on December 9, where three juveniles in a sample of 31 birds and six juveniles in a sample of 60 birds were identified. Resulting in an overall proportion of juvenile of 0.099 for the winter 2022/2023, which is slightly lower than the three previous years of about 0.11 (Figure 3.2-3).

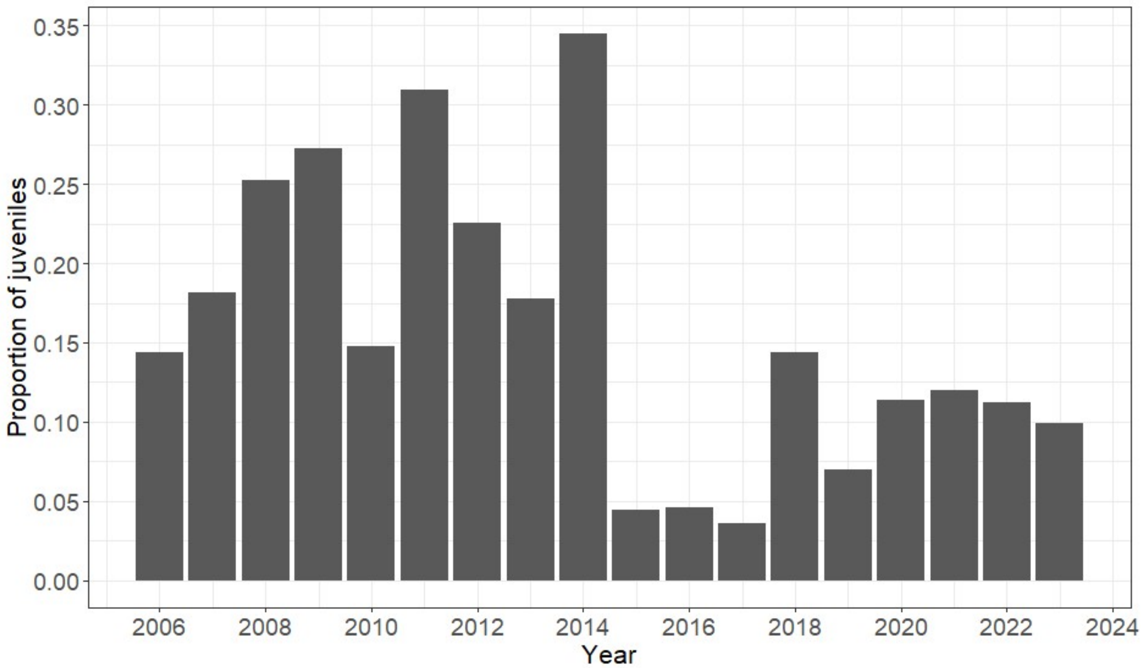



***Figure 3.2-3.*** Annual proportion of juveniles in the Western MU (Scandinavia/Denmark and UK population) of Taiga Bean Goose winter 2005/2006-2022/2023 (=year 2006-2023).

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

There is no information on the status and demography of Eastern 1 MU (West Siberia/Poland and Germany) beyond what was reported in the 2021 Population Status and Assessment Report.

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

*a) Abundance and trends*

Posterior estimates of population size at three times of the year are depicted in Figure 3.2-4. Beginning in March 2022, the population estimate was 65,428 (61,302 – 69,993). In October 2022, the population size was estimated as 68,049 (63,846 – 73,041). The January 2023 population size was estimated as 66,872 (62,761 – 71,736. Finally, the March 2023 population estimate was 66,166 (62,078 – 70,985), which is similar to the March 2022 estimate. March and October population estimates tend to be less than the counts because counts include both the taiga and tundra subspecies, while the posterior estimates are restricted to the taiga subspecies. The January population estimates tend to be greater than the counts because Germany does not provide January count data. The IPM suggests that on average about 13,000 (sd = 9,000) Central MU Taiga Bean Geese are in Germany during winter.

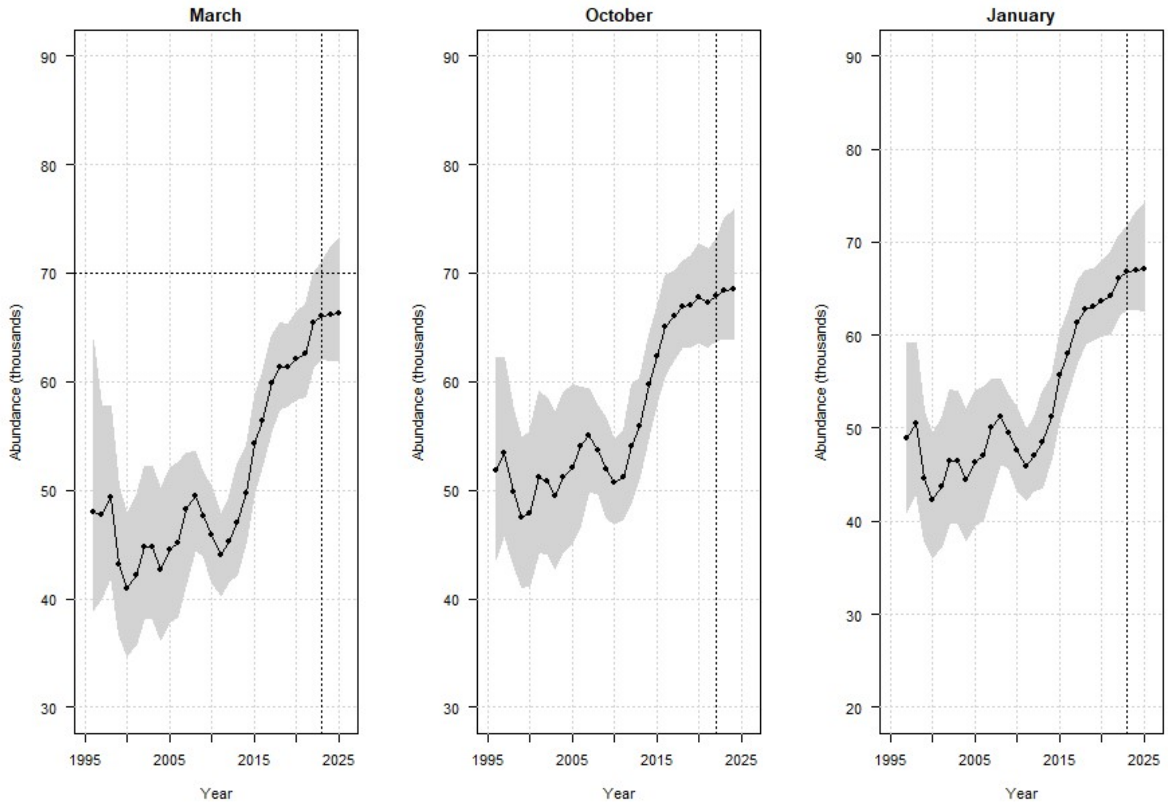



***Figure 3.2-4.*** Posterior estimates of population size (in black, with 95% credible intervals in gray) based on an IPM for Taiga Bean Geese in the Central Management Unit. The vertical, dashed lines represent the last year of data. Future abundances were projected based on an assumed harvest of approximately 1,000 birds. The horizontal line at 70,000 in the left panel represents the median population target.

*b) Mortality and trends*

Posterior estimates of country-specific harvests of Central Management Unit Taiga Bean Geese are provided in Figure 3.2-5. Due to hunting restrictions in the range states, the total harvest has only averaged 153 birds (sd = 71) during the last two years. Posterior estimates of annual harvest rates and apparent survival of the flyway population are provided in Figure 3.2-6. Harvest rates declined dramatically following the Finnish harvest moratorium in 2014, and this decrease in harvest rate coincides with strong growth in the population. Harvest rates during the last five years averaged 3.4% (*sd* = 3%). Estimates of apparent survival increased markedly with implementation of the Finnish harvest moratorium and have averaged 91% (sd = 3%) over the last five years. We refer to these estimates as apparent survival because they do not account for any density-dependent effects that may have been operative.

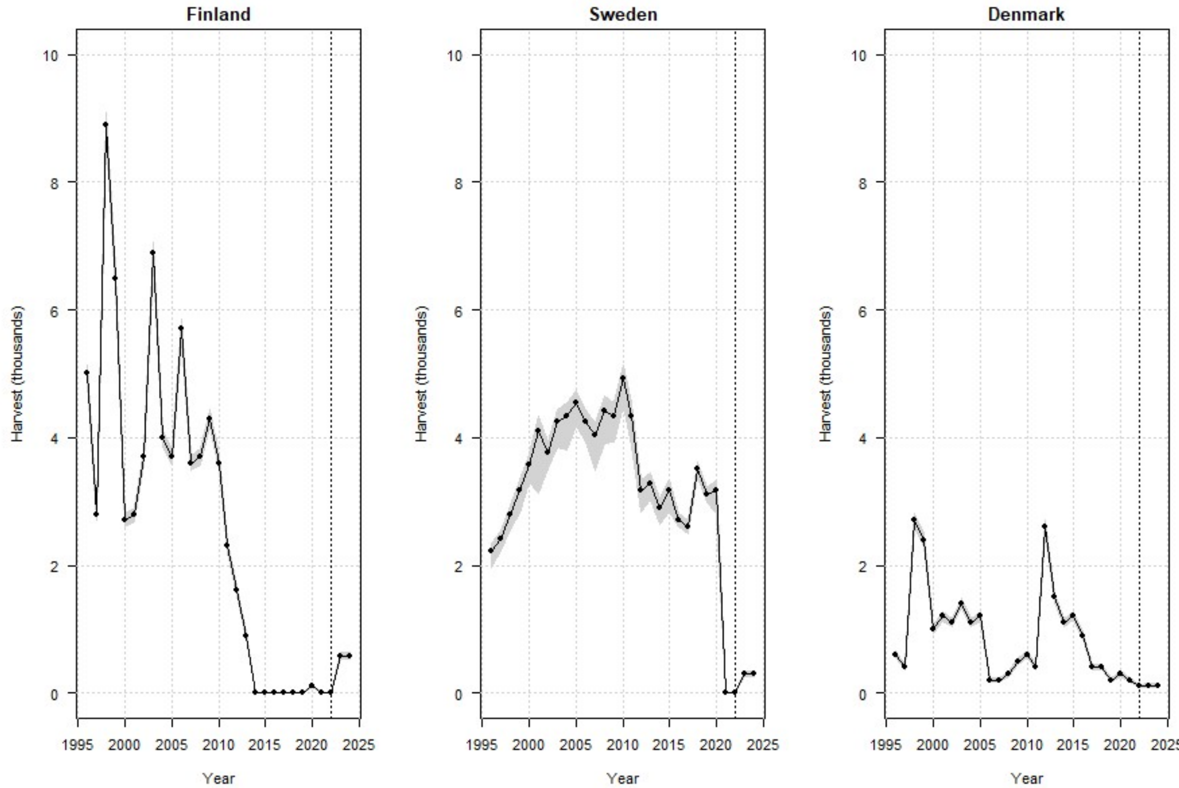



***Figure 3.2-5***. Estimated harvests (in thousands, with 95% credible intervals in grey) based on an IPM for Taiga Bean Geese in the Central Management Unit. The vertical, dashed lines indicate the last year of data. Future harvests were projected based on an assumed harvest of approximately 1,000 birds, with country-specific allocations as agreed upon.

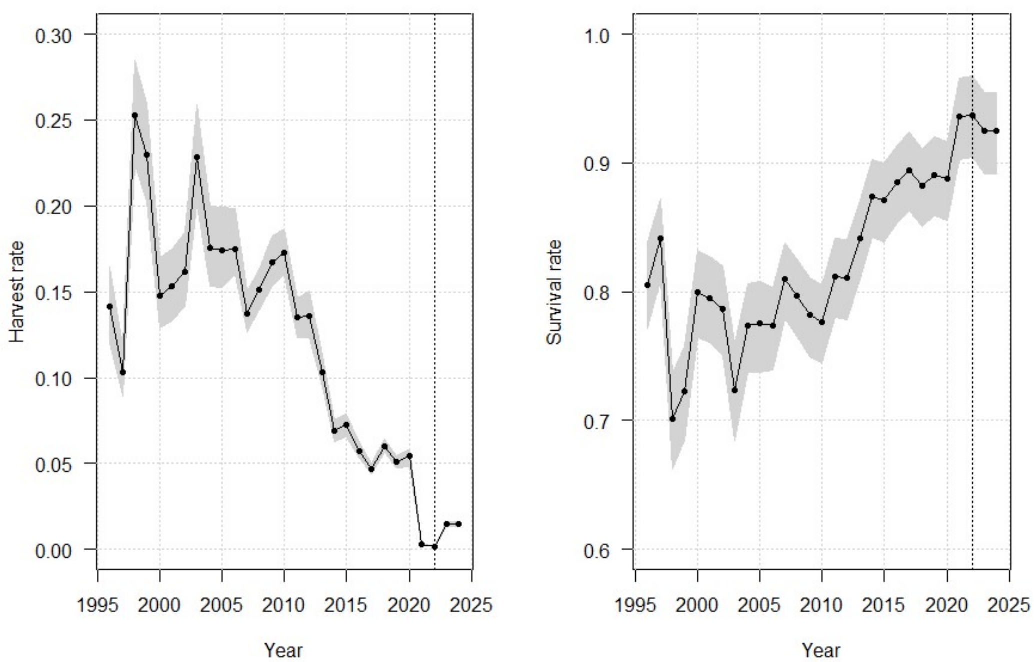



***Figure 3.2-6***. Posterior estimates of harvest and apparent survival rate based on an IPM for Taiga Bean Geese in the Central Management Unit, with 95% credible intervals in grey. The vertical, dashed lines represent the last year of data. Future rates were projected based on tan assumed harvest of approximately 1,000 birds.

*c) Reproduction and trends*

Posterior estimates of the intrinsic reproductive rate (i.e., absent any density-dependent effects that may have been operative) have varied little over the timeframe of the IPM (Figure 3.2-7) and have averaged 0.33 (*sd* = 0.04) (or approximately 25% young absent any density-dependent effects). It should be mentioned that these posterior estimates are similar to their informative prior mean, albeit more precise.

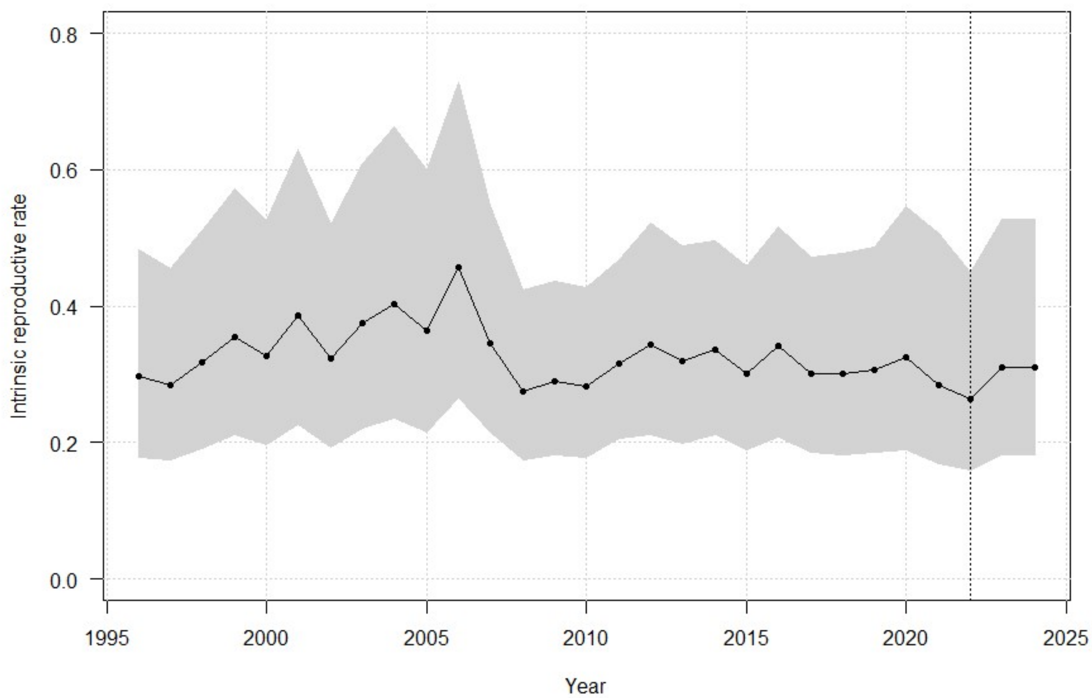



***Figure 3.2-7.*** Posterior estimates of the intrinsic reproductive rate (in black, with 95% credible intervals in gray) based on an IPM for Taiga Bean Geese in the Central Management Unit. The vertical, dashed lines represent the last year of data. Future reproductive rates were projected based on an informative prior distribution.

### 3.2.8 Management guidance

For the Central Management Unit, the forecasts of harvests of 1,000 birds for the years 2023 and 2024 are intended to reflect the dramatic reductions in harvest over the last two years. Moreover, the country-specific harvests for these future years (580, 300, and 120 for Finland, Sweden, and Denmark, respectively) are in accordance with the agreed-upon allocation of total harvest among the three countries. Of particular concern to harvest management, however, is that the current estimate of the carrying capacity (*K*) for the breeding population is 70,194 birds (64,552 – 79,735), which is essentially the same as the population target of 70,000. The prior distribution for *K* established in 2020 based on expert opinion had a higher mean of *K* = 83,600 (73,150 – 94,050), but the posterior mean has decreased with each update of the IPM. This is a reflection of population growth that has slowed in recent years despite very low harvests. We emphasize that if the spring population were at the estimated carrying capacity of *K* = 70,194 birds, there would be *no* harvestable surplus. Thus, the population would have to be reduced below *K* to generate net growth in the population and, thus, harvestable surpluses. The maximum sustainable harvest of 8,900 (8,100 – 9,800) could be achieved at a population level of about 45,000 birds in spring (42,000 – 50,000). This situation serves as a cautionary note about establishing population targets for huntable species in the absence of accounting for the population's biological potential. A total harvest of 1,000 birds during the next two years is projected to maintain the population near its current level (on average).

## 3.3 Greylag Goose

This chapter compiles monitoring data on the population status of the NW/SW European population of Greylag Geese *Anser anser* 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 (AFMP).

### 3.3.1 Range states and management units

The range states for the NW/SW European population of Greylag Goose include Norway (NO), Sweden (SE), Finland (FI), Denmark (DK), Germany (DE), The Netherlands (NL), Belgium (BE), France (FR), and Spain (ES). Geese from this population also occur regularly in Poland, Czech Republic and Portugal, but as the numbers are below 1% of the population, they are not included as principal Range States. Based on the recognition of regional differences in migratory behaviour and the human-wildlife conflicts involved with this population, it has been agreed to define two MUs (AFMP).

MU1 includes the breeding populations from NO, SE, FI and DK that subsequently stage and winter in areas in NL, DE, and BE. Some birds migrate to the southernmost wintering sites in FR and ES. MU2 is the mainly sedentary populations of NL, BE and DE, and include a smaller FR population of c. 8000 individuals. The DE population is regarded as sedentary, although it is known that breeders in the eastern part of the country are showing more migratory behavior (Bairlein et al. 2014) (Figure 3.3-1).

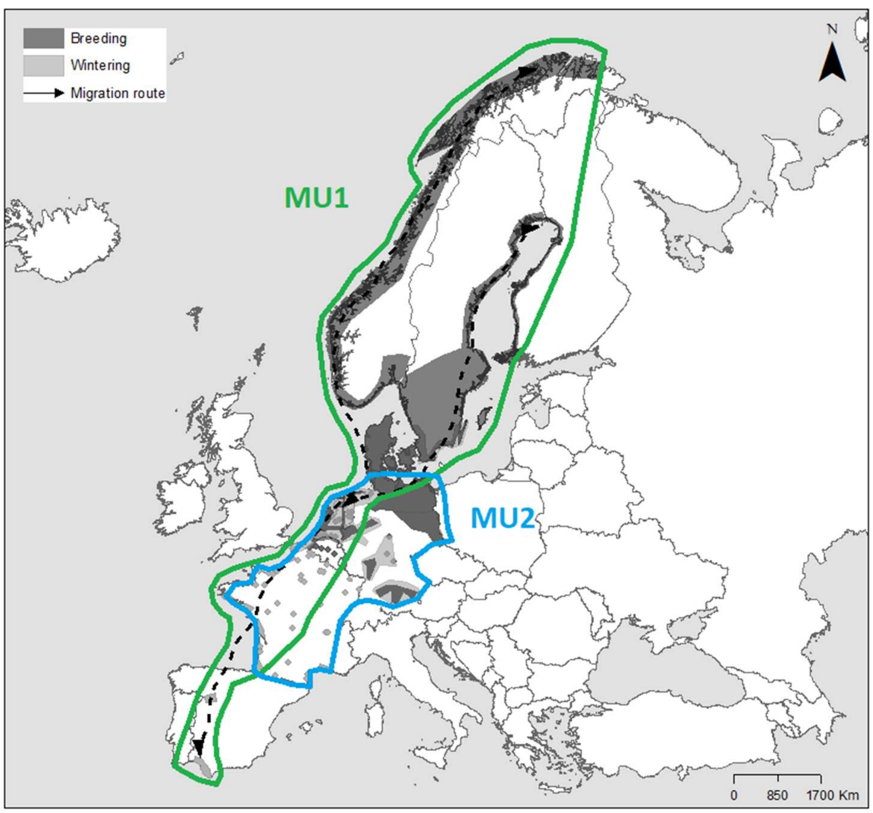



***Figure 3.3-1.*** Annual distribution and main migration routes for the NW/SW European population of Greylag Goose including breeding (grey) and wintering (light grey) areas, as well as areas, which are both used during the breeding and wintering period (dark grey) as presented in the ISSMP (up for evaluation in 2028). 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 to allow decision makers to make informed choices about the magnitude of offtake until more reliable monitoring information is available (Nagy et al. 2021; Johnson and Koffijberg 2021). Using this process, range states agreed on a management criterion of a 15% reduction in the flyway population size over 10 years, which means 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 sport harvest to help attain population targets. In other words, any such prescriptions for sport harvest would be conditional on contemporary levels of derogation.

### 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 components consist of two wintering areas (North and South) (Figure 3.3-2). In the northern unit there is broad overlap in the wintering distributions of the two breeding units. The southern unit is largely comprised of MU1 birds and is of special interest because of concern about the status of those birds. 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.

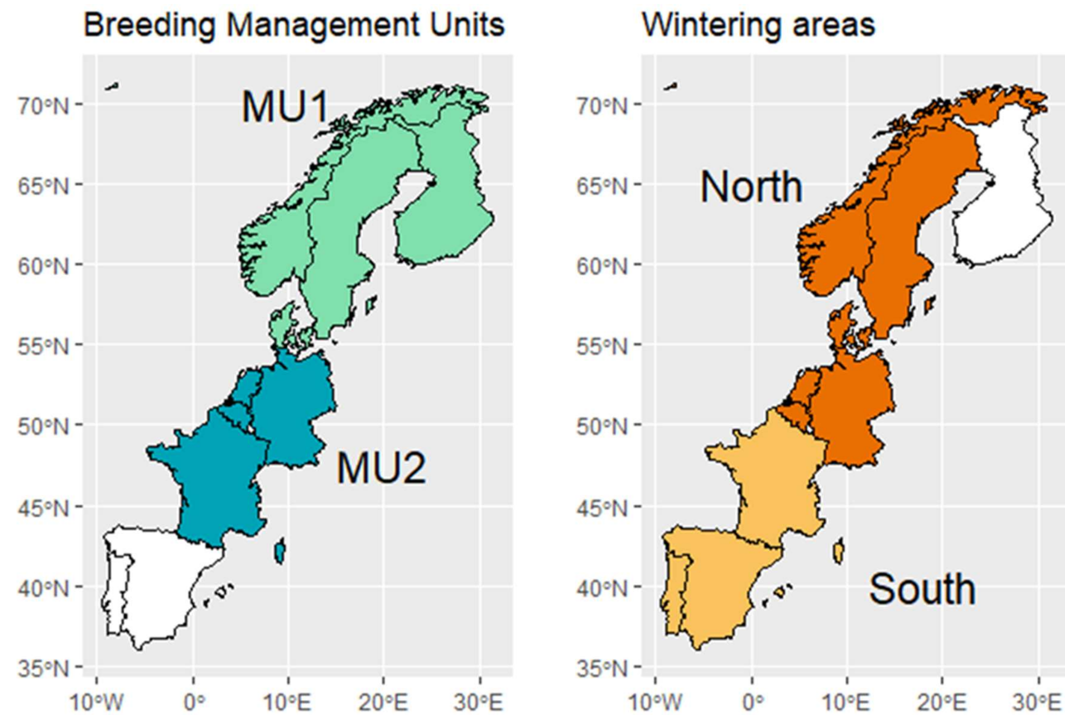



***Figure 3.3-2.*** Breeding management units and wintering units for the NW/SW European population of Greylag Geese.

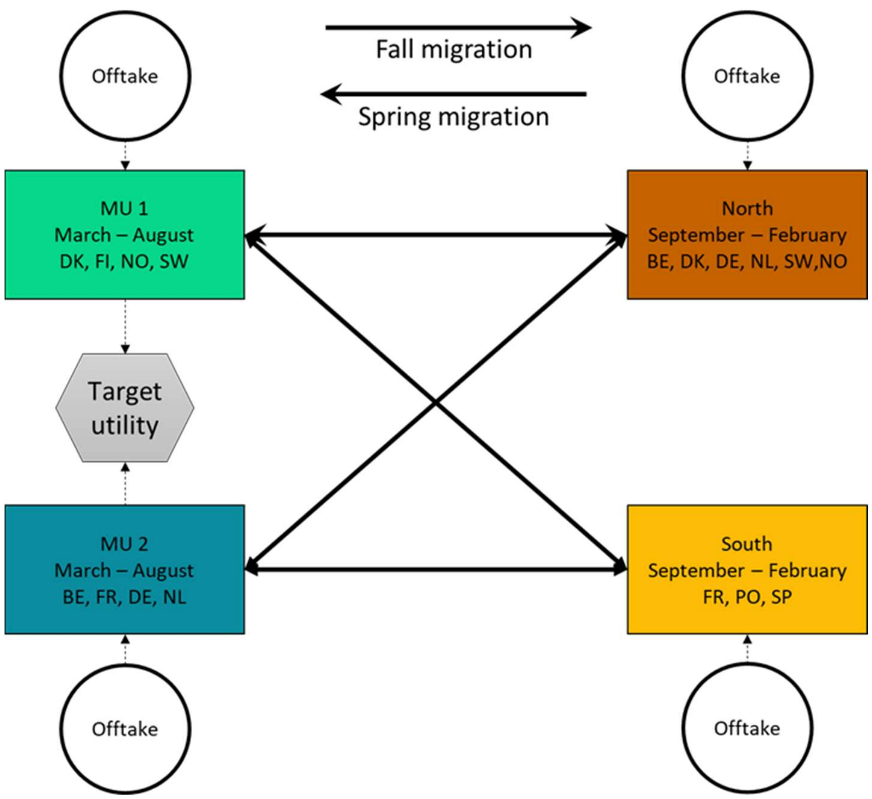



***Figure 3.3-3.*** Diagrammatic representation of the model for the annual cycle of the NW/SW European population of Greylag Goose.

The model was parameterized using basic life history information, as well as some limited empirical data (Appendix A.3). We note that some survey data from summer 2022 are still outstanding and so the post-breeding population sizes for the two MUs have not yet been updated. Finally, no offtake data are currently used in the model because of evidence that they are biased high.

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. If a reliable time-series were sufficiently long, an integrated population model could be used to estimate the latent (unobserved) parameters of natural survival, harvest rate, and reproductive rate, which currently are not based on direct, empirical information. Some improvement to the model can be made in the interim, however, with continued summer counts, with greater effort to collect post-breeding age ratios, and with consistent and reliable estimates of seasonal offtake. 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).

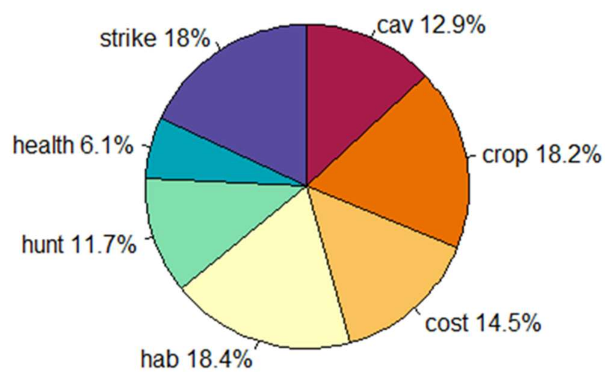



***Figure 3.3-4.*** Relative importance of seven objectives for managing the offtake of the NW/SW European population of Greylag Geese. Management objectives are to maximize cultural and aesthetic values (cav), minimize agricultural damage (crop), minimize management costs to governments (cost), minimize 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).

Participants in the EGMP were recently asked to express their levels of satisfaction with varying levels of Greylag Goose abundance relative to their targets. Respondents were asked to state their relative level of satisfaction if the population were at its FRP, between the FRP and target, at or near the target, 25% above the target, 50% above the target, and twice the target. For each population level, the respondents could register their level of satisfaction as completely unsatisfied, moderately unsatisfied, neither satisfied nor unsatisfied, moderately satisfied, or completely satisfied. Respondents could register responses for one or both breeding management units.

To represent the opinion of the EGMP as a group, we used a consensus-convergence model (Regan et al. 2006) to determine the relative level of satisfaction (called utility, $u$) with varying population levels. Basically, the method relies on the correlations in responses among participants. Higher correlations result in more weight on those participants. In other words, participants with more similar objective weights have more influence on the overall average. Extreme views have less influence on the overall average. The resulting consensus values were then re-scaled so that $0 \leq u \leq 1$ for each management unit. Populations < FRP were assigned 0 utility and populations greater than twice the target were assigned the same utility as that for twice the target. Utilities for intermediate population levels were interpolated based on piecewise linear functions (Figure 3.3-5). It is apparent from Figure 3.3-5 that there is more tolerance for the MU1 population being above the target than that for MU2.

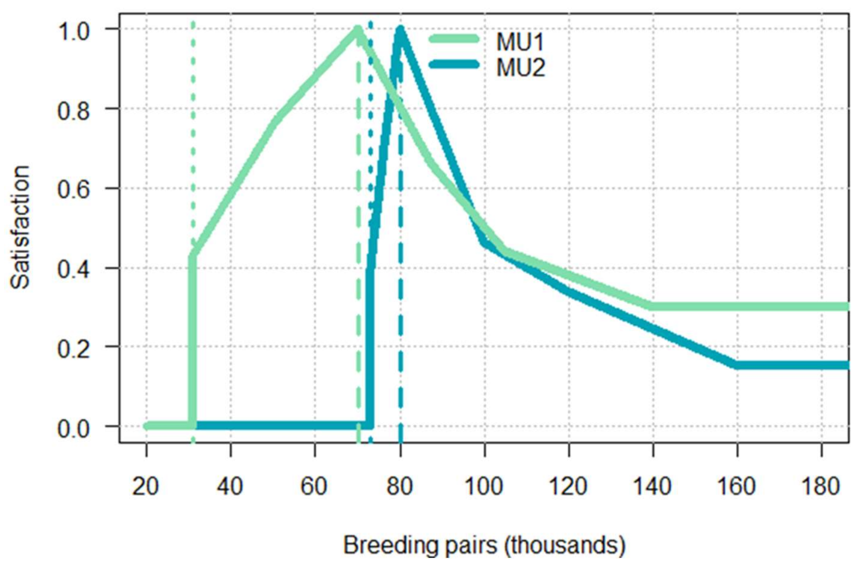



***Figure 3.3-5.*** Utility functions for the two management units of the NW/SW European population of Greylag Geese. The dashed vertical lines represent the targets for the two management units and the dotted vertical lines represent their respective FRPs.

Finally, we required a multi-attribute utility function that expresses overall satisfaction for both populations relative to their targets. We reasoned that overall utility should be high only if populations in both management units were near their target, a situation referred to as complementarity (Keeney and Raiffa 1993). Thus, the overall utility function is $U(p_1, p_2) = u(p_1) \cdot u(p_2)$, where $p_1$ and $p_2$ are the number of breeding pairs (in thousands) in management units MU1 and MU2, respectively.

### 3.3.5 Population status based on raw data

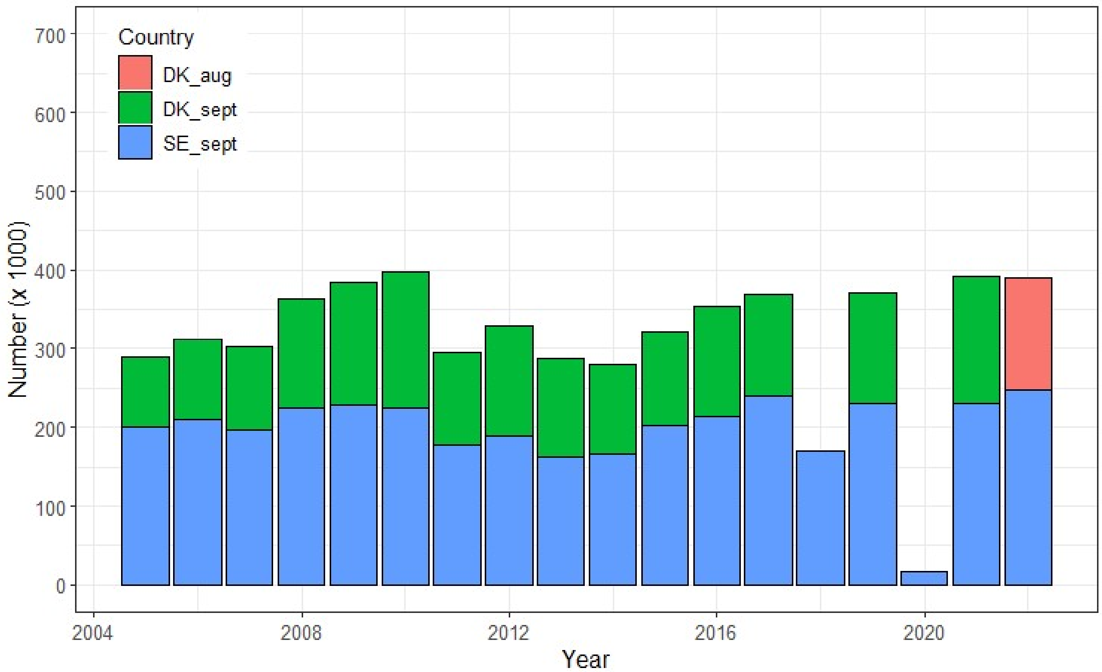
*a) Abundance*

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

Winter abundance is achieved through the International Waterbird Census (IWC) as well as values from a special goose count scheme in Denmark and the Netherlands. The IWC imputed values for the population produced a total of 999,148 individuals in 2022 (Figure 3.3-6). However, as mentioned in Heldbjerg et al. (2021), the IWC total should be viewed critically. Due to major data gaps in Spain at a site level after 2010, the estimates from Spain include a high degree of imputing, and consequently, the IWC imputed totals may overestimate the actual population size by some 200,000 birds in the period of 2011-2013 and 2021-2022. The IWC imputed value for the population excluding estimates for Spain produced a total of 794,318 (Figure 3.3-6).


***Figure 3.3-6.*** Development of the size (individuals) of the NW/SW European mid-winter population of Greylag Geese based on IWC imputed values from 1980-2022, with (solid line) and without estimates from Spain (dot-dashed line). The dashed black line represents the target for the wintering population, and the red dashed line represents the FRP.

Post-breeding abundance is achieved through a range of existing and new national initiatives. For MU1, counts are carried out at selected sites in NO in August 2022 and in DK and SE during September (Novana Grågås 2022, Svensk Fågeltaxering 2022). In 2022 Denmark likewise did a count in August to better estimate the national population size (Jensen et al. 2022). Birds from FI are assumed to be part of the count in SE during September and are therefore not counted in FI. For MU2, counts are carried out and available from parts of DE (Nordrhein-Westfalen and Niedersachsen), NL and BE (Niedersächsische Sommer-Gänsezählung 2022, Koffijberg & Kowallik 2022). Numbers from FR and ES are currently regarded as not essential due to small breeding populations. However, FR has an initiative to estimate population size during spring. Counts from the post-breeding period produced a minimum of 389,115 individuals in 2022 for MU1 (data are missing from NO), and 646,198 for MU2 (from DE data are only available from Nordrhein-Westfalen and Niedersachsen, i.e., only two from 16 Bundesländer) (Figure 3.3-7). These values are somewhat larger than those estimated by the population model using breeding pair numbers from 2018 (330,000 and 549,000 for MU1 and MU2, respectively).



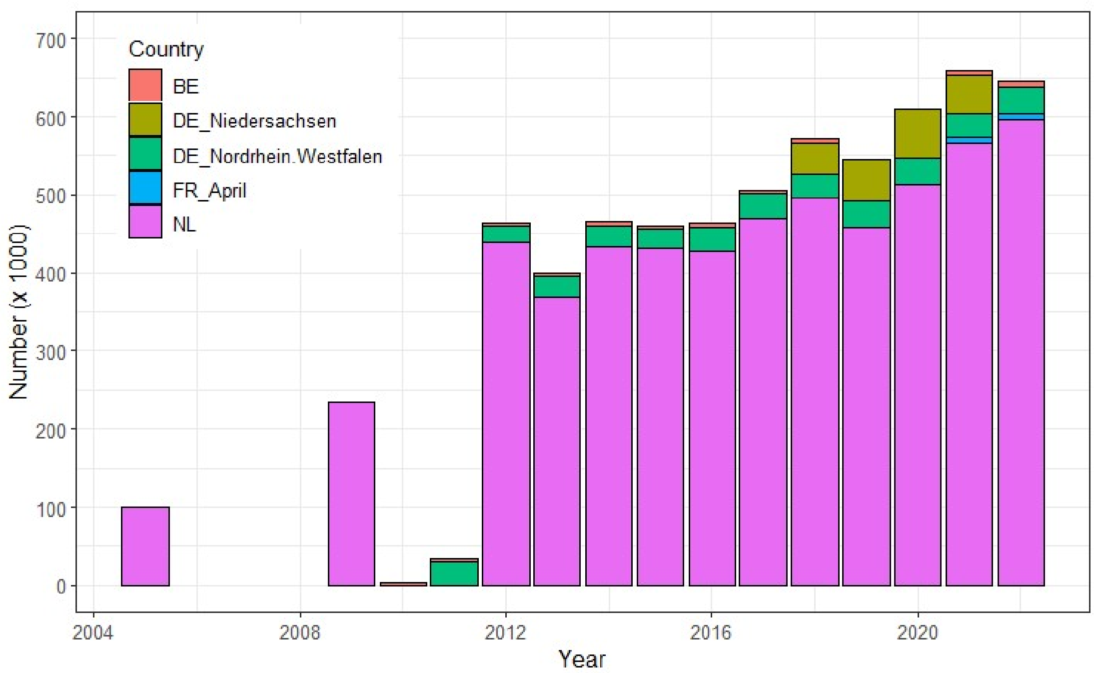




***Figure 3.3-7.*** Development of the size (number of individuals) of the NW/SW European summer population of Greylag Goose at the MU level.

Top) MU1 consists of data from DK 2005-2021 from September and in 2022 from August, as well as from SE 2005-2022, but missing from NO. Furthermore, the count in 2020 in SE suffered problems due to Covid and from 2017 Greylag Geese are only counted every 2nd year in September in DK.

Bottom) MU2 consists of data from BE 2010-2018, 2021-2022, NL 2005, 2009, 2012-2022, Nordrhein-Westfalen, DE 2011-2022, Niedersachsen, DE 2018-2021 and FR 2021/2022, but missing from the rest of the DE.

*b) Survival and mortality*

I) Offtake at population level

The hunting bag estimates are available from all range states and sum to 177,699 for the 2021/2022 season. Data from ES are only from Andalusia, which however represents the majority of the hunting bag. Derogation data from 2021 are available from all range states where derogations have taken place, except DE, and indicates 263,467 geese killed. Thus, data suggest a minimum offtake of about 441,000 Greylag Geese in 2021 (Figure 3.3-8).

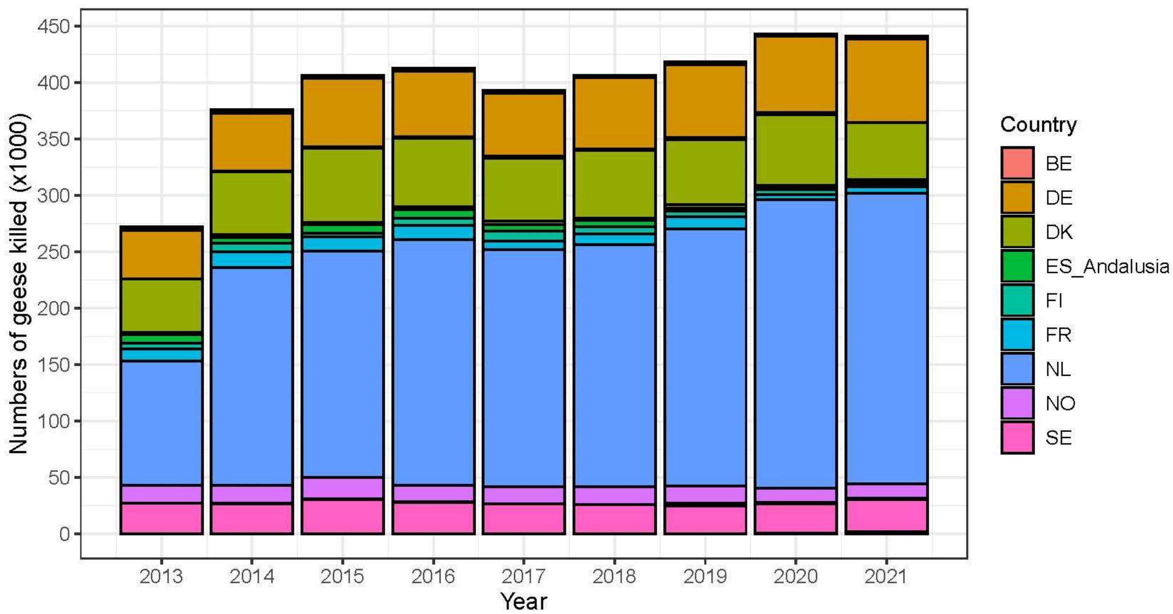



***Figure 3.3-8.*** Total number of Greylag Geese killed under derogation per calendar year from 2013-2021 and hunting per season from 2013/2014-2021/2022. Derogation data from DE in 2021 are missing, as well as hunting bag data outside Andalusia, ES.

II) Survival

A study using capture-mark-recapture data was recently completed by the Université Jean Monnet and the Office Français de la Biodiversité (Schneider and Bacon 2022). According to the authors, "recaptures and recoveries of 7934 individuals, carried out between 1984 and 2016, are used in a multi-state CMR model to study transitions between units and test senescence. The results show two different evolutions of survival between the two units with a decrease for the migratory unit and an increase for the sedentary unit. In the same way, the stable fidelity of the migratory unit contrasts with the progressive sedentarization of part of the population. We observe a strong philopatry of the adults, in particular of the females, but the model did not reveal any senescence."

III) Crippling

At present, data are collected only in the Netherlands and Sweden, with a crippling rate of moulting Greylag Geese of respectively 0.22 (based on 26 X-rayed individuals in 2021) and 0.22 (based on 31 X-rayed individuals in 2021). These rates are comparable to the stabilized crippling rate in Pink-footed Goose after actions had been taken to lower the rate (Clausen et al. 2017).

*c) Reproduction*

In MU1, age counts continue to be limited, and information only exist from two regions in NO; Vesterålen in 2020-2021 and Vestfold county in the Oslofjord-area in 2020-2022, as well as 25 sites along the Bothnian coast in Finland. In Vesterålen the percentage of juveniles was assessed to be 12.1% in 2020 and 33.5% in 2021. In Vestfold county in the Oslofjord-area, juvenile percentages were assessed to be 36,1 %, 24,4% and 34.9% in 2020, 2021 and 2022 respectively (Tombre et al. 2020; Tombre et al. 2021). In Finland the percentage of juveniles was 11.6% across the 25 sites and a total sample size of 2976. For MU2, more extensive age counts are available from NL (Hornman et al. 2021) and North Rhine Westphalia in DE (Koffijberg and Kowallik 2020, 2022). In NL in 1999, the proportion of juveniles was as high as 41%, but reached a minimum level in 2022 of only 5.6 %, after having stabilized at about 15% during the last 10 years in both DE and NL (Figure 3.3-9).

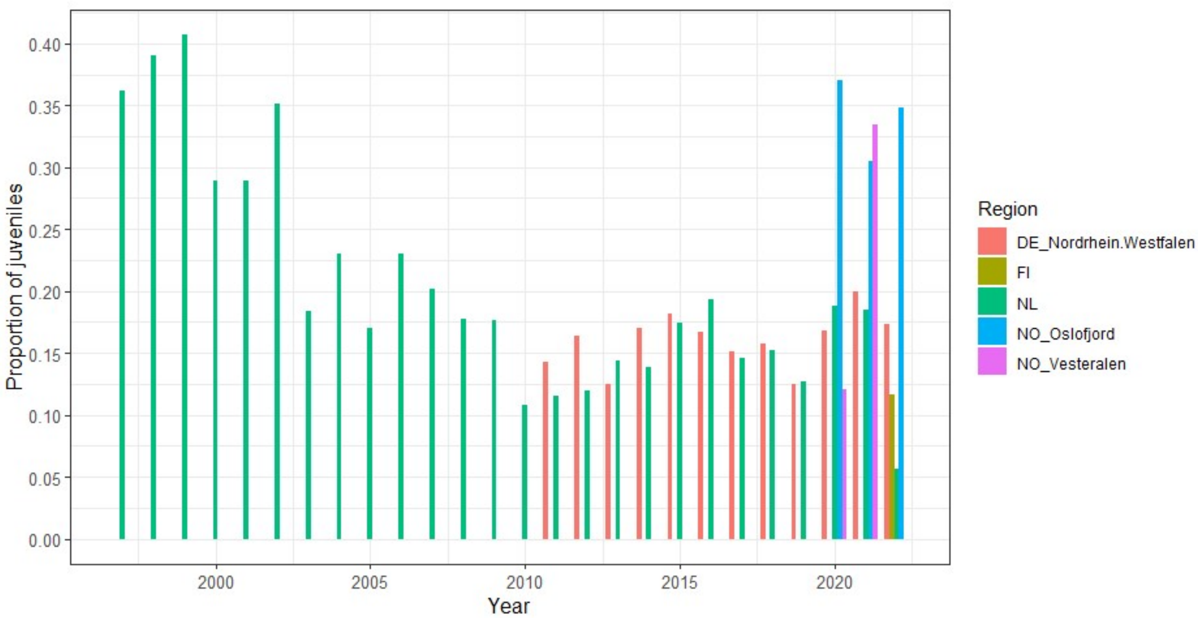



***Figure 3.3-9.*** Proportion of juveniles in the NW/SW European population of Greylag Geese at a country level; Vesterålen, NO from 2020-2021, Oslofjord-area, NO from 2020-2022, FI from 2022, NL from 1997-2022 and North Rhine Westphalia, DE from 2011-2022.

### 3.3.6 Management guidance

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 utility ≥ 0.85 (n = 50), indicating a high probability of meeting both MU targets in eight years. An 8-year timeframe (2022 – 2030) was chosen because the ISSMP is likely due for revision in 2030.

The 50 offtake strategies with high utility 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).

Simulations of the preliminary model thus demonstrate that there is no unique level and distribution of offtake that could 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 concerned countries to carefully review this Annex and take into account legal considerations for managing the offtake of Greylag Geese. In addition, 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 tradeoffs and limitations associated with efforts to coordinate offtake can be better understood by the EGMP IWG.

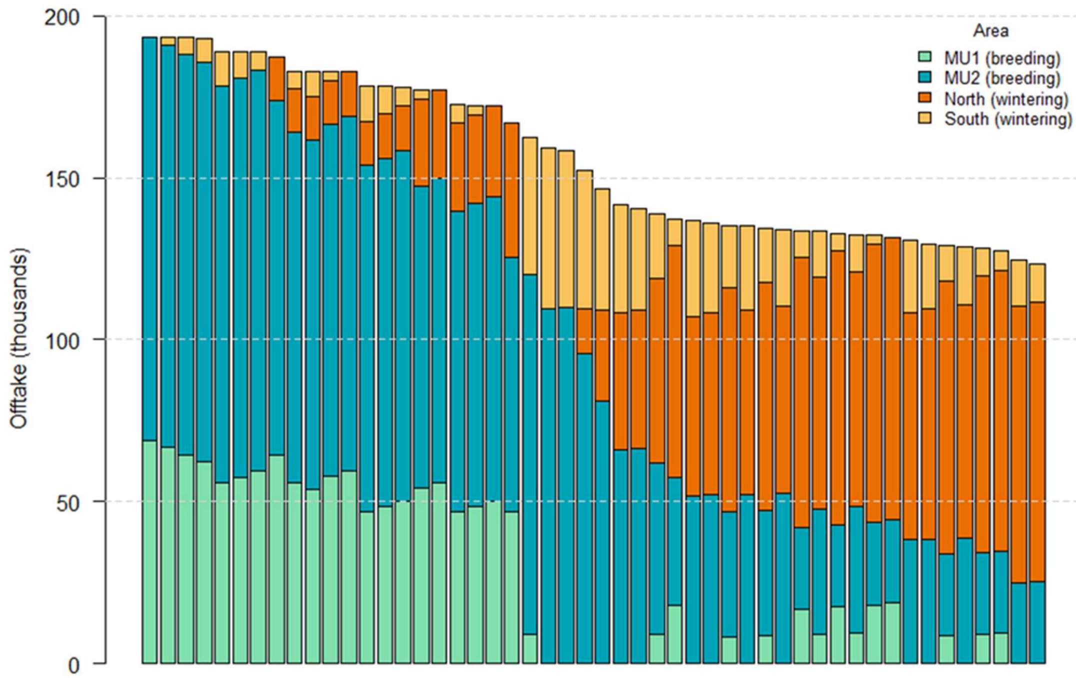



***Figure 3.3-10.*** Fifty alternative offtake strategies for Greylag Geese with high probability of meeting the MU targets after eight years, ordered by decreasing level of total offtake. Values of offtake are the means over the 8-year timeframe.

Comparing the mean levels of offtake for the two sets of management strategies (a and b) with the most recent estimates of offtake from spring-summer of 2020 to spring-summer of 2021 implies either that the flyway population is underestimated by a factor of three or the flyway population is declining by 20% per year, neither of which seem likely (Table 3.3-1). Thus, contemporary estimates of offtake continue to appear that they are 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.
4. Winter counts: all years and countries where available.

Critically, *all data must be accompanied by a short description of the methods for collecting such data* (except for winter counts). At a minimum, the description should specify how the data are collected and should be sufficient to judge their reliability. The methods should also specify the frequency with which the data are collected and when the most recent estimates will be available.

## 3.4 Russian/Netherlands and Germany population of Barnacle Goose

This chapter provides an intermediate assessment of the population status of the Russian/Netherlands and Germany population, including all three management units (see below). In line with the framework set out in the AFMP (Nagy et al., 2021), it is based on an Integrated Population Model (IPM). This model was initially developed for the Russian breeding population only and presented during IWG5 in 2020 (Baveco et al. in Nagy et al. 2021). It was extended to the Baltic and North Sea breeding populations in 2022 and then used in a first full assessment of the population status (Jensen et al. 2022). During IWG7, it was decided to use the model framework of the IPM for an annual update making use of the newest monitoring data. This should be seen as an intermediate assessment, before undertaking the next full assessment in 2024. For this intermediate assessment, results of a review made by the EGMP Data Centre and NINA (F. Johnson, K. Layton-Matthews) in autumn 2022 has been used as well, so a slightly adapted version of the IPM has been applied now (see 3.4.4. for details). The aim is to assess the cumulative impact of derogation (and hunting, where legally allowed) on the status of the populations and use this as a guidance for (future) management.

### 3.4.1 Range states and management units

The range states for the Russian/Netherlands and Germany population of Barnacle Goose include Russia, Finland, Estonia, Sweden, Norway, Germany, the Netherlands and Belgium. Within this range, three management units have been delineated, covering the 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 (breeding in the Oslofjord region) and the Belgian population in MU3 are not part of the AFMP, as their populations have not been recognized as naturally occurring by the respective governments. Still, the birds from these (small) populations mix with the other birds in winter (without being separated), so they have been included in the monitoring setup and the IPM (in any case, their numbers are less than 1% of the flyway population). During winter, birds from all management units mix in Sweden, Denmark, Germany, The Netherlands and Belgium. The Netherlands and Germany are the most important wintering countries (in January 2020 75% of the flyway population).

### 3.4.2 Population FRP's and targets

The FRP for the breeding season is 112,927 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, reflecting the situation in 2000 when AEWA came into force (Nagy et al. 2021). Being an Annex 1 species of the EU Bird Directive, the AFMP does not aim to maintain or bring the population at pre-defined target level. Management is carried out by each EU country under the conditions for derogation, lined out in Art. 9 of the EU Bird Directive. Hunting (harvest) is only carried out outside the EU-countries, mainly 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). Thus, the FRPs represent the lower limits of the legally acceptable population sizes, but as such do not reflect 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 to ensure this. The cumulative impact of derogation and hunting (in Russia) 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 or hunting when the size of the populations (for single MUs or for the entire population) is below 200% of the FRP. This includes monitoring of population size, offtake, prediction of population development (by the IPM), and coordination of offtake and conservation measures where necessary. A protocol for this coordination has been subject to discussions in the Task Force for the Russian/Netherlands and Germany population of Barnacle Goose (see doc. AEWA/EGMIWG/7.14 from EGM IWG7 in 2022).

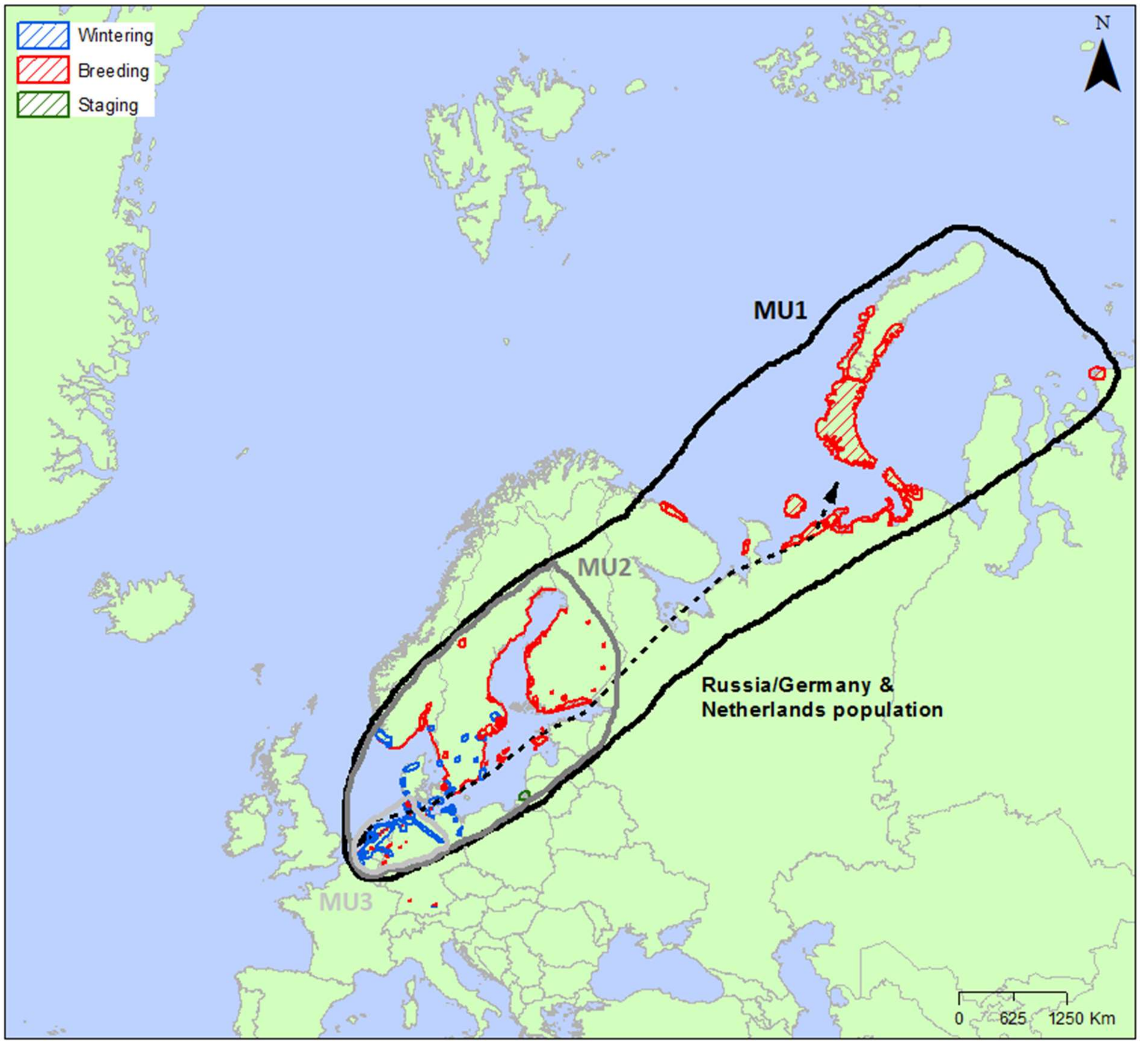



***Figure 3.4-1***. Management units of the Russia/Germany & Netherlands population of Barnacle Goose.

### 3.4.4 Assessment protocol

The assessment of the status of the Russia/Germany & 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 (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 has been included up to 2022 but show some gaps for the last year. 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). Especially in the last season 2021/22 some monitoring data was still missing, so results from this season (usually also coming with large credibility intervals in the graphs) should be treated with caution. This refers e.g., to missing abundance data from Germany (January 2022) and Sweden (January 2021 and 2022). Because prior to 2005 summer counts are completely missing, results of the assessment shown below refer solely to the period 2005-2022. An overview of the longer time series is included in the EGMP Database and the status report 2021 (Heldbjerg et al. 2021). The biggest gap in summer counts is lack of any data from Sweden in recent times.

Following a review by the EGMP in autumn 2022 (see above), 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, is currently being implemented, following the approach taken in the pink-foot goose IPM (Johnson et al. 2022).

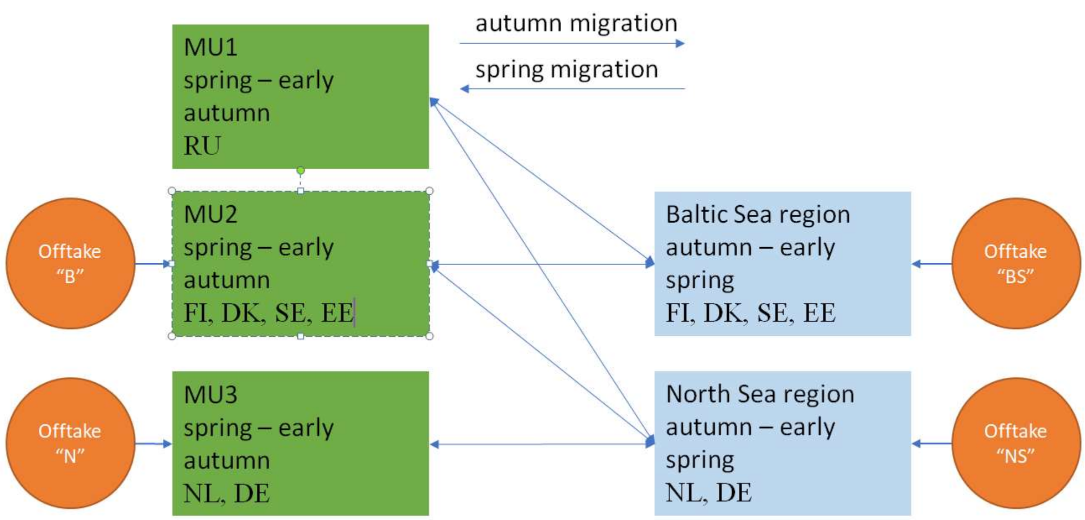



***Figure 3.4-2.*** Overview of the offtake in the different regions experienced by the birds belonging to the different MUs. Local breeding populations (green boxes) in the Baltic Sea and the North Sea areas experience offtake around the breeding period ("B" and "N" respectively). Outside this period (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*

For the size of the flyway population in January (so combining all MUs), results from the IPM and from the counts correspond well (Figure 3.4-3). They show that the flyway population size has reached a level of about 1.4 million individuals in 2020/21 and 2021/22. This is 3.7 times the FRP (100% and 200% levels shown by the dashed line in Figure 3.4-3). This population level has been achieved after a long period of continuous growth (see Heldbjerg et al., 2021), but shows some signs of stabilization in the past three winters.

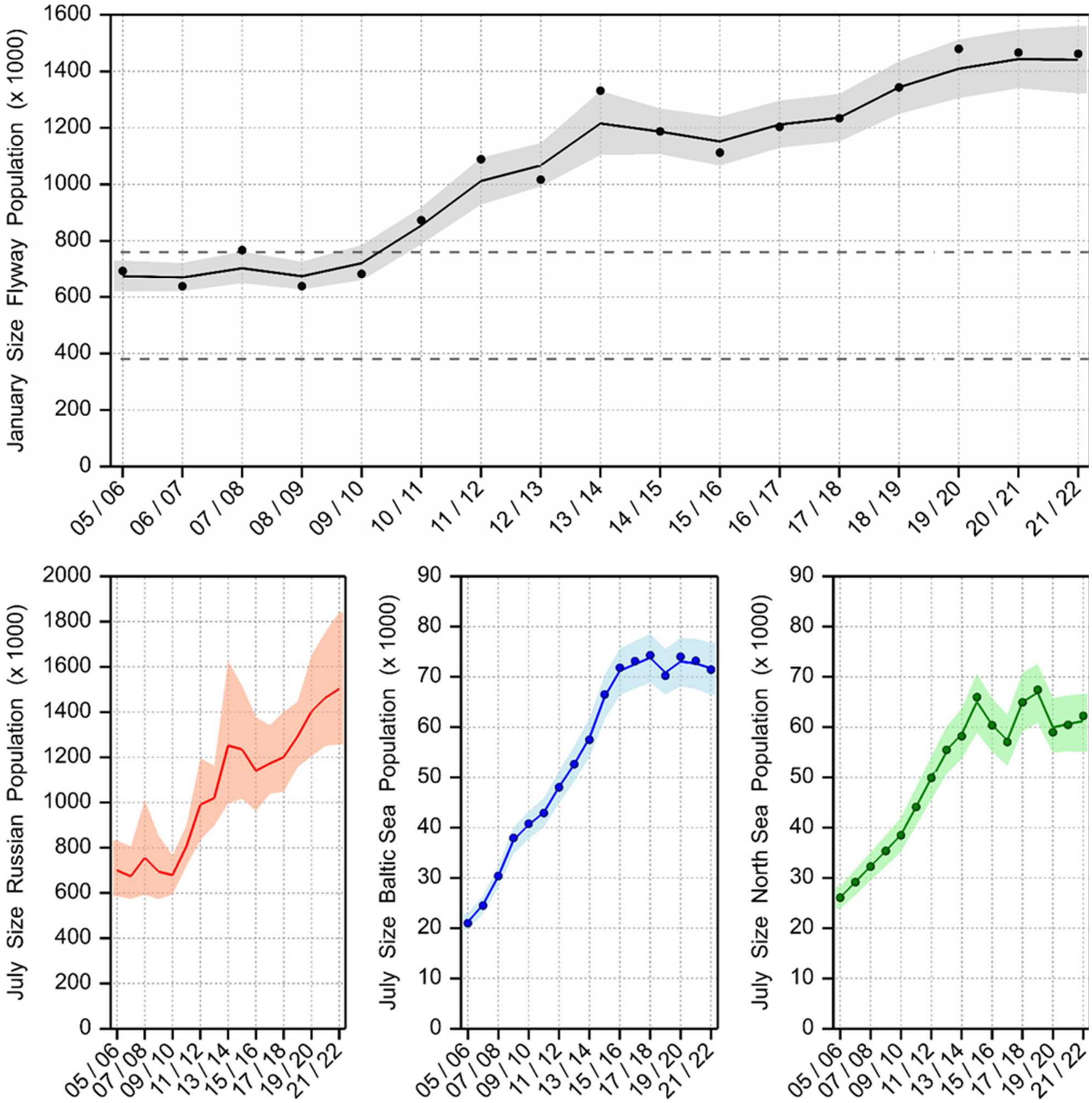



***Figure 3.4-3***. Top panel: January total flyway population counts (dots), posterior means (solid line), 95% intervals (shaded area) and FRP as well as the 200% of the FRP (dashed line). Bottom panels: July population sizes of the three MU-populations along with posterior means and 95% intervals. Left in red MU1, centre in blue MU2, right in green MU3. Note the different scale 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.

Based on posterior abundance estimates in July, the Russian population is by far the largest of all MUs, comprised of 1.5 million individuals, whereas the Baltic populations in MU2 and North Sea populations in MU3 are much smaller: 70,000 and 60,000 individuals respectively (all rounded figures, Figure 3.4-3). Note that these figures 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 (by offtake) mortality occurring between July and January). The Russian MU1-population seems to be still increasing. To the contrary, the Baltic MU2-population seems to have levelled off over the past four years, whereas the North Sea MU3-population shows larger fluctuations around a level of 60,000 individuals. For both MUs, posterior estimates from the IPM and census data correspond well. The saturation of the Baltic population is also well reflected by complete counts from Finland (levelling off from 2017 onwards), but whether the leveling off in the entire MU2 is realistic is not entirely clear as counts from Sweden (and from Norway) are largely missing, and a constant size was assumed for the Swedish population in recent years. However, e.g., at the former stronghold of the island of Gotland in Sweden, numbers are known to have declined (K. Larsson), although it is not known whether Gotland-geese have established elsewhere in Sweden or in neighboring countries.

Converted into breeding pairs, the size of the (still increasing) Russian breeding population in MU1 (posterior estimated mean 550,000 breeding pairs in 2021) is much larger than the FRP set for this MU, also exceeding the 200% threshold level multiple times (Figure 3.4-4). The Baltic MU2-population is also well above the FRP (29,000 breeding pairs in 2021), but much closer to the 200% threshold than the Russian population. The recent decline in the North Sea MU3-population (2021: 15,000 breeding pairs) has brought it close to its FRP now and clearly below the 200% threshold of the FRP (Figure 3.4-4).

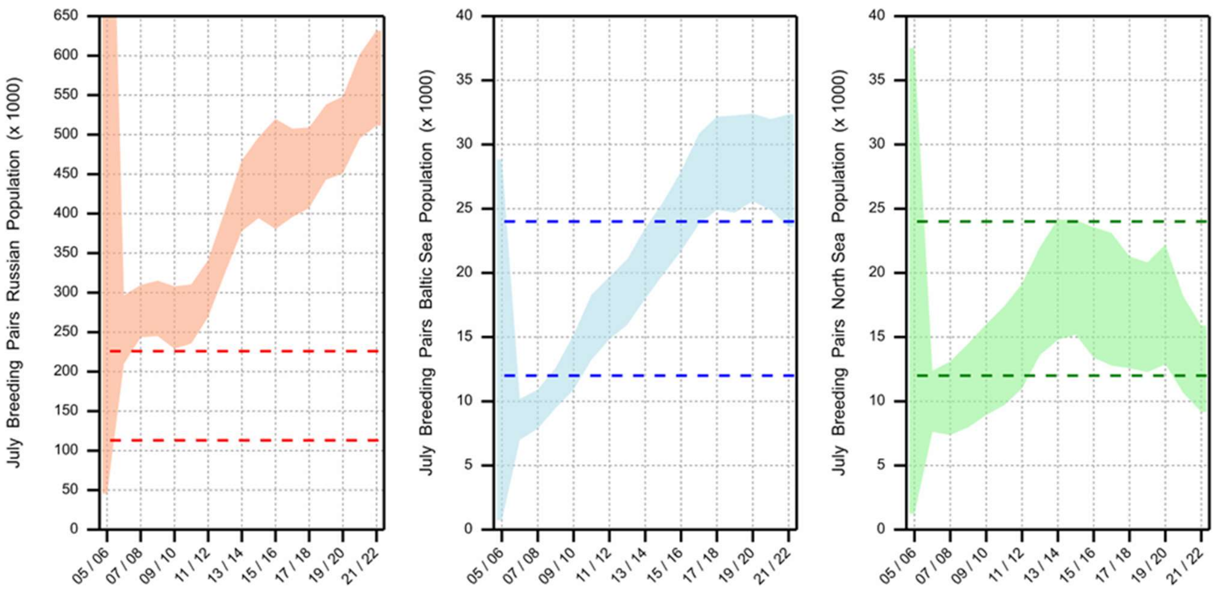



***Figure 3.4-4.*** Posterior means (solid line) and 95% posterior intervals (shaded areas) for the number of breeding pairs in July for the three MU-populations. Dashed lines are the FRP as well as the 200% of the FRP. Left in red MU1, centre in blue MU2, right in green MU3. In the IPM framework, the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

*b) Mortality and offtake*

Survival rates from the IPM, combined for summer and winter, show that adults have much higher survival rates (on average ranging from 0.90 to 0.97) than juveniles (range 0.38 to 0.81) (Figure 3.4-5, excluding the values for the last year, which were based on incomplete data). In all cases, the posterior credible intervals for juvenile survival are much wider than those for adult survival. For the Russian MU1-population, natural survival for juveniles is relatively low in some of the years. This is expected, as natural survival for this MU-population includes unknown offtake in Russia, but in addition this MU-population is also fully migratory and losses among juveniles are likely to occur during autumn migration. For the North Sea population natural survival for juveniles is estimated to be lower than in the Baltic Sea population, at least in the years before 2013. For recent years this is less so, as juvenile survival in the Baltic Sea population appears to decrease.

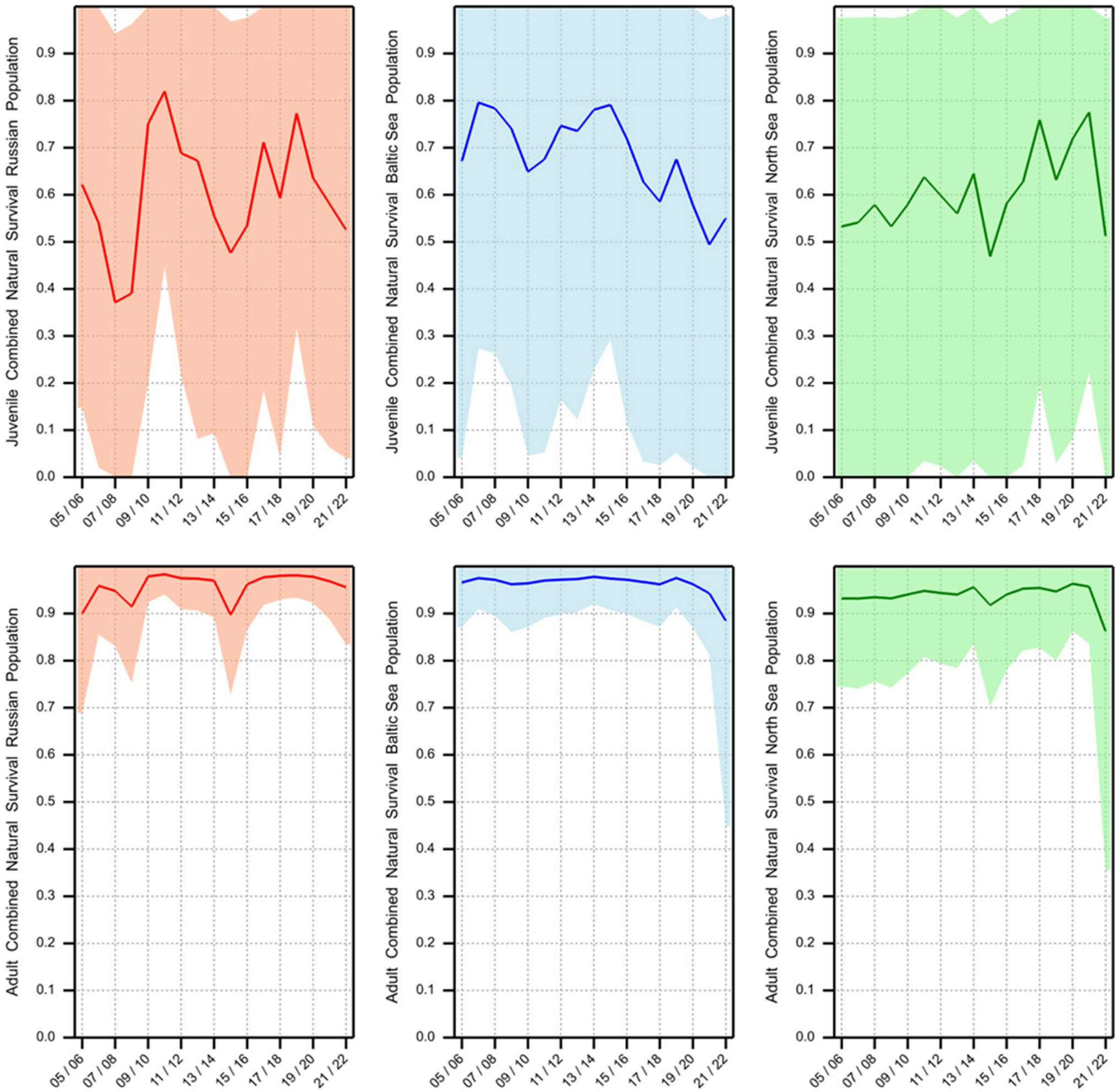



***Figure 3.4-5.*** Posterior means and posterior 95% interval for combined, i.e., summer and winter, juvenile (upper panel) and adult (lower panel) natural survival for the three MU-populations. Left in red MU1, center in blue MU2, right in green MU3. Note that his includes unknown offtake for the Russian population when they are at their breeding site.

Over recent years, combined offtake rates for the Russian MU1- and Baltic MU2-populations amount to around 4 and 5% for adults and 6 and 8% for juveniles (Figure 3.4-6). The difference between Russian and Baltic Sea population values stems from the Russian population's offtake around the breeding period being implicitly included in the natural survival estimate. Baltic Sea offtake rates from the local breeding MU-population are estimated to sum up to approximately 2% in recent years. Combined derogation offtake rates for the North Sea population appear to have increased steeply after 2013, up to approximately 34% for juveniles and 32% for adults in 2020/21. The last year with complete offtake data (2021) indicates a slight decrease in offtake rates for this population (29% for juveniles and 28% for adults), as a result of the outcomes of the assessment in 2022, showing that numbers in the MU3-population were approaching the FRP. The high combined offtake values are caused by high offtake rates on the local breeding MU-population (partly by rounding up flocks during wing moult in June-July), as compared to the offtake rates during the period that the other MU-populations are also present in the North Sea region. Cleary, this outcome depends critically on the way reported offtake is divided over the period that only the local breeding MU-population is present and the period in which also the migrant MU-populations are present in the region. For the country with by far the most derogation offtake in the North Sea region, The Netherlands, this division is however, relatively robust and reliable, as monthly offtake data are available and offtake from June to September can be entirely assigned to MU3. In recent years, offtake in MU3 in summer (so only affecting MU3) increased up to 24,000 individuals while in winter (when other MUs are present) it amounted up to 26,000 individuals. Recently, in 2021 and 2022 it decreased to approximately 12,000 and 5,000 in summer and 26,000 and 18,000 in winter, respectively. In 2021 within the EU-countries, at least 66,165 Barnacle Geese were killed under derogation (data for Estonia missing), of which 90% in the Netherlands and Denmark.

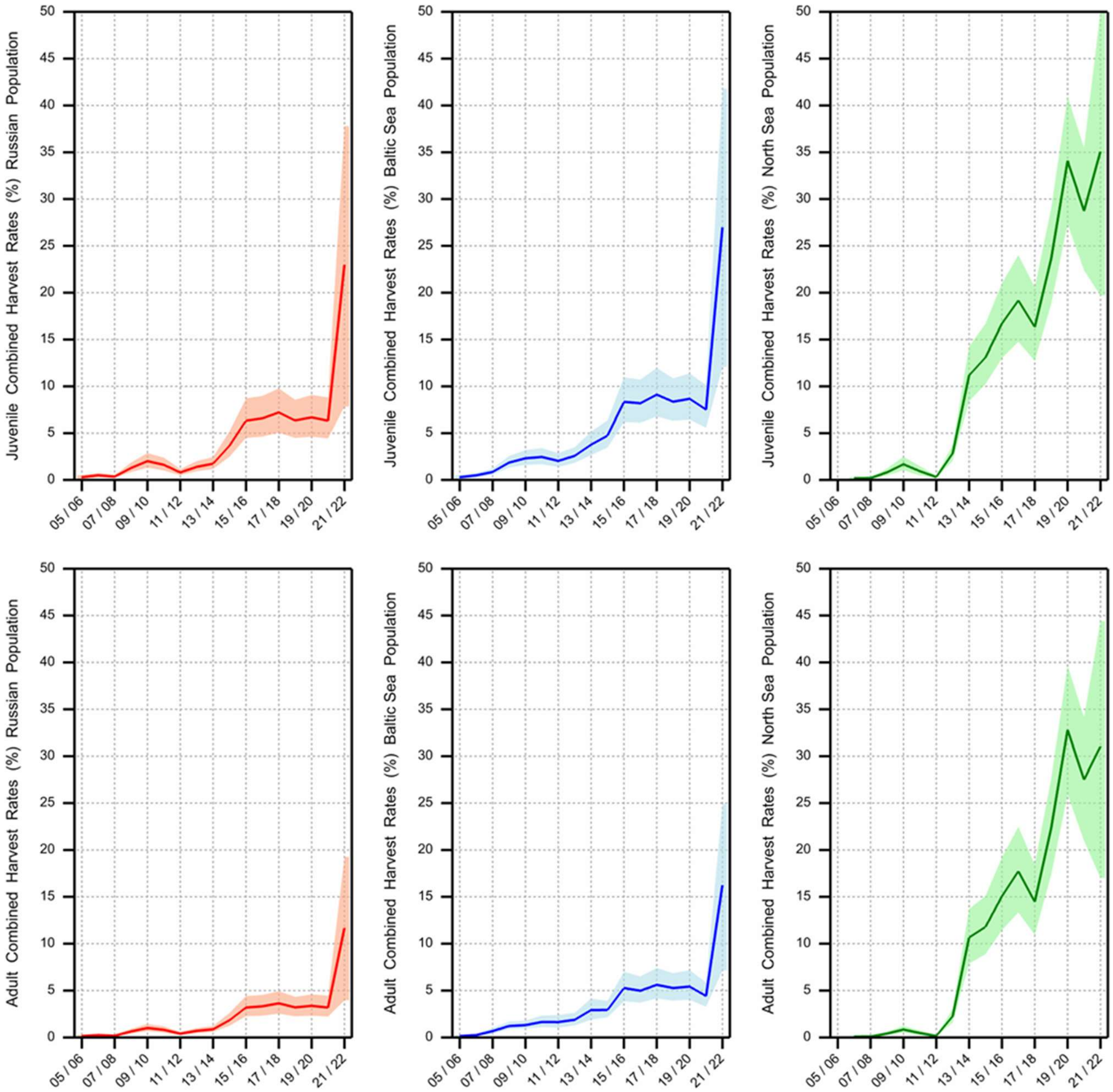



***Figure 3.4-6***. Posterior means (solid lines) and 95% posterior intervals (shaded area) for the combined derogation offtake rates of juveniles (top panels) and adults (bottom panels) for the three MU-populations. Left in red MU1, center in blue MU2, right in green MU3. Note that data for 2021/22 season were incomplete and IPM output comes with large credibility intervals (2021 is the last year with complete derogation data).

*c) Reproduction*

The percentage of juveniles, reflecting a proxy for productivity for MU1 and MU2 (according to abundance mainly MU1), in autumn flocks in mainly The Netherlands shows a high degree of variation, larger than observed when considering only the counts in the field (Figure 3.4-7). Moreover, results from the IPM tend to show a higher level of productivity than the data collected in the field, although in all years they are within the 95% posterior credible intervals of the IPM estimates. There is some evidence that counts in the field, predominantly made in November and December may be biased low, as moult in juvenile birds may have progressed such that proper identification of age can be problematic, but this aspect will be elaborated in more detail (and eventually monitoring protocols will be adjusted). As shown in the previous status report covering a much longer time series (Heldbjerg et al. 2021), productivity has undergone an overall decline in the past decades.

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 24% in some years, but without a clear trend (Figure 3.4-7, lower panel). In the Baltic MU2-population productivity has declined since 2005. The trend in field data and IPM results are similar, but as for the situation at the flyway level in autumn, field data usually shows lower juvenile percentages than the IPM estimates (albeit all within the 95% posterior credible intervals). This is not an identification issue as hypothesized for the situation in autumn but is likely associated with the monitoring data used. This is entirely 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 for a long time and shows some saturation because of local density-dependent effects. Hence, it may not reflect a representative sample, even more so as data from the large Swedish population are completely lacking.

IPM results point to a maximum in reproduction rate of 0.79 offspring per pair (surviving up to 15 July) for the Russian population, decreasing to around 0.44 in recent years. For the North Sea population, it is estimated to be much higher, on average 1.27, but highly fluctuating in recent years. For the Baltic Sea population reproduction appears to have gradually decreased over the years, from a value comparable to the Russian population, to around 0.3 to 0.4 in recent years. These results are comparable to the monitoring data (July census of juveniles), showing the same low and decreasing pattern (Figure 3.4-7, lower panel).

### 3.4.6 Management guidance

Like in the previous assessment, the MU3-population of Barnacle Geese in Belgium, the Netherlands and Germany is the only population which should be currently subject of a coordinated derogation approach, in line with the 200% threshold set in the AFMP. Actually, the latest model output points at a population level which is about the size of the FRP. Thus, derogation effort targeting the breeding population should be undertaken with caution. At present this is only applicable to the Netherlands, where derogations in summer take place, but if derogations during the breeding period are considered in Germany, there should be coordination in place between the two countries. Belgium does consider its small breeding population as non-naturally occurring (Nagy et al. 2021), so stays out of this coordination. In the Netherlands, achievements have been made to arrive at a coordinated approach among the 12 provinces (which each are responsible for goose management) to anticipate on the requirements of the AFMP.

Furthermore, the results from the model suggest that further increase may take place in the Russian breeding population in future. This is in line with recent findings from Lameris et al. (2023) who showed that Barnacle Geese may benefit from warmer springs in the Russian Arctic and expand in areas like Novaya-Zemlya, which were formerly unsuitable as breeding site because of the late onset of spring.

The monitoring data and modelling output also suggest that increased mortality due to high-pathogenic avian influenza, observed in previous winters (see Jensen et al. 2022) so far has not had led to a significant decline in population size, as has been observed in the Svalbard population.

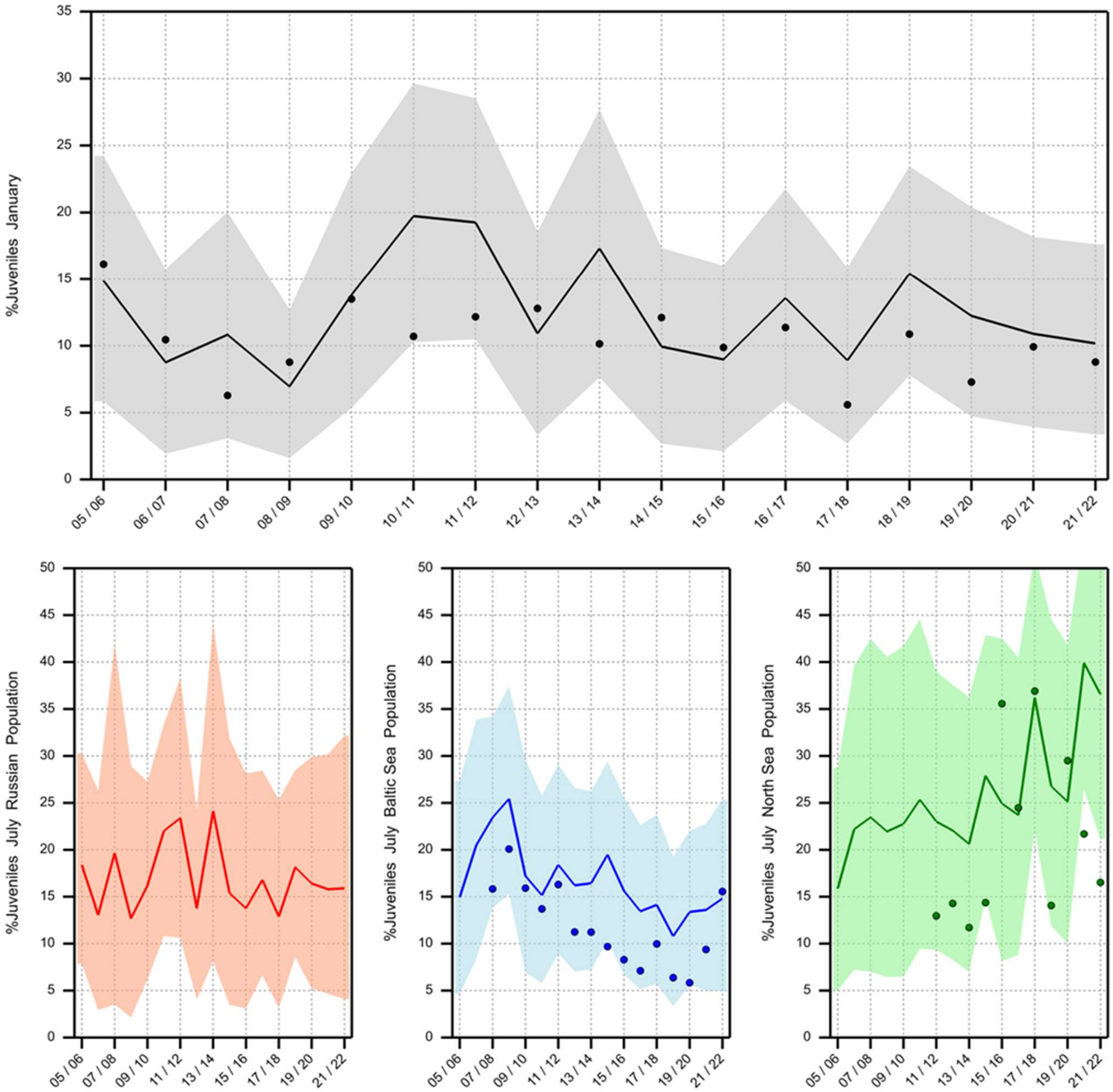



***Figure 3.4-7***. Top panel: Observed January percentage of Juveniles (dots), posterior means (solid line) and 95% posterior intervals (shaded area). Bottom panels: Observed July percentage of Juveniles in the three MU-populations, along with posterior means and 95% posterior intervals. Left in red MU1, center in blue MU2, right in green MU3.

In terms of monitoring data for the IPM, there are multiple issues. For the current assessment, there were no January census data available for Sweden, which did not have a complete census in 2021 and 2022 for specific reasons (including the covid-pandemic). However, the census regime was resumed in 2023 so data will be in place for future assessments. The former gap in census data from Germany has been closed by making use of published information from the two most important federal states, Schleswig-Holstein and Lower-Saxony, which usually have well above 90% of the German wintering population in January. However, data has not been published for January 2022 yet. In case of census data from the summer period, to assess abundance in each single MU larger gaps specifically occur in the Baltic MU2, notably in Sweden. In Finland a late summer census has been in place since 2008. Periodically data have also been collected in the Oslofjord area and Denmark. It is discussed to make use of the Swedish September-count instead, but this comes with some risk of overlapping count data from Finland.

Furthermore, assignment of offtake within a year and assignment to the respective MUs still involves some assumptions and expert judgement, as most data are only available as a total figure for the entire calendar year (currently the Netherlands is the only country with a monthly data resolution). Data with a higher resolution (e.g., per month) would account for a better assignment to each MU and allow more precise input to the IPM. The outcomes of the IPM suggest that autumn age counts may be biased low due to progress of moult in juvenile birds, and this will at least be partly tackled by producing a dedicated manual how to identify adult and first-year Barnacle Geese (at present only available in German). In the Baltic MU2-population it is recommended to have age counts in place to achieve a more representative sample from the entire MU2-population (now data based mainly on Helsinki region in Finland). These counts should preferably assess productivity in the large Swedish population. This can still be done in September (see above), but like census data there is likely some overlap with data from Finland.

## 3.5 Greenland/Scotland and Ireland population of Barnacle Goose

### 3.5.1 Range states and management units

The Range States for the E. Greenland/Scotland & Ireland population 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).

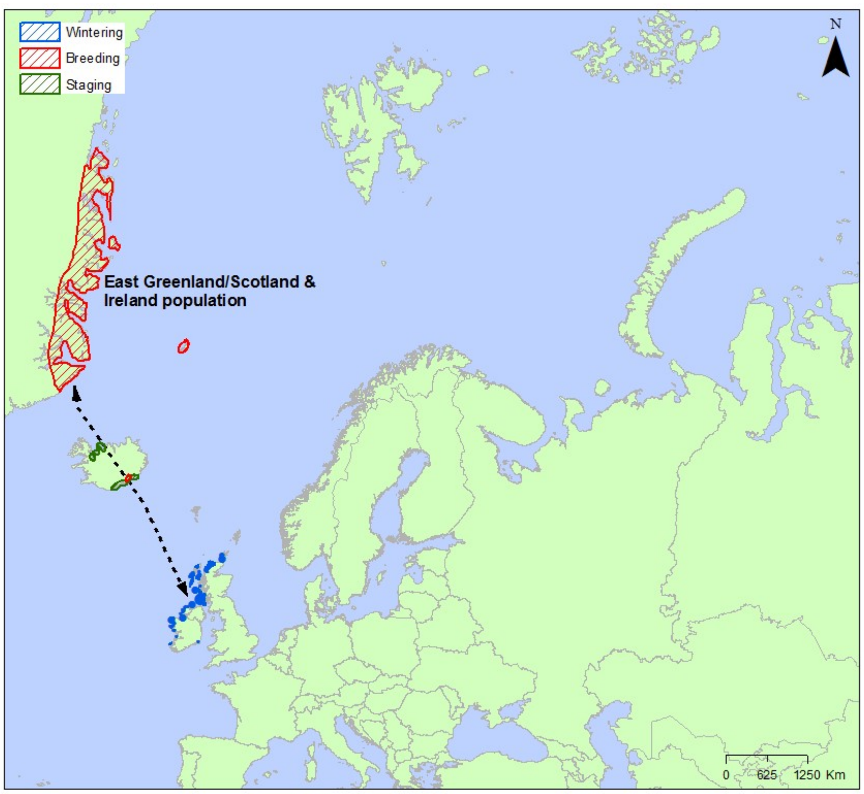



***Figure 3.5-1.*** Annual distribution and migration routes for the E. Greenland/Scotland & Ireland population of Barnacle Geese, including breeding (red), staging (green) and wintering (blue) areas.

### 3.5.2 Population FRP's and target's

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 Bird 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 Bird Directive for EU countries. 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), Greenland and Russia.

### 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 limits of the legally acceptable population sizes, but do not reflect targets for population reduction. Monitoring of the population size and harvest, and predictive modelling (IPM) 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 (in Iceland) 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 or 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. A protocol for this coordination has been subject to discussions in the Task Force and has not been finalized yet.

### 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.

The first assessment of the status of the population was supposed to take place in 2023, using the Integrated Population Model (see chapter 2.4 for details). However, due to a failure to report all data by the deadline and a lack of guidance from the Task Force on projection scenarios for coordinated offtake between Scotland & Iceland, it has not been possible to conduct an assessment. The delays are due to workloads in Scotland and Ireland and lack of understanding of the impacts of a significant outbreak of avian influenza on Islay. Instead, the available raw data is presented.

### 3.5.5 Status

*a) Abundance*

A census of the total population was conducted in February 2023, however information from Ireland is not available yet. Nevertheless, the annual winter count from Islay, the most important wintering site in the UK, indicates a continues decrease in the population from 28,759 in 2022 to 24,656 in 2023, the lowest since 1987 where a total of 20,238 was counted and when the recording was started (Figure 3.5-2). We do know that there was a large fluctuation in numbers of birds on Islay between January and March, so we need to take the Irish count into account when considering overall population numbers and impacts of avian influenza.

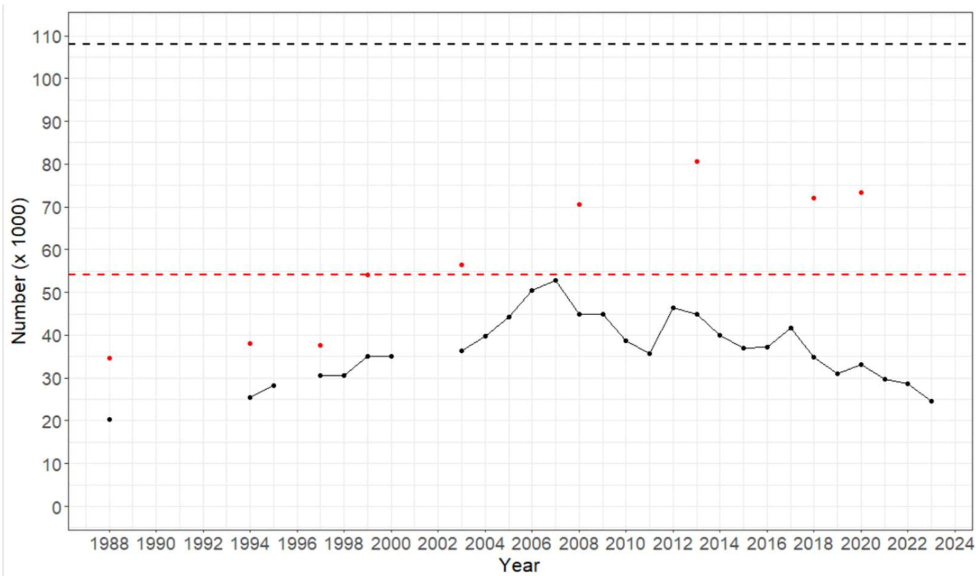



***Figure 3.5-2.*** Development of the winter population size of the E. Greenland/Scotland & Ireland Barnacle Goose (filled red) with additional annual winter counts from Islay the most important wintering site in the UK (black line) (WWT). Black dashed line represents the 200% threshold, and red dashed line represent the FRP.

b) *Mortality and offtake*

Updates on hunting bags and derogation shooting are available from the season 2022/2023, where 58 were shot in Scotland on Islay under derogation and 1,569 were harvested in Iceland. No birds were taken in Ireland (Figure 3.5-3).

There are no updates on survival or crippling rate.

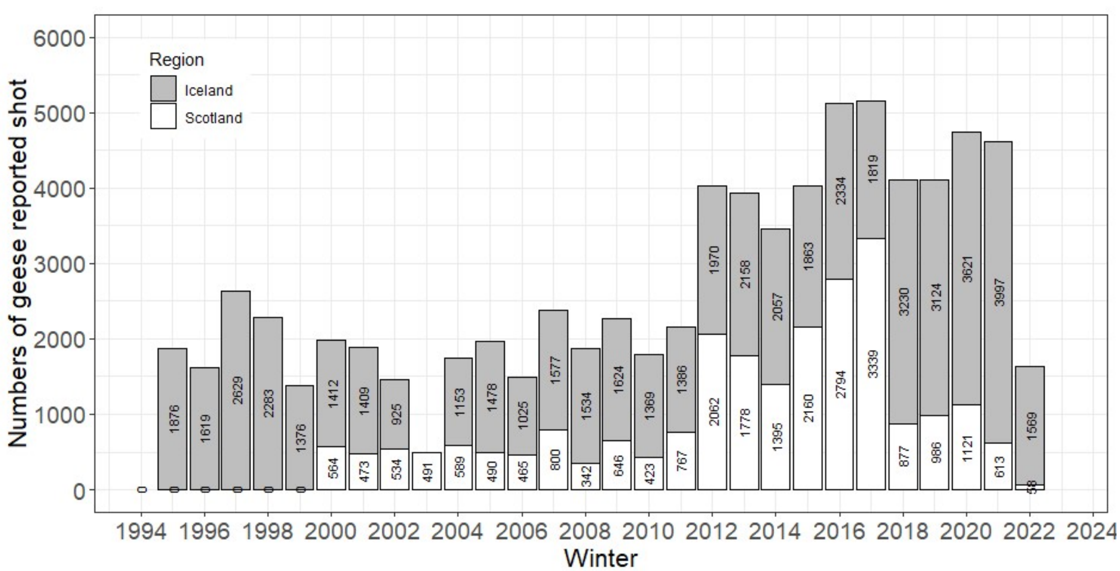



***Figure 3.5-3.*** Development in the harvest of the E. Greenland/Scotland & Ireland Barnacle Goose population in Iceland (hunting) and Scotland (derogation). Numbers on the bars show the numbers killed. In Iceland 2003 data was unusable due to „protest−reports“ delivered by hunters while Ptarmigan hunting was temporarily banned.

*c) Reproduction*

The proportion of juveniles on Islay was 0.03 in November 2022. Only three times before has the record of proportion of juveniles been as low or lower than this (in 1992, 2006 and 2018) (Figure 3.5-4).

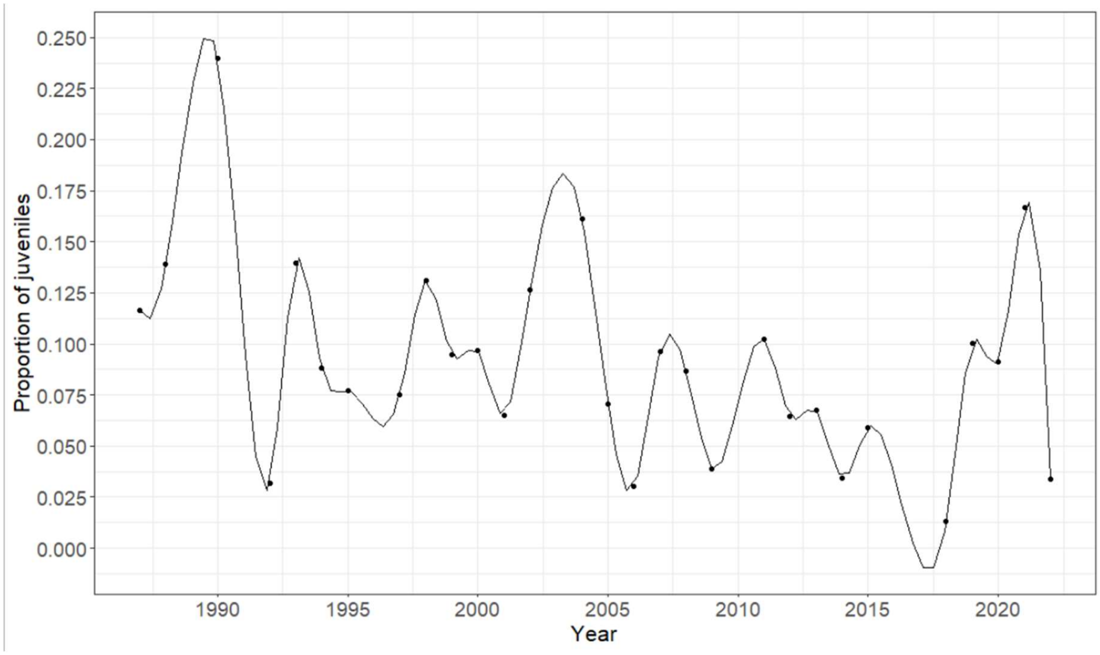



***Figure 3.5-4.*** Annual productivity estimates from Islay based on age counts from November 1st - 17th November. Spline interpolation has been added for better visualization of the trend.

### 3.5.6 Management guidance

Due to missing data from Ireland, it has not been possible to perform the assessment of offtake in 2023.

# 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 | X |
| Hunting bag | X | * | * | X | * | * |
| Wings | - | * | * | X | * | * |
| Crippling | x | * | * | x | * | * |
| Temperature on Svalbard | X | * | * | * | * | * |

## A.2. Taiga Bean Goose

**Table A.2a.** Overview of available monitoring data in the Taiga Bean Goose population, Central MU.
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 | * | * | * | * | - | - | - | - |
| Population counts in mid-winter | * | X | * | 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 | (x) | - | - | - |
| Heads/Wings | - | (x) | (x) | (x) | - | - | (x) | - | - | (x) |

**Table A.2b.** Overview of available monitoring data in the Taiga Bean Goose population, Western MU.
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 | 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 (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 | BE | FR | ES |
| Population counts in January. Received through IWC | X | X | * | X | (x)[1] | X | X | X | (x)[2] |
| Summer count | -[3] | (x)[4] | (x)[5] | (x)[6] | (x)[7] | X | X | (x)[8] | 0 |
| Productivity | (x)[9] | - | (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)[25] | * | * |
| Crippling rate | | (x)[26] | | | | (x)[26] | | | |

1) Available from IWC most years, but the coverage is unknown.
2) Available from IWC most years, but the coverage is limited.
3) Analyses are in progress. Interval unknown.
4) September count is used. Coverage needs to be improved and needs to account for hunting and migration.
5) Focus has been on birds south of Pori and along the Gulf of Finland, thus the Central Greylag Goose population, but plans are to include the Gulf or Bothnian as well, thus the NW/SW European Greylag Goose population.
6) Interval is unknown, see project report.
7) Available from Nordrhein-Westfalen (since 2011) and Niedersachsen (2018). Schleswig-Holstein is available for September most years, but it is not clear to what extent immigration from MU1 has occurred.
8) Available every 6 years from 2022.
9) Available from Vesterålen and Oslofjord-area.
10) Only one year of data from 2022.
11) Available from Nordrhein-Westfalen.
12) No species-specific information from Saarlad (Datenspeicher Jagd Eberswalde, Thünen-Institut).
13) Coverage and method unknown.
14) Available from Andalusia.
15) Hunting season 21.07-23.12. Assume all hunting takes place between Sep-Feb.
16) Open hunting season 11.08-31.01. Assume all hunting takes place between Sep-Feb. Conditional hunting season: all years, but assume all takes place between March-Aug.
17) Hunting season 10.08-31.12. Assume all hunting takes place between Sep-Feb.
18) Hunting season 01.08-31.01. Assume all hunting takes place between Sep-Feb.
19) Hunting season 15.07-31.01. Assume all hunting takes place between 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) All year, assume all derogation takes place between March-Aug.
24) Derogation period: 01.01-09.08, the majority takes place in July-Aug. Assume all derogation takes place between March-Aug.
25) Assume all derogation takes place between March-Aug.
26) 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 |
|---|---|---|---|

| | | | |
|---|---|---|---|
| $\phi$ | annual survival in absence of hunting | 0.88 | allometric relationship (Johnson et al. 2012) |
| $\phi(0.90)$ | annual survival of young from MU1 | 0.79 | loosely based on Pistorius et al. (2006) and Schneider (2022) |
| $\alpha$ | rate of production of young by birds aged 3+ | 0.46 | derived using $\phi$ and population growth rate of 1.014 from EGMP Population Status and Offtake Assessment Report (2022) |
| $\psi_1$ | proportion of MU1 birds wintering in the North | 0.67 | based on marking data (Leo Bacon, pers. comm.) |
| $\psi_2$ | proportion of MU2 birds wintering in the North | 0.95 | based on marking data (Leo Bacon, pers. comm.) |
| $\pi_1, \pi_2$ | fidelity of MU1 and MU2 birds | 1.0 | Schneider (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 |
| $\nu_s$ | differential vulnerability of young in summer | 1.0 | assumed given no selectivity in summer derogations |
| $\nu_w$ | differential vulnerability of young in winter | 2.0 | assumed to be similar to pink-footed geese (Johnson et al. 2020) |

## A.4. Barnacle Goose – Russian/Netherlands and Germany population

**Table A.4.** Overview of available monitoring data in the Russia/Netherlands and Germany 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) | (x) | (x) | X | (x) | |
| Productivity, MU1 and MU2 | * | * | * | - | * | - | X | X | - | Autumn, Nov-Dec |
| Productivity, MU2 | * | (x) | - | - | (x) | - | * | * | * | Summer, Jul-Aug |
| Productivity, MU3 | * | * | * | * | * | * | (x) | X | - | Summer, Jul |
| Offtake, hunting | - | * | * | * | * | * | * | * | * | In EU-countries only derogations |
| Offtake, derogations | * | X | X | X | X[2] | X | X | X | X | Mostly annual totals |

[1] note that Germany only submits data once every six years (full dataset up to 2016), and recent years are based on published data only.
[2] Norway is not an EU-country but applies similar rules when it comes to management for Barnacle Goose, although derogations are for scaring purposes only.

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

**Table A.5.** Overview of available monitoring data in the East Greenland/Scotland and Iceland 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 year | 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

Bacon, L., J. Madsen, G. H. Jensen, L. de Vries, A. Follestad, K. Koffijberg, H. Kruckenberg, M. J. J. E. Loonen, J. Mnsson, L. Nilsson, B. Voslamber, and M. Guillemain. 2019. 'Spatio–temporal distribution of greylag goose Anser anser resightings on the north-west/south-west European flyway: guidance for the delineation of transboundary management units', *Wildlife Biology*, 2019(1)1:1-10(2019), https://doi.org/10.2981/wlb.00533

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.*

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

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.

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

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., M. Kavelaars, K. Koffijberg, E. van Winden, P. van Els, A. DeJong, R. Kleefstra, J. Schoppers, R. Slaterus, C. van Turnhout, and L. Soldaat. 2022. 'Watervogels in Nederland in Soldaat 2022'. Sovon rapport 2022/06, RWS-rapport BM 22.03. Sovon Vogelonderzoek Nederland, Nikmegen.

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., 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., 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., 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., 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. 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

Keeney, R. L., and H. Raiffa. 1993. Decision Analysis With Multiple Objectives. Cambridge University Press.

Kery, 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

Kery, M. and M. Schaub. 2012. *Bayesian Population Analysis Using WinBUGS*. Elsevier, Academic Press, https://doi.org/10.1016/C2010-0-68368-4

Koffijberg, K. & 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. 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

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 Biol* 46, 67–76 (2023). https://doi.org/10.1007/s00300-022-03110-8

Lindstrom, T., and G. Bergqvist. 2020. 'Estimating hunting harvest from partial reporting: a Bayesian approach', *Scientific Reports*, 10, 21113(2020), https://doi.org/10.1038/s41598-020-77988-x

Madsen, J., G. Cracknell, and A. D. Fox. 1999. *Goose populations of the western Palearctic. A review of status and distribution.* Wetlands International Publication Wetlands International Wageningen The Netherlands National Environmental Research Institute Rønde Denmark.

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., F. A. Johnson, J. Shaw, and S. Bearhop. 2021. 'An integrated population model for the flyway population of east Greenland Barnacle Geese - Final project report.' in S. Nagy, H. Heldbjergz, G. H. Jensen, F. A. Johnson, J. Madsen, O. Therkildsen, E. Meyers and S. Dereliev (eds.), *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, 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

Nipkow, M. 2019. 'Ergebnisse der 1. Niedersächsischen Sommergänsezählung 2018.', *Die Vogelwarte*, 57: 230-31.

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

Novana Grågås 2022. https://novana.au.dk/fugle/fugle-2018-2019/traekfugle/traekfuglearter/graagaas

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

Pecbms. 2019. 'Trends of common birds in Europe, 2019 update.' Pan-European Common Bird Monitoring Scheme. Available online: https://pecbms.info/trends-of-common-birds-in-europe-2019-update/

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

Regan, H. M., M. Colyvan, and L. Markovchick-Nicholls. 2006. 'A formal model for consensus and negotiation in environmental management'. *Journal of Environmental Management* 80(2):167-176, https://doi.org/10.1016/j.jenvman.2005.09.004

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.

Sumaila, U. R., and 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

Svensk Fågeltaxering 2022. http://fageltaxering.se/inventera/metoder/sjofagel-host-och-vinter/metodik-sjofagel-host-och-vinter

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

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., S. Nagy, G. Citegetse & H. Schekkerman. 2018 (eds). East Atlantic Flyway Assessment 2017: 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.