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# EGMP POPULATION STATUS AND OFFTAKE ASSESSMENT REPORT 2024

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

**Executive Summary**

This report provides the 2024 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*

Last year, the Data Centre committed to investigate potential biases in the biannual counts by exploring the use of GPS-tagged birds to estimate detection probabilities. The estimated detection probability during the spring count in 2023 was 0.89 (sd = 0.04), indicating a negative bias. In May 2024, counters were supplied GPS locations to increase the detection probability. The estimated detection rate was 1.10 (sd = 0.08), indicating a positive bias. During the November counts the estimated detection probability was 0.87 (sd = 0.07). The greatest difference in population estimates based on the new GPS corrections occurs over the last five years. This is precisely the period when IPM was previously having trouble reconciling the difference in raw counts between May and November of the same year. In contrast to that reported last year, bias-corrected population estimates no longer suggest a decline in the population, but rather a stabilization of numbers since 2010. Beginning with the May 2023 estimate of 73,631 (63,134 – 86,595), the population grew to an estimated 78,139 (66,001 – 93,133) birds in November 2023. The estimate of the May 2024 population size is 77,713 (61,767 – 90,867). Harvests and harvest rates were increasing prior to the implementation of the adaptive harvest management program in 2013 but have been somewhat stable since. We note that harvest has decreased substantially in Denmark during the last three years for reasons that are unclear (possibly related to geese using non-traditional areas). Estimates of annual survival have generally decreased during the entire period of record, although there is quite a bit of uncertainty associated with the estimates in the last few years (due to the cessation of the capture-mark-recapture program). The harvest quota for the 2024/2025 hunting season, based on the estimated population of 77,713 individuals and 11 days above freezing in Svalbard in May 2024 is 26,700. For comparison, the realized harvest averaged 10,111 (sd = 734) during the last three years. The 2024 harvest quotas for Norway and Denmark this year are 8,010 and 18,690, respectively.

*Taiga Bean Goose*

In the Scandinavia/Denmark and UK population, the January count in 2024 was almost twice as high as in 2023 (up to 1174 individuals recorded, compared to 631 last year), with the main increase seen in Denmark. Research on the West Siberia/Poland and Germany population continue, yet so far only limited information updates have been made available. For the Finland and NW Russia/Sweden, Denmark and Germany population, population estimates have been corrected for incomplete counts using GPS-tagged individuals. The March 2024 population estimate is 75,363 (66,829 – 84,837), which is essentially the same as the March 2023 estimate of 74,356 (65,929 – 83,704). Once incomplete detection probabilities are accounted for, there is an 88% probability that the March 2024 population is above the median goal of 70,000. Due to hunting restrictions in all three range states, the total harvest has only averaged 453 birds (sd = 71) during the last two years. Harvest rates declined dramatically following the Finnish harvest moratorium in 2014, and this decrease in harvest rate coincides with strong growth in the population. If the Finland and NW Russia/Sweden, Denmark and Germany population were at its median conservation goal of 70,000, the harvestable surplus would be 5,200 birds.

*Greylag Goose – NW/SW European population*

Despite considerable improvements in data availability, it has still not been possible to move from the information-gap decision model at population level to a dynamic and model-based management at MU level. Progress has been made over the last two years, including the development of a flyway population model, a utility model used to evaluate various offtake strategies in terms of their ability to meet population targets, and a model for estimating number of breeding pairs from post-breeding counts. Such counts were carried out in all Range States in 2022 (although data is only available from three of the German federal states). The results of these counts have now been summarized to provide an estimate of the breeding population size.

A post-breeding population of 540,115 individuals in MU1, resulting in an estimated ~132,000 breeding pairs, and a post-breeding population of 768,956 individuals in MU2, equivalent to ~183,000 breeding pairs, indicate that both MUs are well above the set targets of 70,000 and 80,000 breeding pairs, respectively. Model-based MU or population level management is, however, still not possible as data on post-breeding and winter population size are still lacking in some cases. Moreover, offtake data still appear to be biased high, perhaps extremely so.

*Barnacle Goose – Russia/Germany and Netherlands population*
This report provides an intermediate offtake assessment of all management units (MUs) in the Russia/Germany and Netherlands population for the period 2005/06-2022/23. Data from field counts as well as estimates from the IPM point at an estimated flyway population of about 1.4 million individuals in midwinter 2022/23, thus 3.8 times the FRP. The population has been around this level for four years now, after a long period of nearly continuous growth. Converted into breeding pairs, Russian MU1 and Baltic MU2 are well beyond the FRP, albeit for the Baltic MU2 population the credibility intervals touch the level of 200% FRP (urging for coordination if a significant increase in derogations in planned in countries of this MU). In the North Sea MU3-population, the number of breeding pairs is very close to the FRP. Thus, derogation effort targeting the breeding population should be undertaken with caution here (not relevant for Belgium as the breeding population here is not considered naturally occurring). At present this is only applicable to The Netherlands, where derogations mainly take place in the summer period. If significant derogation activities are planned in Germany during the breeding period, there should be coordination in place between these two countries. Furthermore, as derogation in The Netherlands is the responsibility of the provincial administrations, a coordinated approach is needed here as well which has been in progress in 2023.

*Barnacle Goose – Greenland/Scotland and Ireland population*
This year marks the first time we report status based on the integrated population model. After a peak flyway population of 80,000 in 2006 and in 2012, abundance declined to 56,994 (48,616 – 66,230) in March 2024. For much of the period of record, abundance on Islay exceeded that in all other wintering areas, but that pattern has been reversed since 2018. The total harvest rate of adults has increased over the period of record, from around 0.01 to a peak of 0.05 (0.04 – 0.07) in 2017. Thereafter, harvest rate declined to 0.03 (0.02 – 0.05) in 2023. Annual survival rate of adults (including both harvest and natural mortality) declined at the same time harvest rates were increasing, suggesting that harvest may have contributed to the decline in flyway abundance, although poorer than average reproduction could also have played a role. There currently is a 24% probability that the March 2024 population is below the FRP of 54,000. Because of the proximity of the population to the FRP, the Adaptive Flyway Management Plan requires tighter coordination of offtake between Iceland and Scotland to ensure the population does not fall below the FRP.

**Action requested from the EGM IWG9:**

The EGM IWG9 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 2024 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.

## Compilers

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## Acknowledgements

Many individuals are involved in the data collection in each Range State. Those listed in the EGMP Database may be the ones delivering data to the EGMP Data Centre, but not necessarily the ones responsible for the actual data collection. 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 ranges 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.
- 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.
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- 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.
- The Danish Environmental Protection Agency for funding the assessment of potential biases in the population counts of Pink-footed Goose.

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# 1 Introduction

The first management plan to actively manage a migratory population of waterbirds in Europe was adopted in 2012 and has been implemented since 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 2018, four more populations were added to the EGMP; the NW/SW European population of Greylag Goose, as well as the three populations of Barnacle Goose: the Russia/Germany and Netherlands population, E. Greenland/Scotland & Ireland population and the Svalbard/SW Scotland population. In some specific populations, management units have been established to delineate subpopulations, which are considered to have their own demography and/or dispersal and thus need a specific management and conservation approach. Thus, four goose species and their respective management units are currently part of the EGMP (Table 1-1). During the 8th Session of the Meeting of the Parties to AEWA (MOP8) in 2022, it was decided to split the Taiga Bean Goose population into three populations based on the management unit delineation. The three new populations follow the previous management units as following; the Western MU is now the Scandinavia/Denmark and UK population; the Central MU is now the Finland and NW Russia/Sweden, Denmark and Germany population, and the Eastern1 MU is now the West Siberia/Poland and Germany population. At the same time birds belonging to the former Eastern2 MU were listed as a population of Bean Goose (subspecies *johanseni*) in the AEWA Annexes (UNEP/AEWA Secretariat 2022). However, it has since been recommended by the AEWA Technical Committee and BirdLife International that these birds should be treated as a population of Taiga Bean Goose, and this change is expected following MOP9 in 2025.

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

| **Population** | **Management/Action Plan (ISSMP/ISSAP)** | | | **Adaptive Flyway Management Plan (AFMP)** | | |
|---|---|---|---|---|---|---|
| | **Link** | **Adopted** | **Review** | **Link** | **Adopted** | **Review** |
| Svalbard population of Pink-footed Goose | ISSMP | 2012 | 2025 | Not developed | - | - |
| Scandinavia/Denmark and UK population of Taiga Bean Goose (former Western MU) | ISSAP | 2015 | 2025 | Not developed | - | - |
| Finland and NW Russia / Sweden, Denmark and Germany population of Taiga Bean Goose (former Central MU) | ISSAP | 2015 | 2025 | Not developed | - | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| West Siberia/Poland and Germany population of Taiga Bean Goose (former Eastern1 MU) | ISSAP | 2015 | 2025 | Not developed | - | - |
| NW/SW European population of Greylag Goose consisting of 2 MUs; MU1 (migratory) and MU2 (sedentary) | ISSMP | 2018 | 2030 | AFMP | 2020 | 2026 |
| Russia/Germany and Netherlands population of Barnacle Goose consisting of 3 MUs; MU1 (Arctic), MU2 (Baltic) and MU3 (North Sea) | ISSMP | 2018 | 2030 | AFMP | 2020 | 2026 |
| E. Greenland/Scotland & Ireland population of Barnacle Goose | ISSMP | 2018 | 2030 | AFMP | 2020 | 2026 |
| Svalbard/SW Scotland population of Barnacle Goose | ISSMP | 2018 | 2030 | Not developed | - | - |

This report, together with the EGMP Database, 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 from previous years are available at: https://gitlab.com/aewa-egmp. Most recent files (current assessment) and further details are available from the EGMP Data Centre (fred.johnson@ecos.au.dk).

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

## 1.1 The assessment processes

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

1) *Monitoring*

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

2) *Assessment*

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

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

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

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

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.

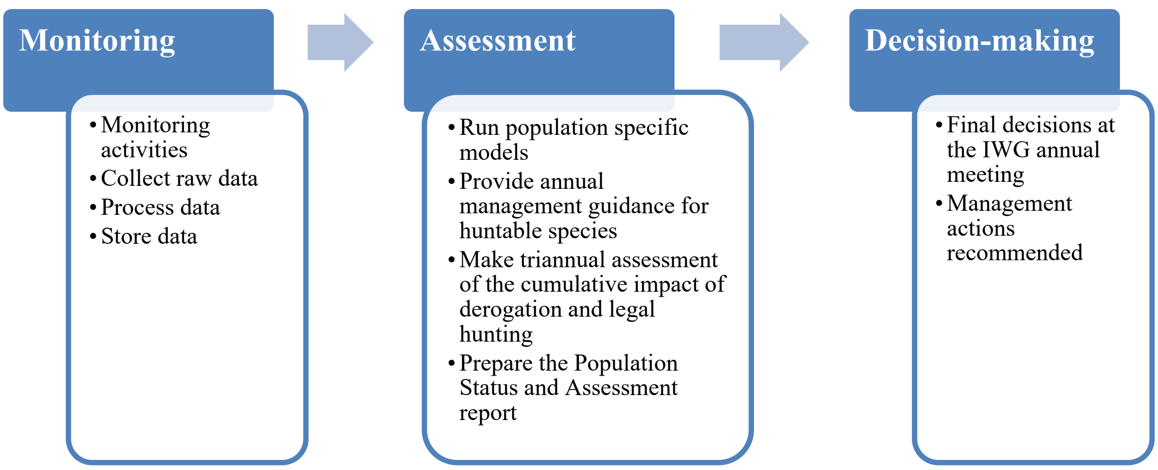



***Figure 1.1-1.*** The EGMP assessment process, including annual activities related to monitoring, assessment and decision-making.

# 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 wetland areas, but in some countries include schemes specifically for geese as well, covering occurrence in farmland areas. Field work is usually carried out by a large network of volunteers during daytime on feeding sites or at dawn/dusk at roost sites, but precise methods, and especially coverage may vary slightly between countries. In addition, some countries (e.g., The Netherlands, Belgium) account for missing geese in the network of counting sites by estimating missing counts ("imputed") with algorithms that account for the long-term trend and the phenology in similar census areas within the region (Hornman et al. 2021; Onkelinx et al. 2017). That way the data used for trend calculations represent a complete dataset and is not subject to variation in counting effort. Goose counts are collected by national coordinators and reported to Wetlands International who coordinates the IWC (van Roomen et al. 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 takes place towards the end of the hunting season for most species, thus allowing an assessment of the effects of offtake. However, for widely dispersed species like e.g., Greylag Goose, the January census only provides information on the overall trend of the entire flyway population, as coverage is currently regarded too low to assess total population size. Moreover, the January count is not suitable to assess the size and trend for some populations and specific MUs as different MUs mix during winter. For these reasons, specific counts are also organised at other times during the year, in order to assess the size of the respective MU-populations. Under the EGMP, data from the IWC is currently only used directly in the assessment of the NW/SW European population of Greylag Goose.

*Autumn census:* In continental Europe, special population counts have previously been made for all grey geese (*Anser sp*.) in November, as well as in September for Greylag Goose (Madsen et al. 1999). In recent years, most Range States have performed additional counts, 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. For Greylag Goose, most Range States now perform post-breeding counts prior to the hunting season.

*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. To estimate population sizes of breeding waterfowl and wader species, including Greylag Goose, France has recently introduced a spring census which will take place at regular intervals (currently planned for every six years).

*Summer census:* For 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, while the number of breeding pairs must then be calculated from the results of the post-breeding censuses. Summer counts are carried out during daytime and focus on wetlands and waterbodies, which in summer host nearly all birds during daytime. Hence, coverage is regarded as high (usually >90%), but in some large countries (e.g., Norway, 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 in October and November, Greylag Goose is however already assessed during July and August (in some cases in combination with the summer census), as it is otherwise difficult to distinguish juveniles from adults (see Koffijberg 2022). Assessing productivity at the staging and wintering grounds is, however, likely to be affected by several factors as we are compelled to sample from an open population, in which the temporal and spatial age composition can vary, e.g. due to differential migration, mortality and flocking 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 each country name).

*Derogation:* EU Member States are obliged to report all derogations to the European Commission in annual derogation reports (according to Article 9 in the Birds Directive (Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds), see EU 2020). However, for a number of Member States, the data is only available after a delay of several years. Furthermore, in some countries this reporting involves several administrative levels and with some uncertainty as to the true number of birds killed. Derogation data are available from the EU Eionet central data repository (https://ec.europa.eu/environment/nature/knowledge/rep_birds/index_en.htm), but for this report data has also been provided by the countries themselves or for 2022 taken from drafts data available through the EU central data repository mentioned above.

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

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

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

## 2.4 Population assessment methods

Integrated population models (IPM) are currently used to derive estimates of abundance and demographic rates for four goose populations covered by the EGMP: Svalbard Pink-Footed Goose (Johnson et al. 2020), the Finland and NW Russia/Sweden, Denmark and Germany population of Taiga Bean Goose (Johnson, Heldbjerg, and Mntyniemi 2020), 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 *Anser brachyrhynchus*

### 3.1.1 Range states and management units

This chapter compiles monitoring data on the population status of the *Svalbard population of Pink-footed Goose*, as well as providing guidance for the upcoming hunting season (2024/2025). The range states for this population include Norway, Denmark, Belgium and the Netherlands (Figure 3.1-1). More recently, Pink-footed Geese have established a new migration route through Sweden and Finland with breeding grounds in Novaya Zemlya in north Russia. This new group consists of at least 4,000 individuals and is increasing partly due to immigration from the traditional flyway (Madsen et al. 2023). How this new development will be treated will be discussed as part of the evaluation and revision process of the ISSMP in 2024/2025, but the AEWA Technical Committee, supported by the EGMP Pink-footed Task Force, has decided to consider the new group as a range expansion, hence it continues to be part of the *Svalbard population* (AEWA/TC meeting March 2024, doc.19.6).

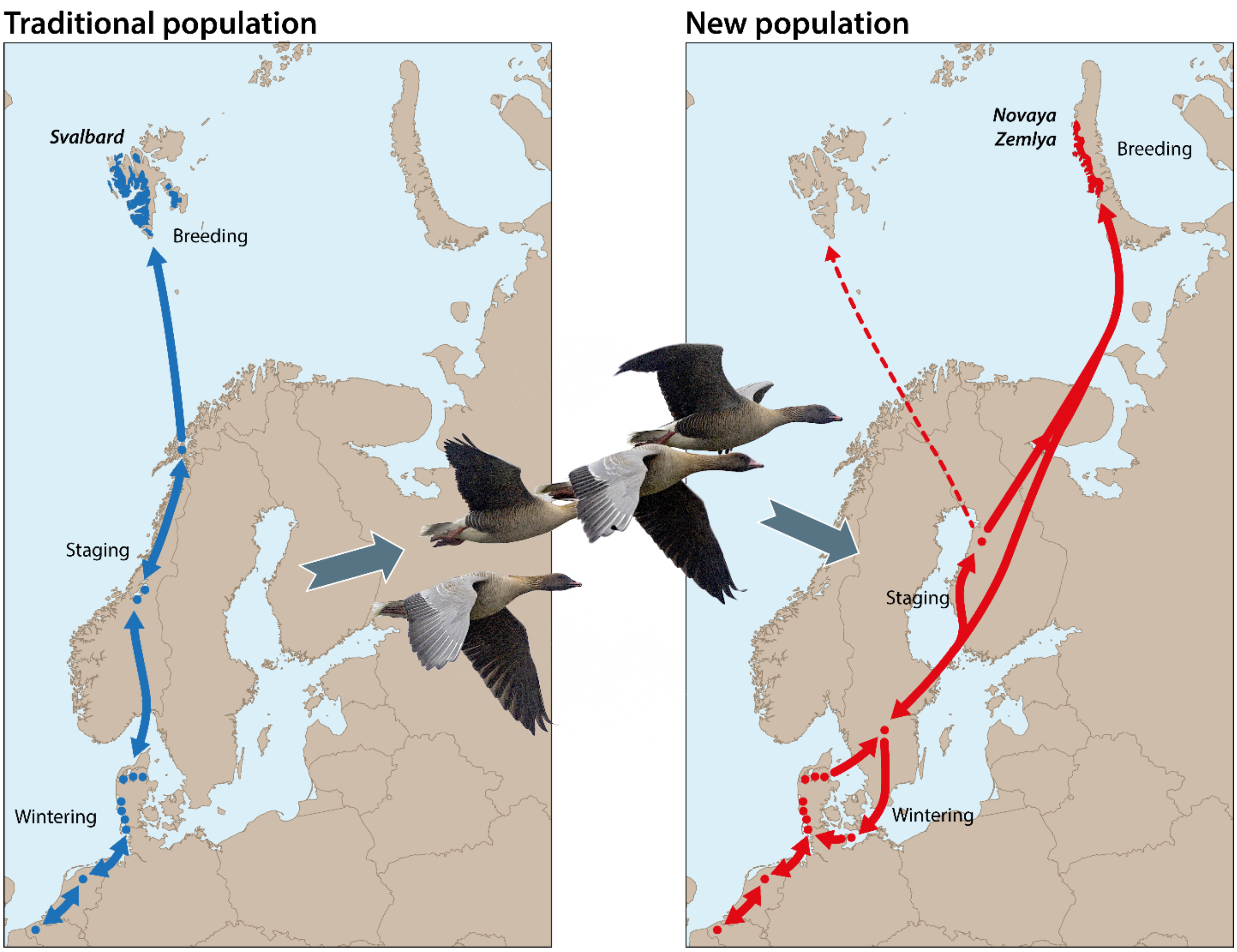



***Figure 3.1-1.*** Annual distribution and migration route of Svalbard Pink-footed Goose traditional population (left) as well as the new population (right) (Madsen et al. 2023).

### 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 on breeding grounds in Svalbard.

### 3.1.3 Management strategies

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

### 3.1.4 Assessment protocol

We used the integrated population model described by Johnson et al. (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:

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

Raw data and the results of the 2024 update of the IPM are available from the EGMP Data Centre.

Posterior estimates of natural mortality, differential vulnerability of young to harvest, and the regression coefficients expressing the relationship between thaw days and reproductive success were used to derive an optimal harvest policy. We used a computation algorithm known as stochastic dynamic programming (SDP), which can explicitly account for various sources of uncertainty in 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. The optimal harvest strategy was computed using the publicly available software MDPSolve (© 2010 – 2011 Paul L. Fackler, https://github.com/PaulFackler/MDPSolve), which is a set of SDP tools written in the proprietary MATLAB® programming language.

### 3.1.5 Population status

*a) Abundance and trends*

We begin by discussing some monitoring issues that came to light in last year's update of the IPM. For most of the period of record the November count was less than the Lincoln-Peterson (LP) estimate in May, which is not biologically realistic. When combined with the available productivity data, the IPM therefore concluded that the November count must be biased low. Around 2015, however, the November count "caught up" with the May LP estimate and greatly exceeded it in 2020 and again in 2021. Again, when combined with productivity data, the IPM concluded that the November count had become biased high. Moreover, the May count has always been less than the May LP estimate, which is not surprising because counts (i.e., a "census") are often biased low (Fryxell et al. 2014). Beginning in 2010, May LP estimates were able to "arbitrate" between the November and May counts (both of which likely have biases). In 2021, however, the May LP estimates were discontinued. The IPM now had difficulty interpreting the decreasing May count and the increasing November count. Last year, the Data Centre committed to investigate the magnitude of bias in the biannual counts by exploring the use of GPS-tagged birds to estimate detection probabilities.

We compared the time and location of counts with that of GPS-tagged individuals in the November 2022, May 2023, November 2023, and May 2024 censuses. We tallied the number of GPS tags not present in a counting area on the day of the count, those recorded once in a counting area, and those recorded twice (i.e., double counted). We combined GPS tallies from the November 2022 and November 2023 censuses to increase sample size. We did not, however, combine the GPS tallies from the two May censuses. In May 2024, the locations of GPS-tagged individuals at the start of the counts were provided to the observers in Trøndelag, Norway (where the majority of the population is concentrated in May) to increase the probability of a complete census. When the multinomial sample sizes were combined with other data in the IPM, the estimated detection probability during the spring count was 0.89 (sd = 0.04) in 2023, indicating a negative bias. In May 2024, however, the estimated detection rate was 1.10 (sd = 0.08), indicating a positive bias (Figure 3.1-2). During the November counts the estimated detection probability was 0.87 (sd = 0.07), indicating a negative bias. Detailed methods for the comparison of counts versus GPS-tags are described in a separate document (EGMP Data Centre in prep.). For May and November counts prior to 2024, we assumed the estimated means and sampling variances were constant over time but allowed year-specific detection probabilities to be drawn from these distributions. The May 2024 count was corrected for the positive bias.

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

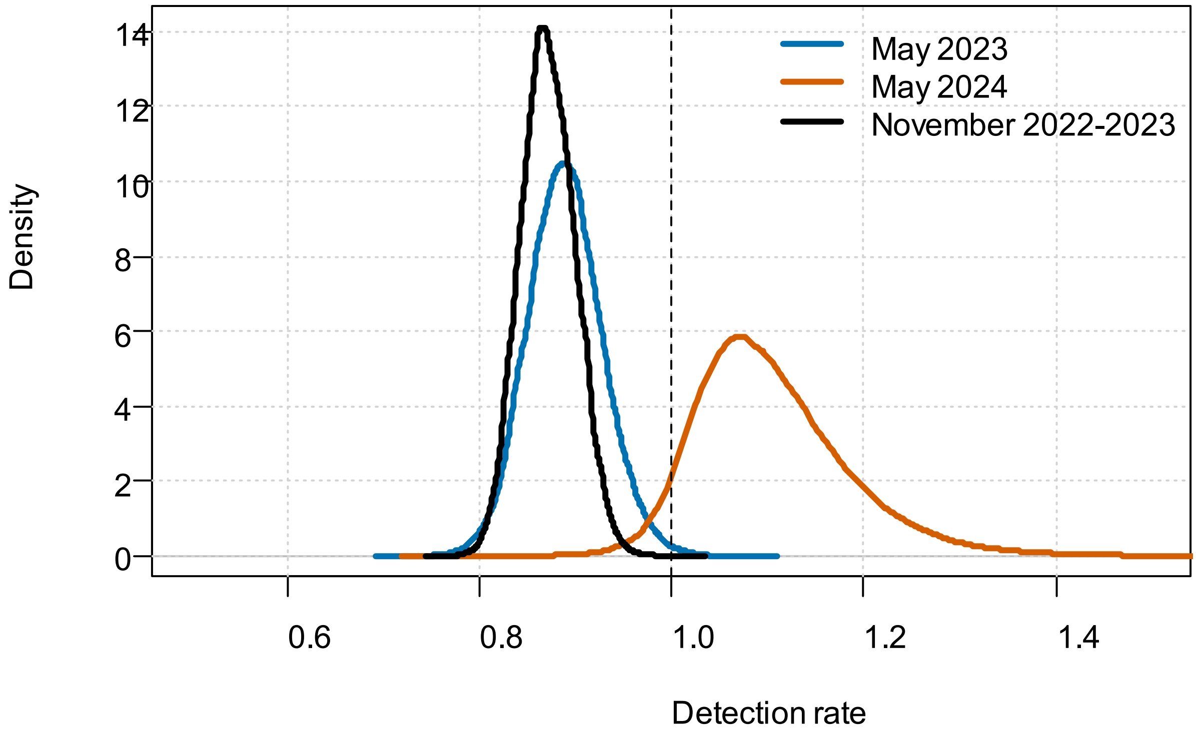



***Fig. 3.1-2.*** IPM-derived posterior distributions of detection rates during counts of *Svalbard Pink-footed Geese* based on the co-location of counts and GPS-tagged individuals. Values below 1.0 indicate a negative bias in the counts, while values greater than 1.0 indicate a positive bias (i.e., double counting).

Estimated population sizes in May and November are provided in Figure 3.1-3. In contrast to that reported last year, there no longer appears to be a decline in the population, but rather a stabilization of numbers since 2010. Beginning with the May 2023 estimate of 73,631 (63,134 – 86,595), the population grew to an estimated 78,139 (66,001 – 93,133) birds in November 2023. The estimate of the May 2024 population size is 77,713 (61,767 – 90,867). Notably, in early May 2024, 9,942 pink-footed geese were counted in western Finland, which is 44% more than in the year before. Hence, the growth of the segment migrating via Sweden and Finland continues to grow.

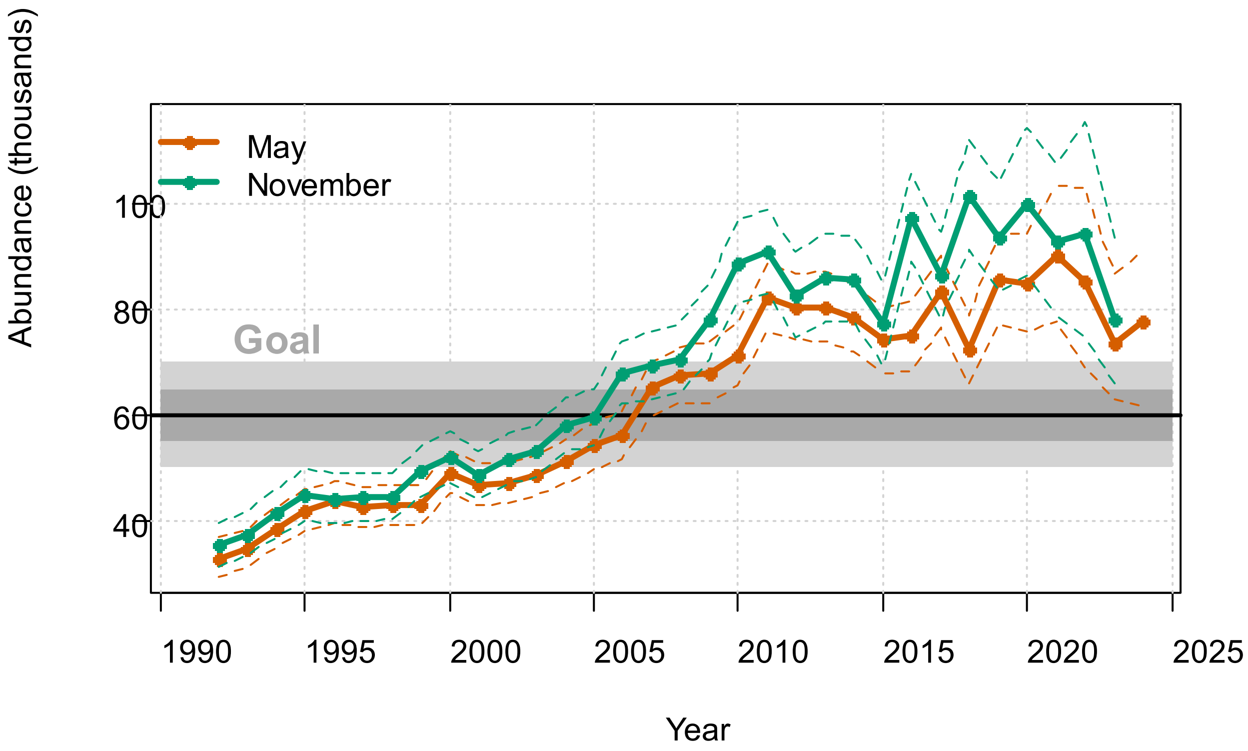



***Figure 3.1-3.*** IPM-based estimates of abundance of *Svalbard Pink-footed Geese* in May and November, relative to the goal of 60,000 (95% credible intervals are indicated by the dashed lines). The dark grey band centered on the goal defines near-complete stakeholder satisfaction with population sizes, while the light grey band exhibits ≥½ of maximum satisfaction.

*b) Mortality and trends*

Posterior estimates of country-specific harvests of Svalbard Pink-footed Geese are provided in Figure 3.1-4. Posterior estimates of annual harvest and survival rates of the flyway population are provided in Figure 3.1-5. Harvests and harvest rates were increasing prior to the implementation of the adaptive harvest management program in 2013 but have been somewhat stable since. We note that harvest has decreased substantially in Denmark during the last three years for reasons that are unclear (possibly related to geese using non-traditional areas and because the Danish Hunters' Association – following the decision taken during IWG8 - encouraged Danish hunters to reduce their offtake in 2023/24 due to uncertainty about population size). Estimates of annual survival have generally decreased during the entire period of record, although there is quite a bit of uncertainty associated with the estimates in the last few years (due to the cessation of the capture-mark-recapture program). In particular, the apparently large increase in annual survival in 2023 should be viewed with some scepticism.

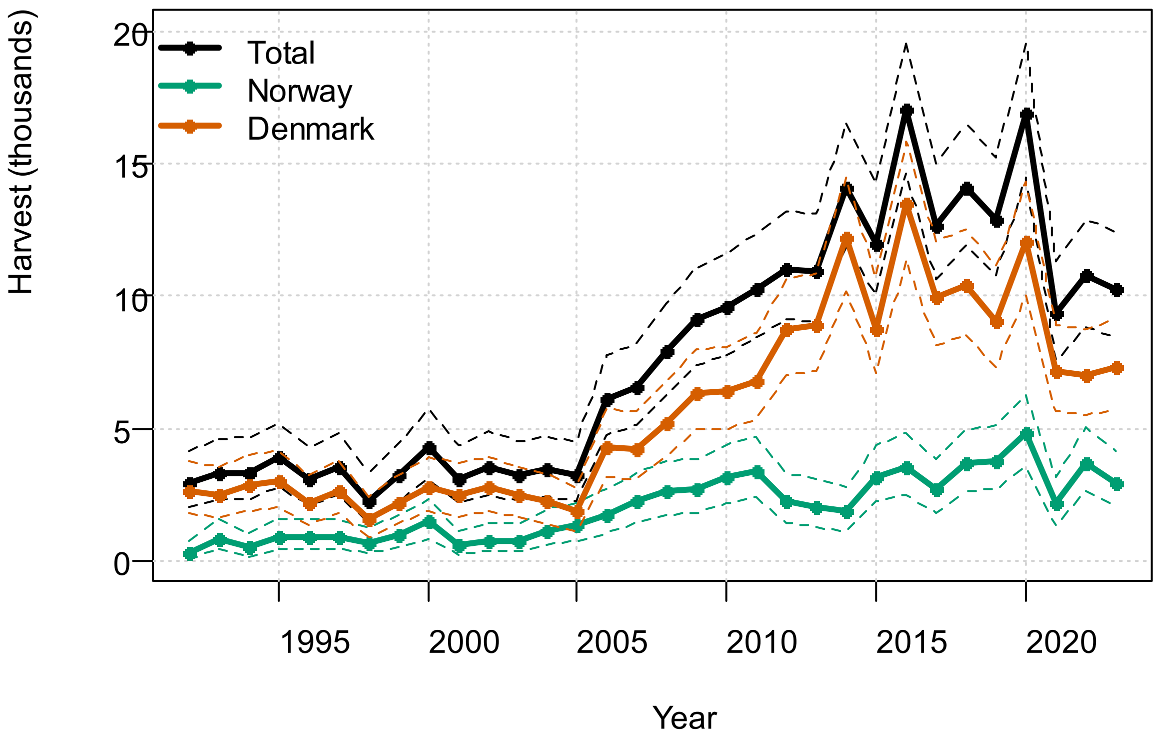



***Figure 3.1-4.*** IPM-based estimates of harvests of *Svalbard Pink-footed Geese* (95% credible intervals are indicated by the dashed lines).

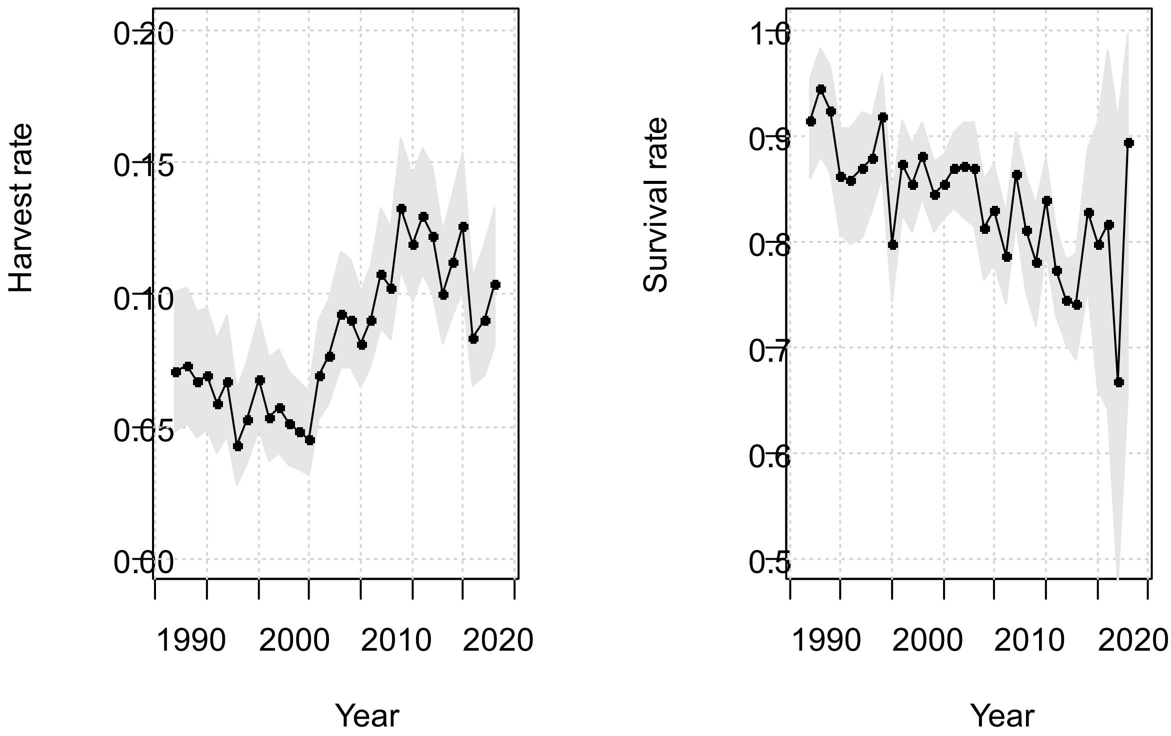



***Figure 3.1-5.*** IPM-based estimates of harvest and annual survival rates of adult *Svalbard Pink-footed Geese* (95% credible intervals are indicated by the shaded polygons).

*c) Reproduction and trends*

Estimates of productivity, as indicated by the post-breeding proportion of young in the population, have been variable, with an average proportion of 0.19 (*se* = 0.01) young (Figure 3.1-6). Productivity has generally increased over the period of record and is highly correlated with the increasing number of days in which the mean air temperature is above freezing in May in Svalbard. The post-breeding proportion of young reached a maximum of 0.37 (0.32 – 0.42) in 2018 following a record 27 days above freezing in May in Svalbard. In contrast, the record low proportion of 0.13 (0.11 – 0.14) occurred in 1998, following 0 days above freezing in May in Svalbard. In 2023, the estimated post-breeding proportion of young was 0.18 (0.17 – 0.19), following 9 days above freezing in May in Svalbard.

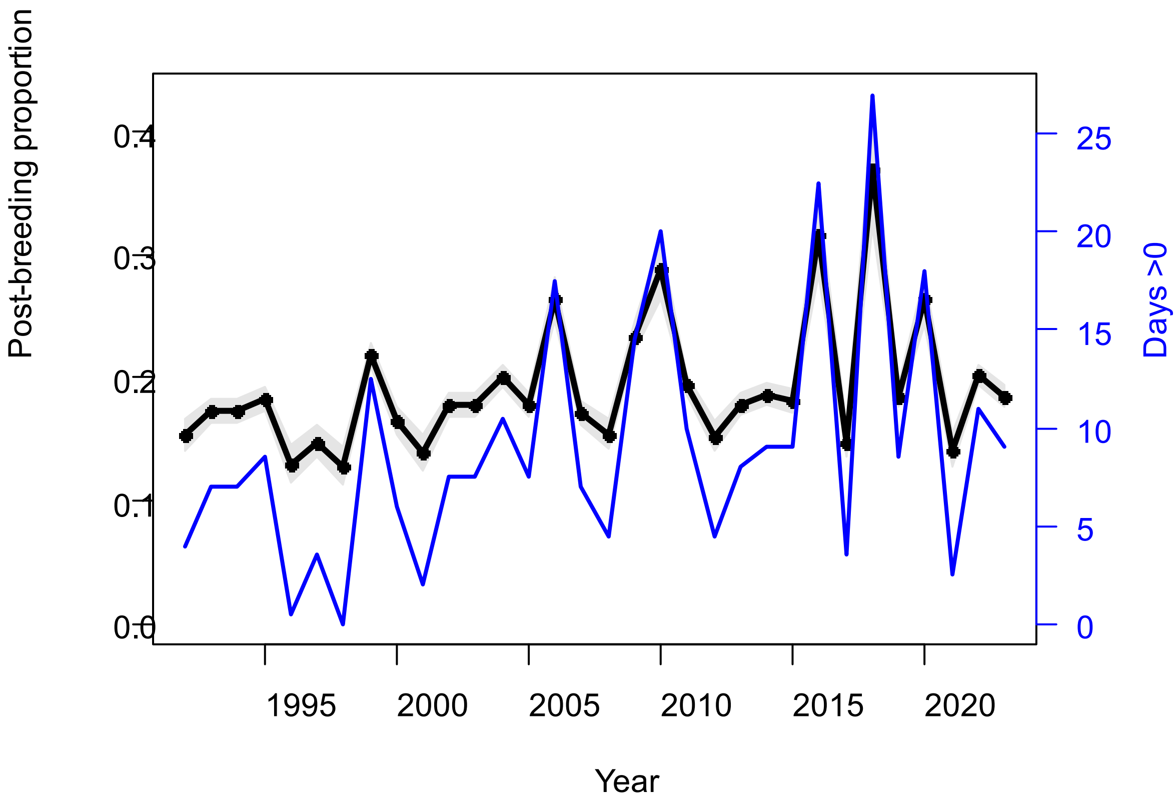



***Figure 3.1-6.*** IPM-based estimates of the post-breeding proportion of young for *Svalbard Pink-footed Geese* (95% credible intervals are indicated by shaded polygon). In blue are the number of days above freezing in May in Svalbard.

### 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 38,000 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. Moreover, for a population near its target of 60,000, small changes in population size or days above freezing in Svalbard can lead to changes in quotas that are well below those which can be regulated effectively. The management strategy in Figure 3.1.7 also depicts the evolution of May population size, days above freezing in May, and harvest quotas since implementation of AHM in 2013.

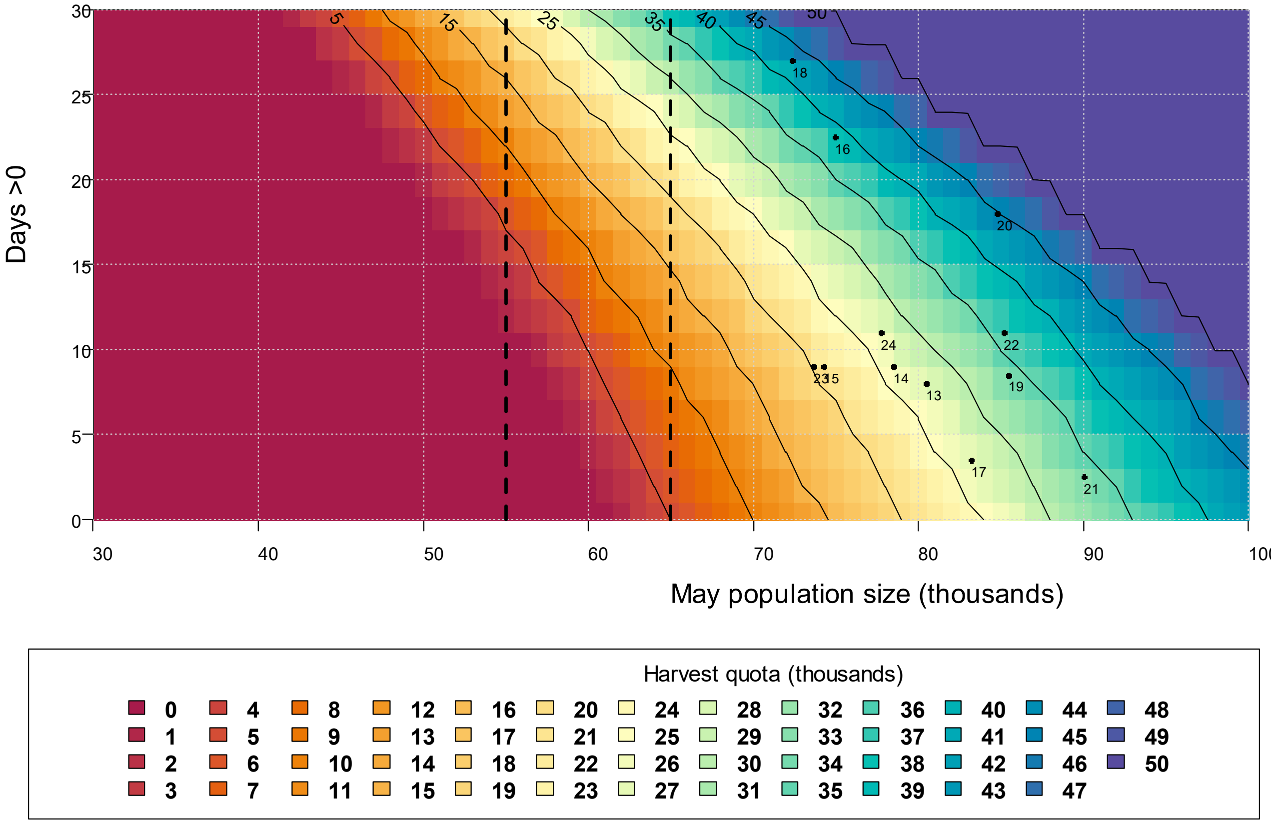



***Figure 3.1-7.*** Optimal harvest quotas for *Svalbard Pink-footed Geese* based on an IPM and an objective to maintain population size near 60,000. Days >0 represents the number of days above freezing in May in Svalbard. The black vertical dashed lines depict near-complete stakeholder satisfaction with population sizes. Also depicted are population sizes and days above freezing for the years in which AHM has been in place, with 13 = year 2013 and 24 = year 2024.

The estimated breeding population this year is 77,713 individuals. With 11 days above freezing in Svalbard in May, the predicted proportion of young in the fall is 21%, suggesting a post-breeding population size of 94,348 individuals. Accordingly, the optimal harvest quota for the 2024/2025 hunting season is 26,700, which if achieved, would result in a spring population near the target of 60,000 in 2025. For comparison, the realized harvest averaged 10,111 (sd = 734) during the last three years. If we use the quota of 26,700 and the agreed upon allocation of the quota (30% for Norway, 70% for Denmark), harvest quotas for Norway and Denmark this year are 8,010 and 18,690, respectively. During the last three years, the harvest in Norway and Denmark averaged 2,941 (sd = 783) and 7,136 (sd = 130), respectively. Thus, harvests will have to be increased considerably to achieve the population target of 60,000 in spring.

## 3.2 Taiga Bean Goose *Anser fabalis fabalis*

### 3.2.1 Range states and management units

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

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

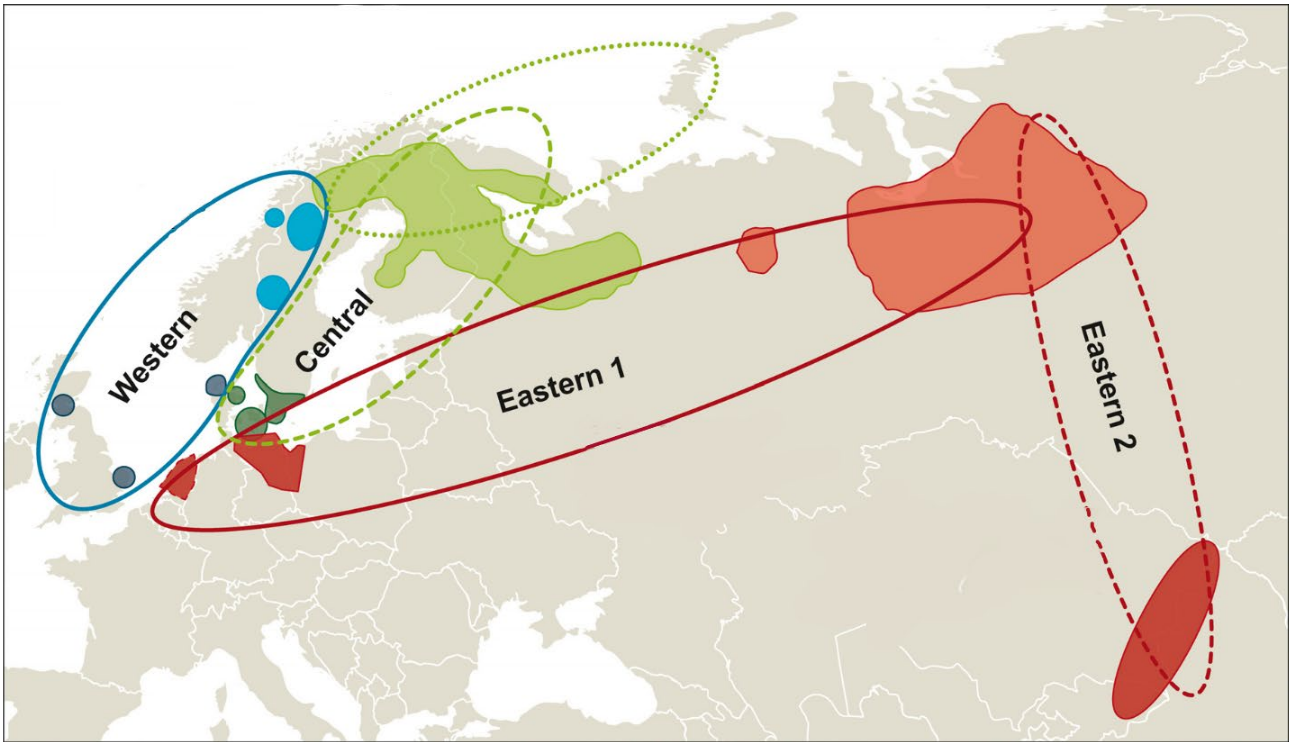



***Figure 3.2-1.*** The former Western, Central and Eastern1 Management Units (now *Scandinavia/Denmark and UK population*, *Finland and NW Russia/Sweden, Denmark and Germany population* and *West Siberia/Poland and Germany population*, respectively) of Taiga Bean Goose (green dotted line indicates linkages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

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

### 3.2.2 Population 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 *Scandinavia/Denmark and UK population*, 60,000 – 80,000 individuals in the *Finland and NW Russia/Sweden, Denmark and Germany population*, and 100,000 individuals total in the *West Siberia/Poland and Germany population* and the Eastern 2 MU, with stable or increasing trends in all (Marjakangas et al., 2015).

### 3.2.3 Management strategies

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

### 3.2.4 Assessment protocol

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

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

where $N^M$ is 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:

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

in which we assume seven months of natural mortality, all 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"). Raw data and the results of the 2024 update of the IPM are available from the EGMP Data Centre.

We bring to your attention two issues that have arisen since the last assessment in 2023. The most notable is evidence that the spring and autumn counts of Taiga Bean Geese are incomplete, i.e., detection rates are not 100% (Piironen et al. 2023) due to some geese being missed in the counts. A less than perfect detection rate is a common problem in wildlife censuses. We therefore used the comparison of the locations of counts and GPS-tagged individuals reported in Piironen et al. (2023) to correct for the observed bias by assuming a multinomial distribution in the statistical likelihoods of the spring and autumn counts, representing the probabilities that GPS-tagged birds were either not observed in the count, observed once, or observed twice (i.e., double-counted). When the multinomial sample sizes were combined with other data in the IPM, we estimated the detection probability during the spring count as 0.88 (sd = 0.05), and during the autumn count as 0.83 (0.06). We assumed these means and sampling variances were constant over time but allowed year-specific detection probabilities to be drawn from these distributions. Accounting for these biases have resulted in estimated population sizes from the IPM that are higher than those reported in past years.

While we in the Data Centre believe the evidence for bias in the counts cannot be ignored, there are some caveats to consider. First, we must assume that the locations of GPS-tagged individuals are representative of the spatial and temporal distribution of the population. Second, the reliability of the comparison between counts and GPS locations depends on simultaneous measurements, which was not assured, especially for the spring counts. Third, we pooled data for 2019 and 2020 due to small sample sizes and then assumed that the mean biases were constant over time, which may not be the case. Finally, the small sample sizes of GPS locations imply considerable sampling error, which is reflected in the wider credible intervals for population size. Going forward, we recommend, to the extent possible, that the precise location and time of counts be recorded so they can be more carefully aligned with the presence of GPS-tagged individuals. Maintaining enough GPS–tag individuals in the population (e.g., 30 – 50) is also important.

The second issue involves the autumn counts. October counts in Sweden in 2021 and 2022 appeared to be unusually low, given the much higher counts directly preceding and following this period. Therefore, last year we 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). Unfortunately, the November count in Sweden was dropped starting in 2022. It is interesting, however, that the low October count in Sweden in 2022 was accompanied by a relatively high count of Taiga Bean Geese in Finland, suggesting some birds had not yet migrated to Sweden. And this may be the reason that occasionally the November count in Sweden is higher than in October. In any case, we do not have a complete record of Finnish counts to examine this possibility further (to date, Finnish counts have not been used in the IPM). Finally, it appears that the proportion of total bean geese that are identified as taigas may have declined in recent years in Sweden. All of this is to say that there may be changes in the spatial and temporal distribution of Taiga Bean Geese in the autumn that merit further investigation. For purposes of this year's assessment, we have not made any associated changes in the IPM. Fortunately, the IPM can "smooth" over these sorts of problems if they occur only occasionally in the data record. Systematic changes over a sustained period, however, can produce spurious inference.

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). By agreement of the range states, the total harvest is to be allocated among Russia (15%), Finland (49%), Sweden (26%), and Denmark (10%) based on the historic distribution of the harvest. 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%, 30%, and 12% for Finland, Sweden, and Denmark, respectively.

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

a) *Abundance*

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

In Denmark, dedicated Bean Goose counts were carried out in the Pandrup Area on 9 January and Thy on 11-12 January, a few days before the general IWC count. These are the two main areas known to be used by this population of Taiga Bean Goose, and the count resulted in a total of 1,014 geese located at seven sites in Thy; none were recorded in Pandrup. The total was higher than in 2023, but much lower than in 2022. No Tundra Bean Geese were recorded during the counts.

In Scotland, the wintering population is relatively small, yet the behaviour of flocks utilising several different roosting and feeding areas during any given day makes it difficult to count the birds in the Slamannan Plateau landscape. This past winter, the highest visual count of 160 individuals was recorded on 11 November 2023 (Figure 3.2-2). On 1 December, 178 birds were recorded at one feeding site by use of thermal imaging, this flock may have included a small number of Pink-footed Geese, however.

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

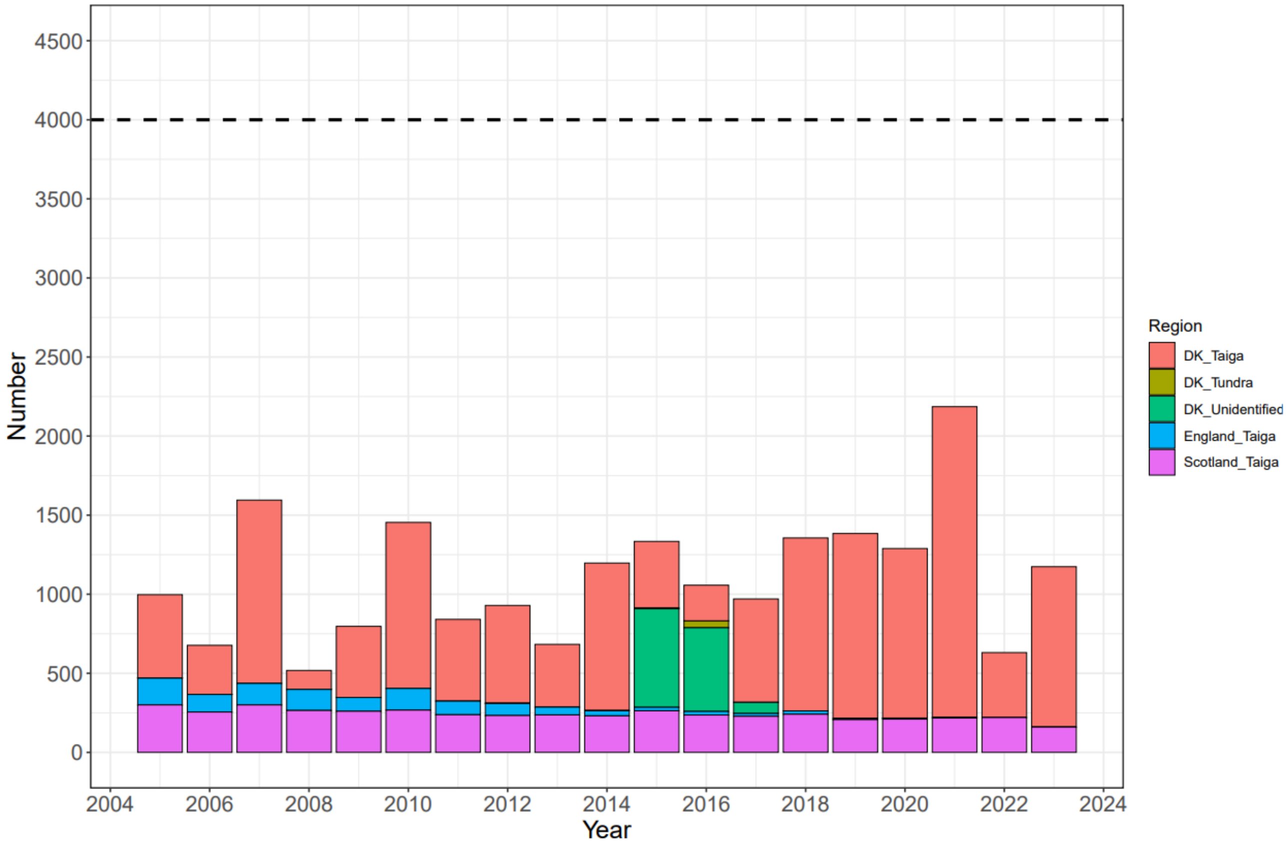



***Figure 3.2-2.*** Population size of the *Scandinavia/Denmark and UK population* of Taiga Bean Goose during winter since 2005/2006 in the UK and since 2015/2016 in Denmark. The number of Tundra Bean Geese and unidentified Bean Geese are included for Denmark. Data is missing from England in winters 2022/2023 and 2023/2024. The dashed black line represents the target for the wintering population.

*b)* <u>*Mortality*</u>

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

*c)* <u>*Reproduction*</u>

An age count was carried out in Scotland on 11 October 2023, shortly after the birds first arrived. Within a flock of 90 birds, 14 juveniles were recorded, including one brood of three juveniles and one brood of two, resulting in a juvenile percentage of 15.5% for the winter 2023/2024 (Figure 3.2-3).

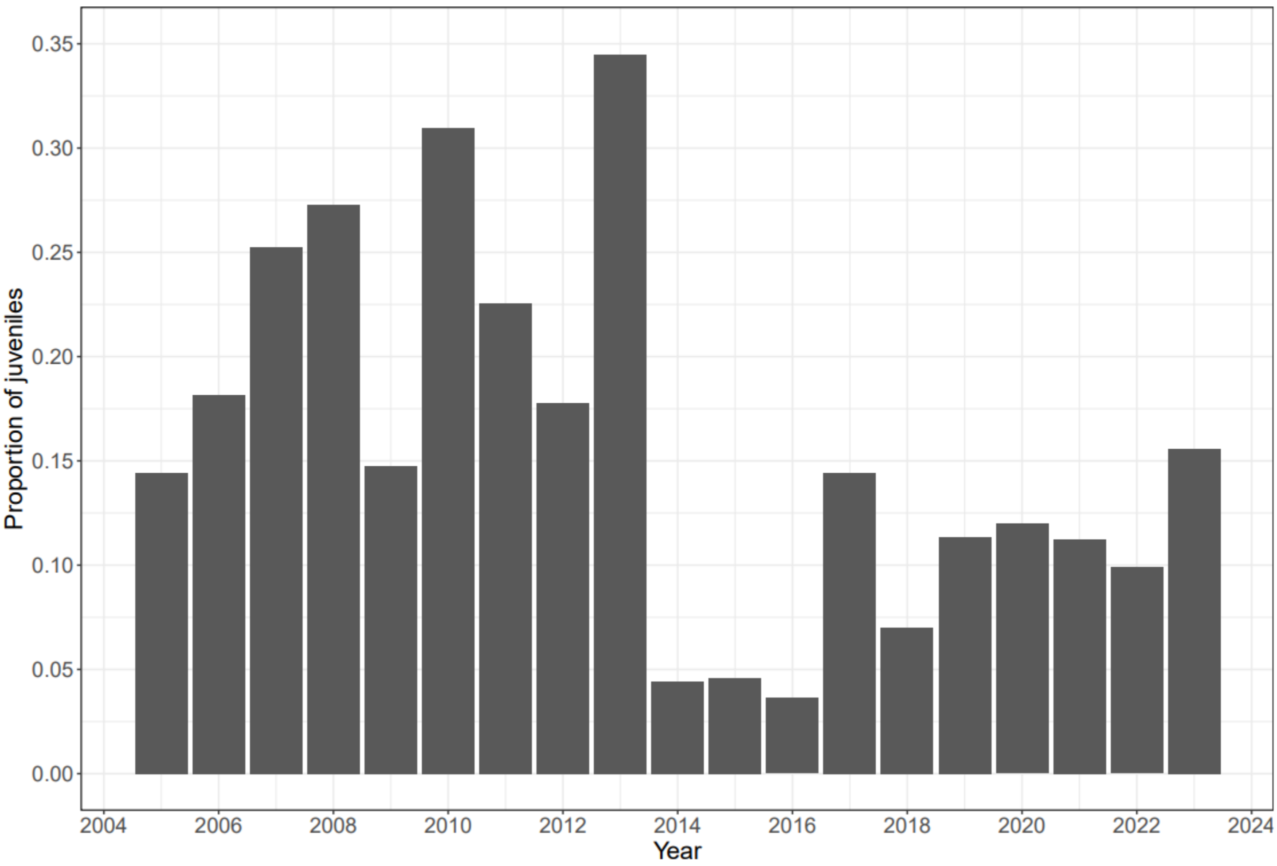



***Figure 3.2-3.*** Annual proportion of juveniles in the *Scandinavia/Denmark and UK population* of Taiga Bean Goose since 2005.

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

Updated information on the status of the *West Siberia/Poland and Germany population* continues to be limited, beyond what was reported in the EGMP Population Status and Assessment Report 2021. However, it is encouraging to report that research on the Russian breeding population(s) is still ongoing, and that Taiga Bean Goose is now officially included in the Red Data Books of Yamalo-Nenets Autonomous Okrug (2023) and Krasnoyarsk Krai (2022) (Sonia Rozenfeld pers. comm.). In the Red data book from Krasnoyarsk Krai, the population is estimated at 17,000-20,000 individuals.

The Taiga Bean Geese are now protected in large parts of their Russian breeding range, and further results from tracking and modelling efforts are expected to be published later this year (Sonia Rozenfeld pers. comm.).

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

*a) <u>Abundance and trends</u>*

Bias-corrected, posterior estimates of population size at three times of the year are depicted in Figure 3.2-4. In March 2024, the population estimate was 75,363 (66,829 – 84,837), which is essentially the same as the March 2023 estimate of 74,356 (65,929 – 83,704). Once incomplete detection probabilities are accounted for, there is an 88% probability that the March 2024 population is above the median goal of 70,000. Seasonal estimates of population size were combined into a single time series in Figure 3.2-5. Recall that the biological year runs from approximately 1 March in calendar year *t* to 30 April in calendar year *t*+1. Thus, we expect the lowest population in March following hunting and natural mortality in the previous winter, the highest population in October after reproduction occurs, and an intermediate population size in January following the hunting season. Interestingly, the rate of change in abundance from March to October appears to have decreased as the spring population has grown (Figure 3.2-6), reflecting the increasing effect of density dependence (although additional causes cannot be discounted). Finally, we note that January counts of Taiga Bean Geese do not include data from Germany because they are not routinely made available. Nonetheless, the IPM implies that an average of 19,807 (sd = 8,737) geese may be wintering in Germany, a figure largely in agreement with the occasional values reported from Germany (Thomas Heinicke, pers. comm.).

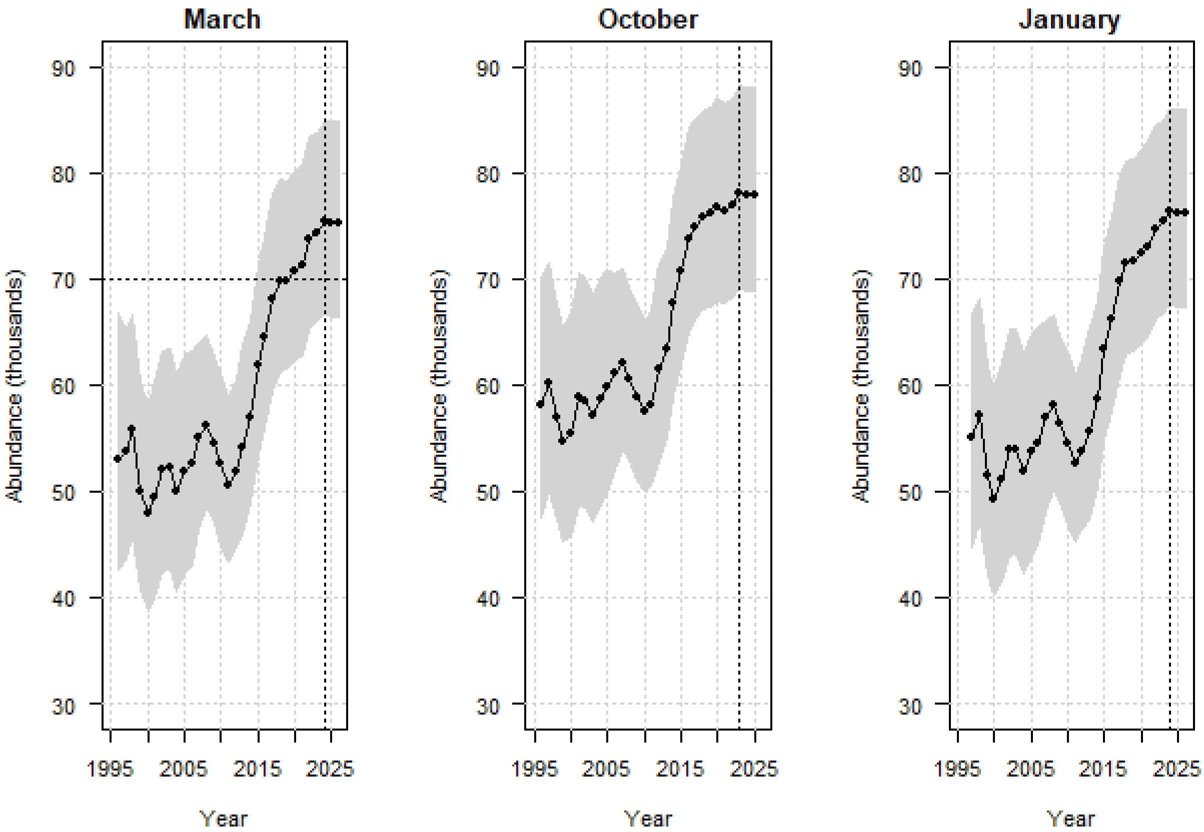



***Figure 3.2-4.*** Posterior estimates of population size (in black, with 95% credible intervals in grey) based on an IPM for Taiga Bean Geese in the *Finland and NW Russia/Sweden, Denmark and Germany population*. The vertical, dashed lines represent the last (biological) year of data. Future abundances 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.

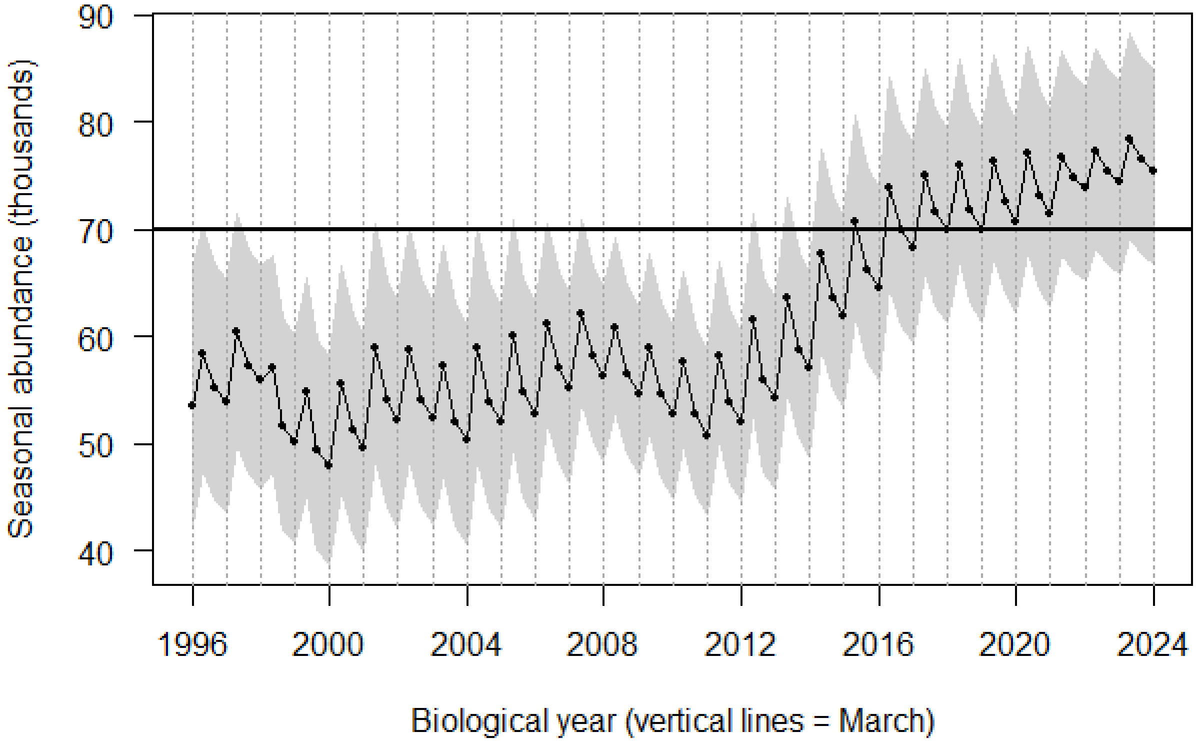



***Figure 3.2-5.*** Posterior estimates of seasonal (March, October, January) population size (in black, with 95% credible intervals in grey) based on an IPM for Taiga Bean Geese in the *Finland and NW Russia/Sweden, Denmark and Germany population*. The vertical dashed lines represent March of each year. The horizontal line at 70,000 represents the median population target.

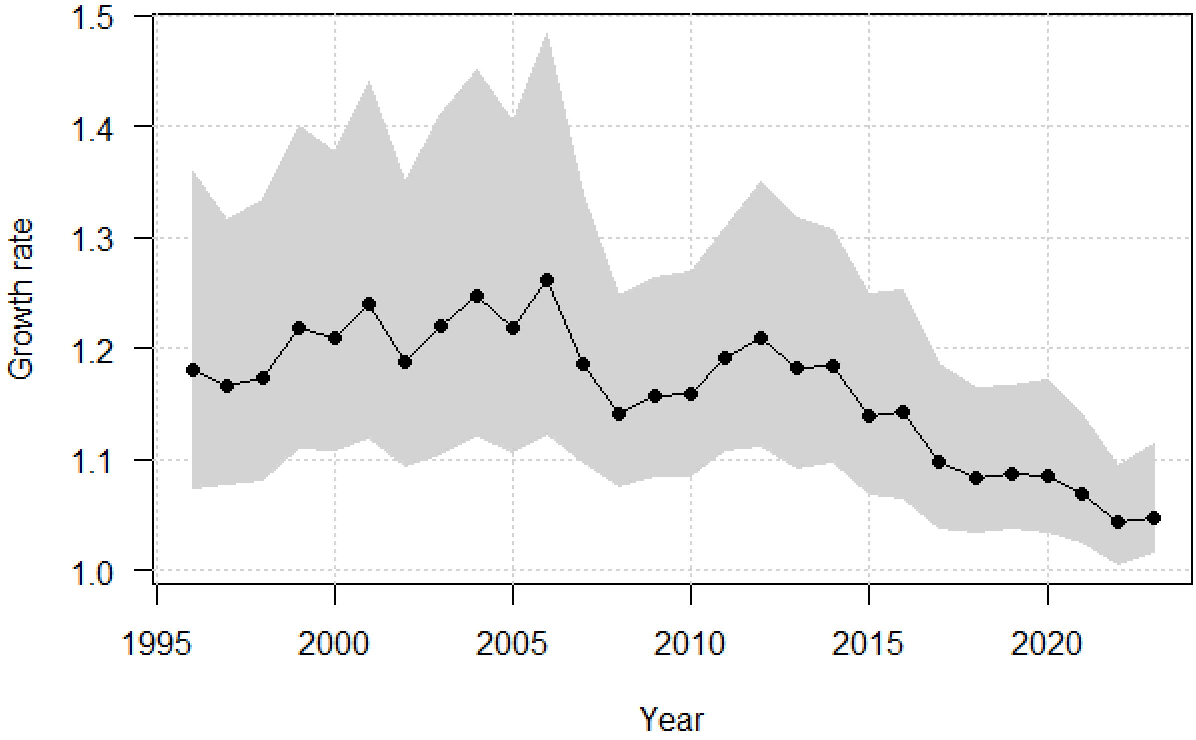



***Figure 3.2-6.*** Posterior estimates of the population growth rate between March and October (in black, with 95% credible intervals in grey) based on an IPM for Taiga Bean Geese in the *Finland and NW Russia/Sweden, Denmark and Germany population*.

b) <u>*Mortality and trends*</u>

Posterior estimates of country-specific harvests of the *Finland and NW Russia/Sweden, Denmark and Germany population* are provided in Figure 3.2-7. Due to hunting restrictions in all three range states, the total harvest has only averaged 453 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 3.2-8. Harvest rates declined dramatically following the Finnish harvest moratorium in 2014, and this decrease in harvest rate coincides with strong growth in the population. Estimates of apparent survival increased markedly and have averaged 91% (sd = 1%) 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.

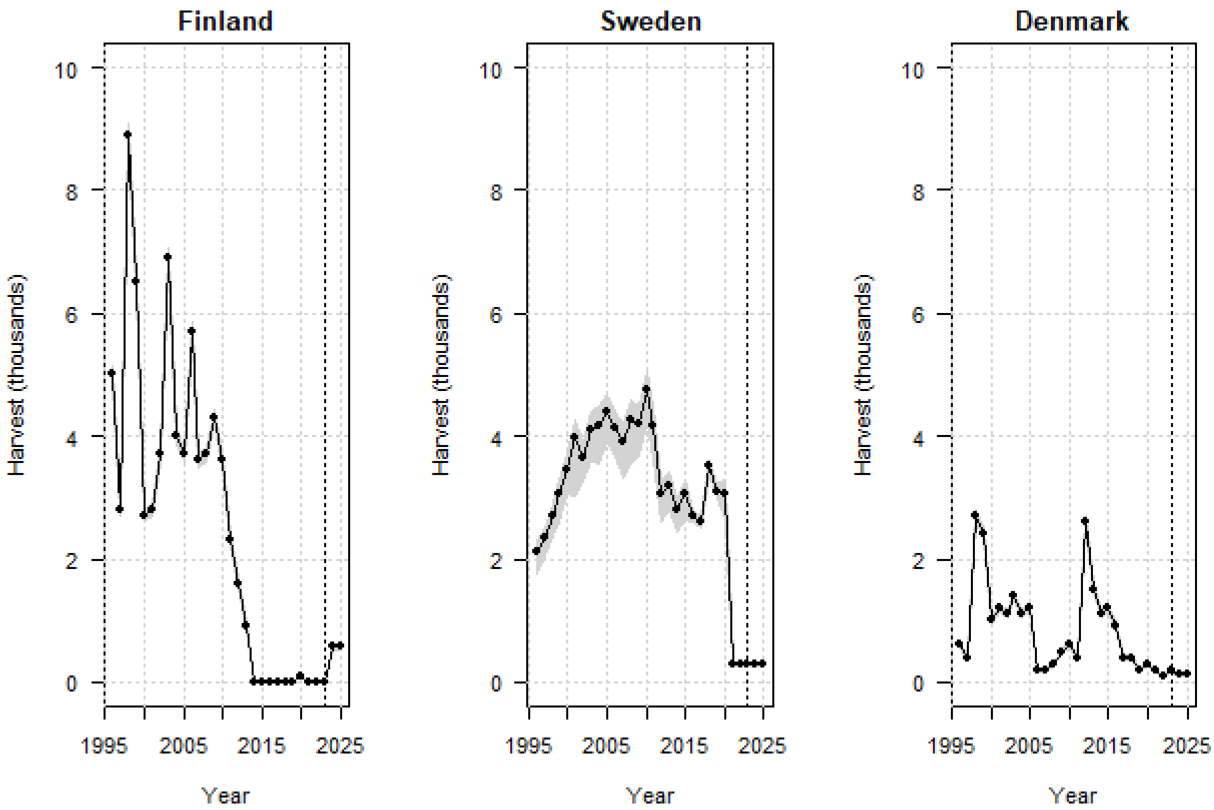



***Figure 3.2-7***. Estimated harvests (in thousands, with 95% credible intervals in grey) based on an IPM for Taiga Bean Geese in the *Finland and NW Russia/Sweden, Denmark and Germany population*. The vertical, dashed lines indicate the last year of data. Future harvests were projected based on an assumed harvest of approximately 1,000 birds, with country-specific allocations as agreed upon.

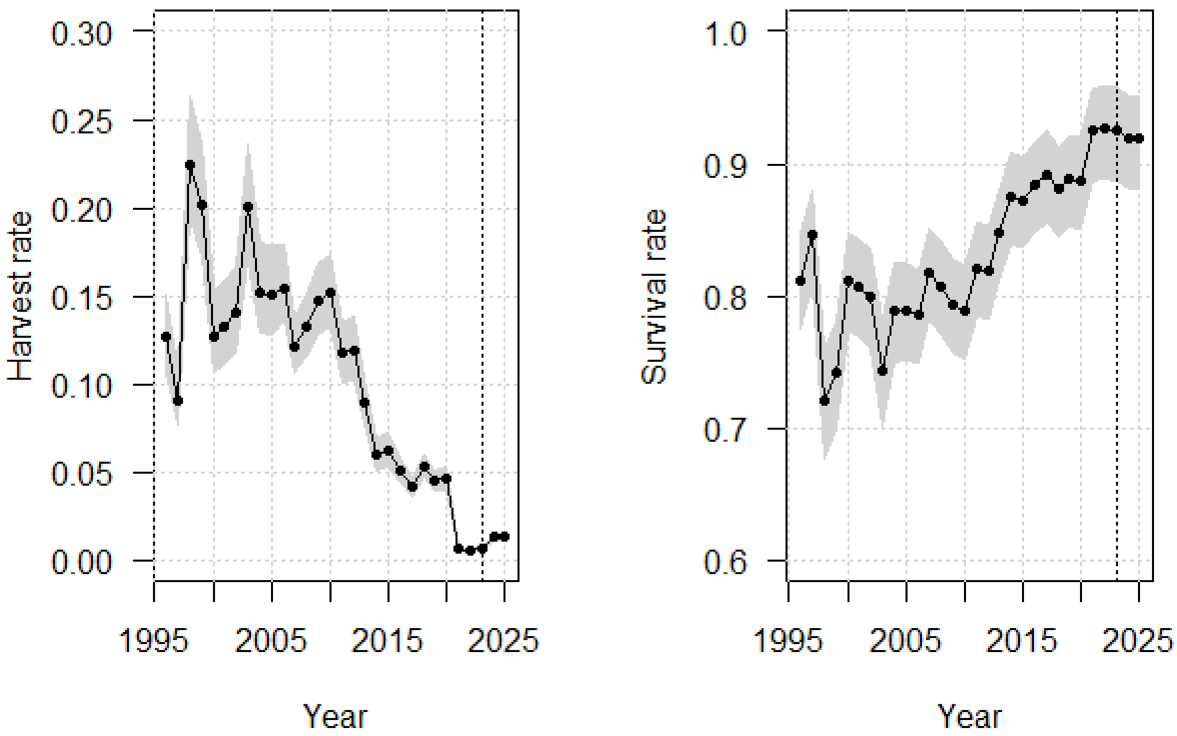



***Figure 3.2-8***. Posterior estimates of harvest and apparent survival rate based on an IPM for Taiga Bean Geese in the *Finland and NW Russia/Sweden, Denmark and Germany population*, with 95% credible intervals in grey. The vertical, dashed lines represent the last year of data. Future rates were projected based on an 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 0.32 (*sd* = 0.03) (or approximately 24% young absent any density-dependent effects). It should be mentioned that posterior estimates are similar to their informative prior mean, albeit more precise.

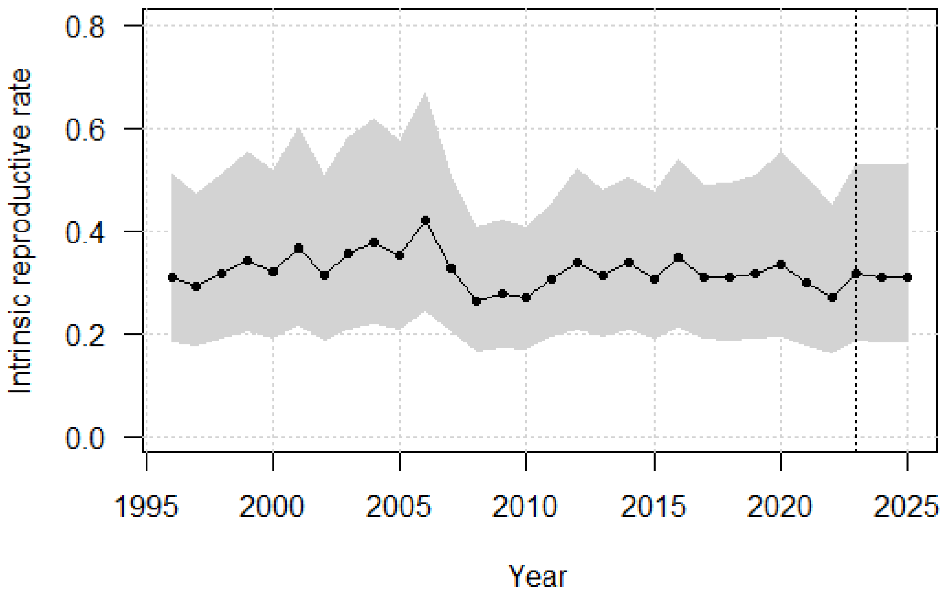



***Figure 3.2-7.*** Posterior estimates of the intrinsic reproductive rate (in black, with 95% credible intervals in grey) based on an IPM for Taiga Bean Geese in the *Finland and NW Russia/Sweden, Denmark and Germany population*. The vertical, dashed lines represent the last year of data. Future reproductive rates were projected based on the posterior distribution of the long-term mean.

### 3.2.8 Management guidance

Previous assessments without any correction for imperfect counts suggested that the Finland and NW Russia/Sweden, Denmark and Germany population had not quite reached the median conservation goal of 70,000. However, the bias-corrected estimate of population size in March 2024 is 75,363 (66,829 – 84,837), and there is an 88% probability that it is greater than the median conservation goal. The implications for harvest management have changed accordingly. Due to existing hunting restrictions in Finland, Sweden, and Denmark, we projected population size two years into the future based on a relatively low level of harvest – approximately 1,000 total birds. In this case, we would expect March abundance to remain largely unchanged. If the population were at its median conservation goal of 70,000, the harvestable surplus would be 5,200 birds.

## 3.3 Greylag Goose *Anser anser*

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

### 3.3.1 Range states and management units

The range states for the *NW/SW European population of Greylag Goose* include Norway (NO), Sweden (SE), Finland (FI), Denmark (DK), Germany (DE), The Netherlands (NL), Belgium (BE), France (FR), and Spain (ES). Geese belonging to this population also occur regularly in Poland, Czech Republic and Portugal, but these countries are not included as principal Range States as numbers recorded here constitute less than 1% of the total population. Based on the recognition of regional differences in migratory behaviour and the human-wildlife conflicts related to this population, it has been agreed to define two MUs (Nagy *et al*. 2021).

MU1 includes the breeding populations in NO, SE, FI, and DK that subsequently stage and winter also 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, including also a small FR population of c. 8,000 individuals. Although the DE population is generally regarded as sedentary, breeding birds in the eastern part of the country are known to show migratory behaviour (Bairlein et al. 2014) (Figure 3.3-1).

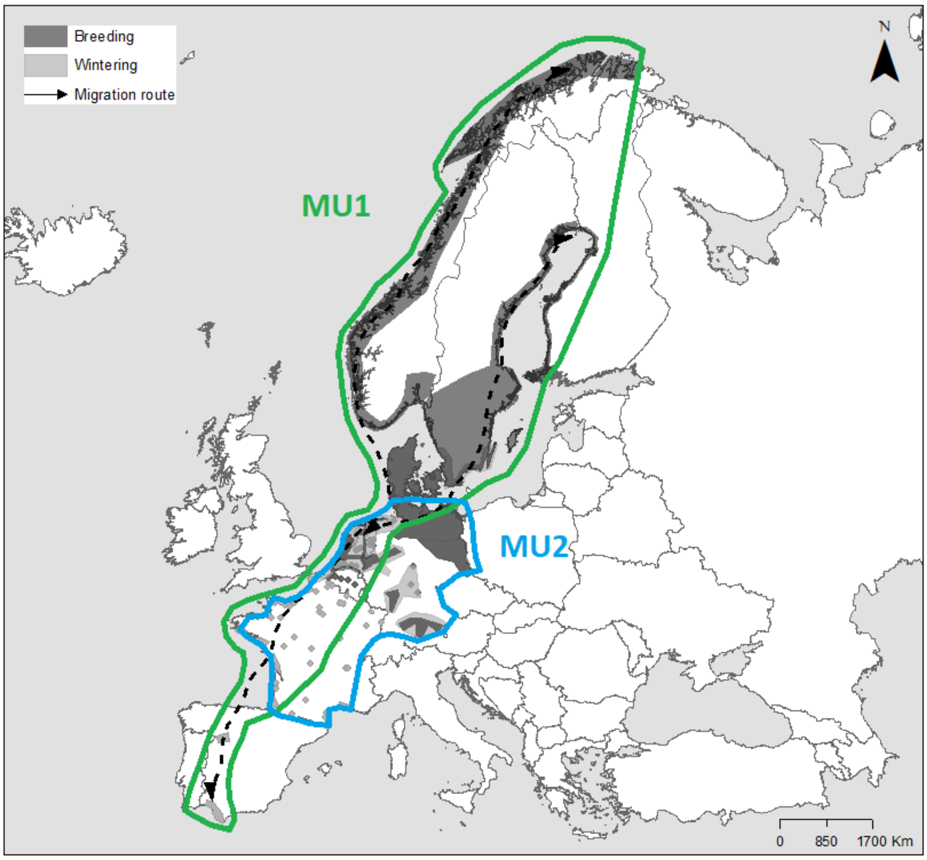



***Figure 3.3-1.*** Annual distribution and main migration routes for the NW/SW European population of Greylag Goose including breeding (medium grey) and wintering (light grey) areas, as well as areas, which are both used during the breeding and wintering period (dark grey) as presented in the ISSMP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

### 3.3.2 Population FRPs and targets

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

### 3.3.3 Management strategies

In the face of deep uncertainty related to estimates of population size and offtake at the flyway level, an information-gap ("info-gap") decision model was developed 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 recreational hunting 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 component consists of two wintering areas (North and South) (Figure 3.3-2). There is a broad overlap in the wintering distributions of the two breeding units. The southern unit is largely comprised of MU1 birds and is of special 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.

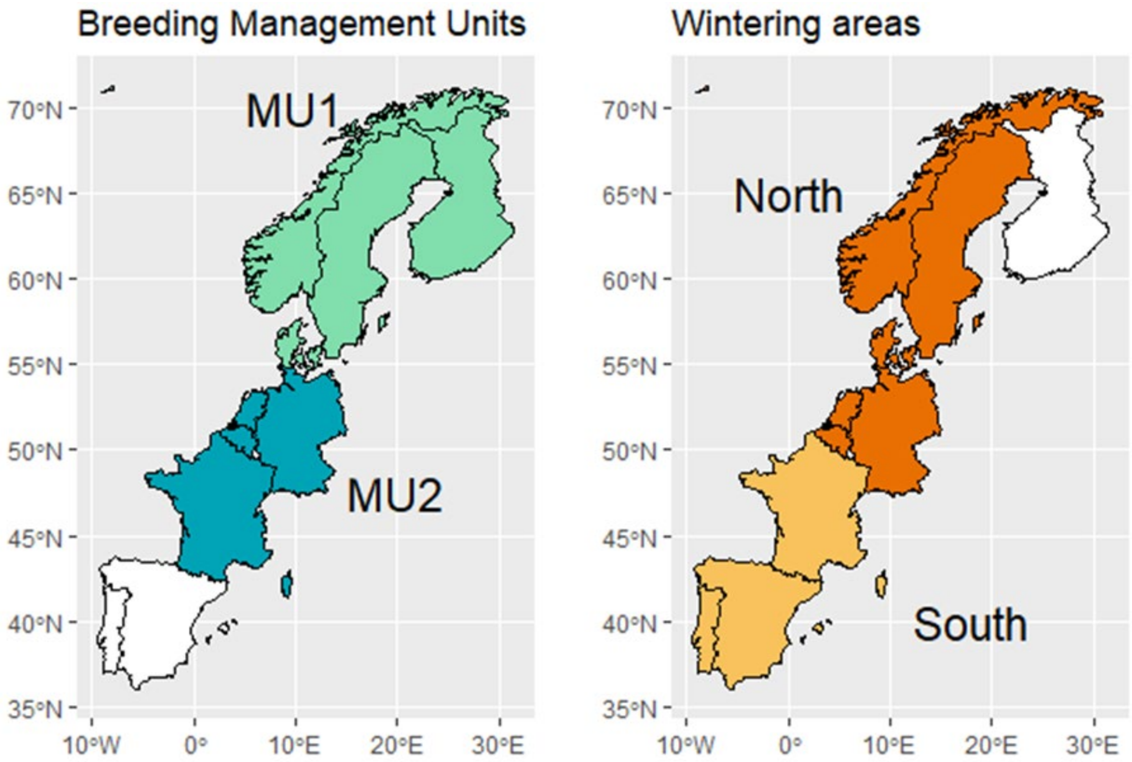



***Figure 3.3-2.*** Breeding management units and wintering areas for the NW/SW European population of Greylag Goose.

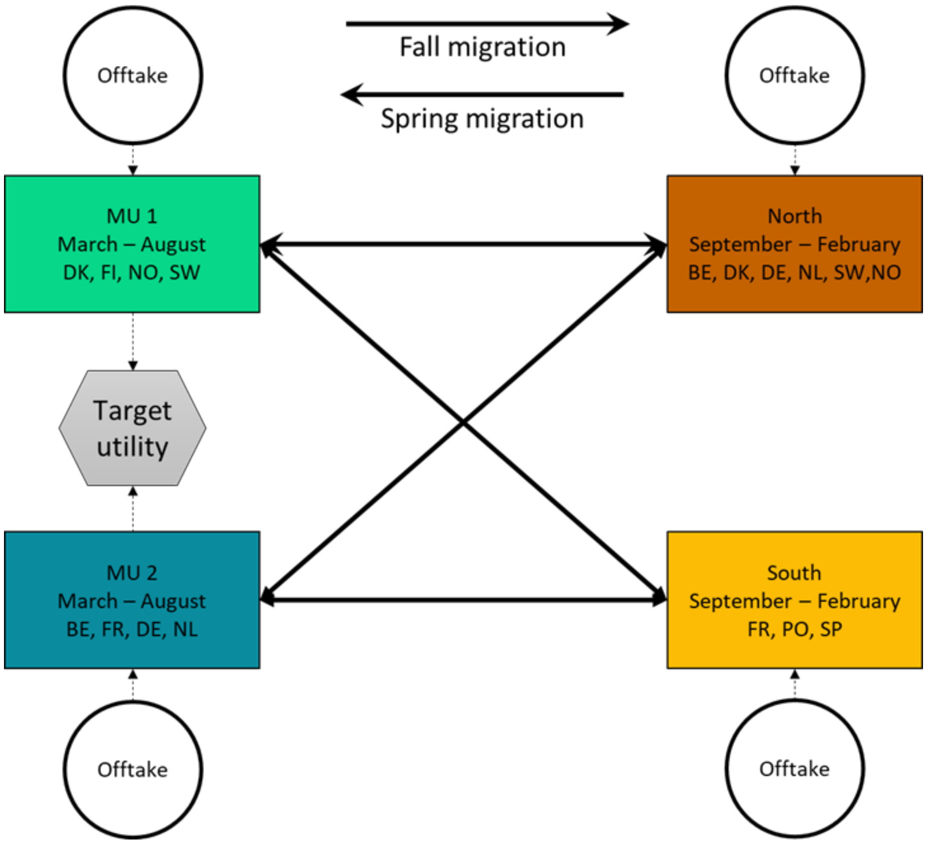



***Figure 3.3-3.*** Diagrammatic representation of the model for the annual cycle of the NW/SW European population of Greylag Goose.

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

*b) Utility function*

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

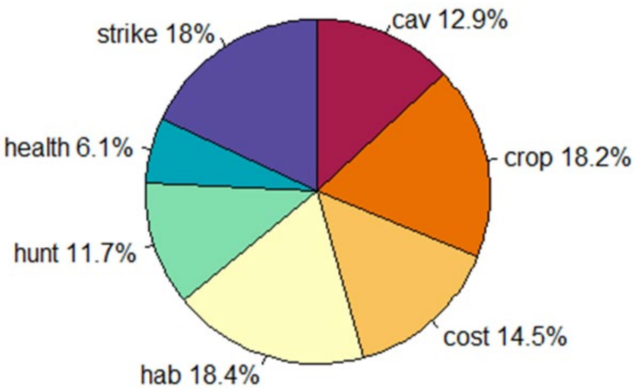



***Figure 3.3-4.*** Relative importance of seven objectives for managing the offtake of the NW/SW European population of Greylag Geese. Management objectives are to maximize cultural and aesthetic values (cav), minimize agricultural damage (crop), minimize management costs to governments (cost), minimize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

### 3.3.5 Population status

*a) Abundance*

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

Winter abundance is achieved through the International Waterbird Census (IWC) as well as values from special goose count schemes in Denmark and the Netherlands. The IWC imputed value for population size was 823,693 individuals in January 2023 (Figure 3.3-6). As mentioned in Heldbjerg et al. (2021), estimates from Spain include a high degree of imputing due to data gaps during 2010-2013, which may have resulted in an overestimation of the actual population size by some 200,000 birds during those years. The IWC imputed value for the population excluding estimates for Spain produced a total of 800,325 for 2023 (Figure 3.3-6).

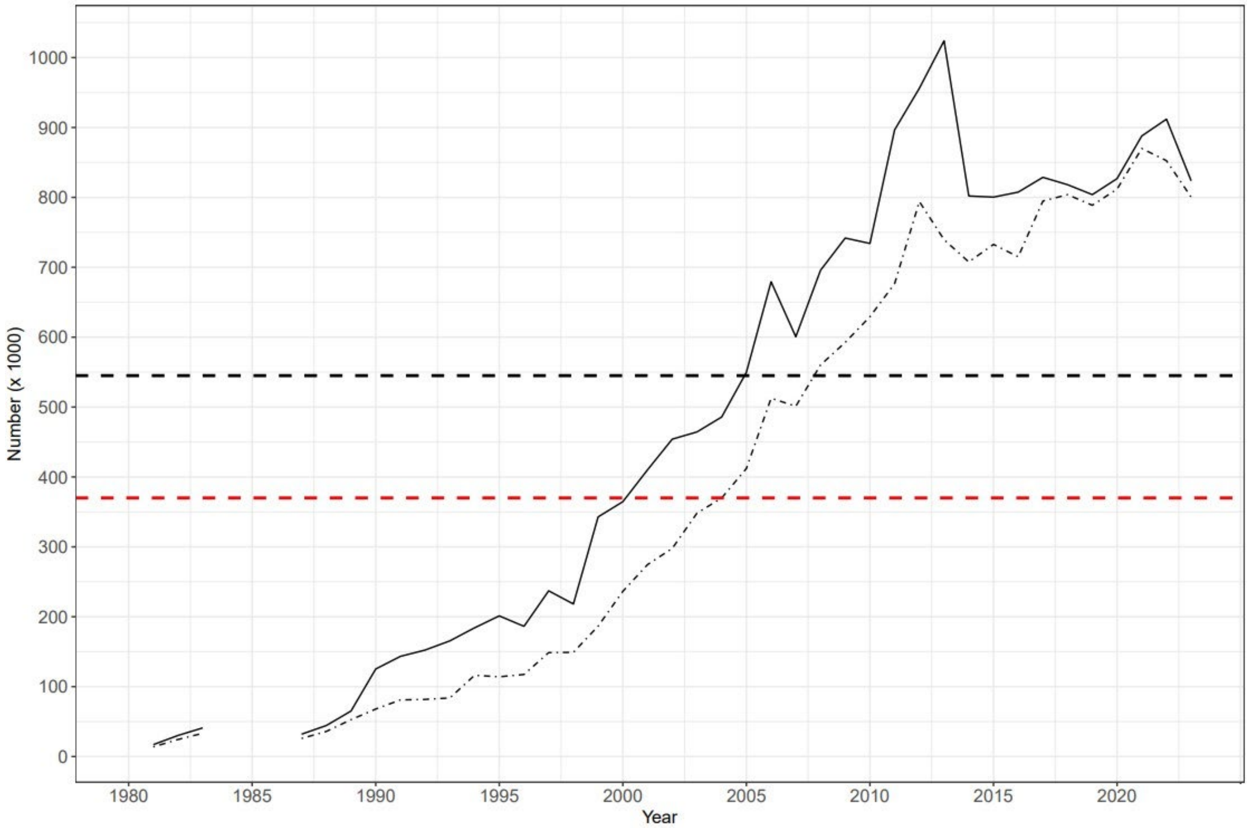



***Figure 3.3-6.*** Development of the size (number of individuals) of the NW/SW European mid-winter population of Greylag Goose based on IWC imputed values from 1980-2023, with (solid line) and without (dot-dashed line) estimates from Spain. The dashed black line represents the target for the wintering population, and the red dashed line represents the wintering FRP.

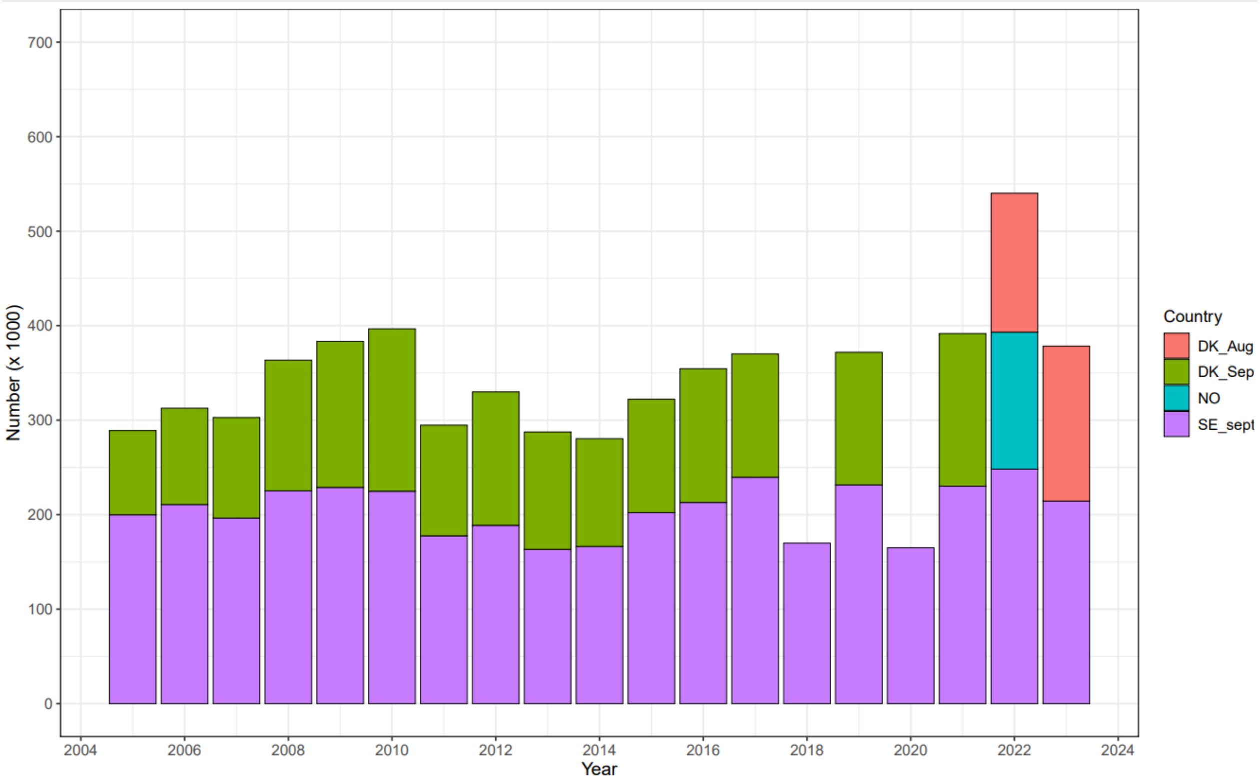
Post-breeding abundance is achieved through a range of long running and recently established national initiatives. For MU1, annual post-breeding counts have been carried out in DK and SE during September for decades (Nielsen *et al*. 2023, Haas *et al.* 2022). In 2022, Denmark organized an August count to provide a better estimate for the national population size (Jensen *et al.* 2023), after which the national September count was moved to August and will be carried out every second year from 2023. Birds from FI have also been counted annually during 2021-2023, but as these birds are assumed to be included in the Swedish September count, they are currently not added to the annual total for MU1. In NO, counts were carried out at selected sites in August 2022, and a model-based estimate for the population size was subsequently produced including also previous counts at selected sites, data from the Norwegian breeding bird monitoring scheme, and national hunting bag statistics (see Doc. AEWA/EGMIWG/9.10). For MU2, counts are carried out and available from parts of DE (Nordrhein-Westfalen, Niedersachsen and Schleswig-Holstein), NL and BE (Niedersächsische Sommer-Gänsezählung 2022, Koffijberg & Kowallik 2022, Wolff et al. 2023). Numbers from FR and ES are currently regarded as non-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 540,115 individuals in 2022 for MU1, with counts in DK and SE producing similar results in 2023 (but no updated estimate from NO). In 2023, 637,332 birds were reported for MU2 (no data available from FR, and from DE data are only available from Nordrhein-Westfalen, i.e., only one of 16 Bundesländer) (Figure 3.3-7).

We have investigated how the number of breeding pairs in the spring might be calculated from post-breeding censuses for the two management units of the NW/SW European Population of Greylag Goose. We stress that our methods only give a rough approximation for the number of breeding pairs because empirical data are insufficient to do otherwise. In particular, the age structure of the population in the censuses is unknown, and there are no empirical estimates of breeding propensity nor summer survival of breeding birds. Nonetheless, we can use the general structure and initial parameterization of a post-breeding matrix model for Greylag Geese to perform the calculations. We note that the original matrix model has three age classes, but four post-breeding age classes (0.5, 1.5, 2.5, 3.5+ years) are required to correctly account for breeding only at age 3+ years. We explicitly accounted for uncertainty about model parameters to the extent possible. However, we stress that we cannot verify our estimates of the number of breeding pairs and, thus, we urge caution in their use. Details of the estimation process are available from the EGMP Data Centre (fred.johnson@ecos.au.dk).

The most recent year of complete data is 2022. For MU1, for a post-breeding population of 540,115 (Sweden, Finland, Denmark, and Norway) the estimated number of breeding pairs is 132,146 (113,348 – 150,862). Around the middle of the last decade, the number of breeding pairs (all countries) in MU 1 was believed to be about 84,000 (S. Nagy, personal communication). The target for Management Unit 1 is 70,000 breeding pairs.

For MU2, we used a 2022 post-breeding population of 768,956 (Netherlands, Belgium and Nordrhein-Westfalen, Niedersachsen, and Schleswig-Holstein, Germany) and a spring population in France of 6,158. Be aware that this is an underestimate of the total population size in MU2 as data are only available from three German federal states. The estimate of the number of breeding pairs is 182,758 (145,291 – 203,469). Around the middle of the last decade, the number of breeding pairs (all countries) in MU 2 was believed to be about 139,400 (S. Nagy, personal communication). The target for Management Unit 2 is 80,000 breeding pairs.



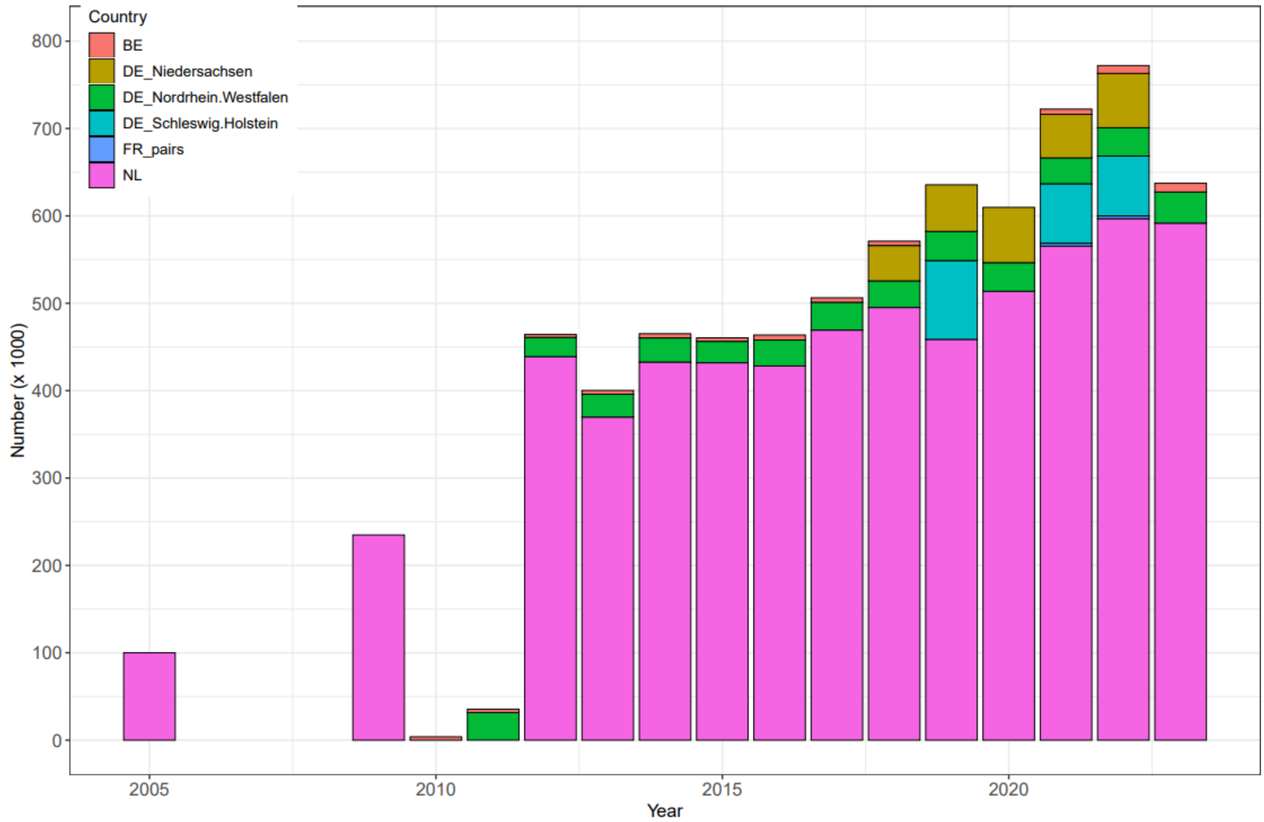



***Figure 3.3-7.*** Development of the size (number of individuals) of the NW/SW European summer population of Greylag Goose at the MU level.

Top) MU1 consists of data from DK 2005-2021 from September and in 2022-2023 from August, as well as from SE 2005-2022. Data from NO is included for 2022 only. The SE count in 2020 was incomplete due to Covid. Since 2017, Greylag Geese are counted biannually in DK (except for 2022).

Bottom) MU2 consists of data from BE 2010-2018, 2021-2023, NL 2005, 2009, 2012-2023, Nordrhein-Westfalen, DE 2011-2023, Niedersachsen, DE 2018-2022, Schleswig-Holstein, DE 2019, 2021-2022, and FR 2021/2022.

*b)* *<u>Survival and mortality</u>*

I) Offtake at population level

The hunting bag estimates are available from all range states and sum to 179,274 for the 2022/2023 season. Data from ES are only available from Andalusia, which however represents the majority of the hunting bag. Derogation data from 2022 are available from all range states where derogations have taken place, except DE, and indicates that 267,638 geese were killed under derogation. Thus, data suggest a minimum offtake of around 447,000 Greylag Geese in 2022 (Figure 3.3-8).

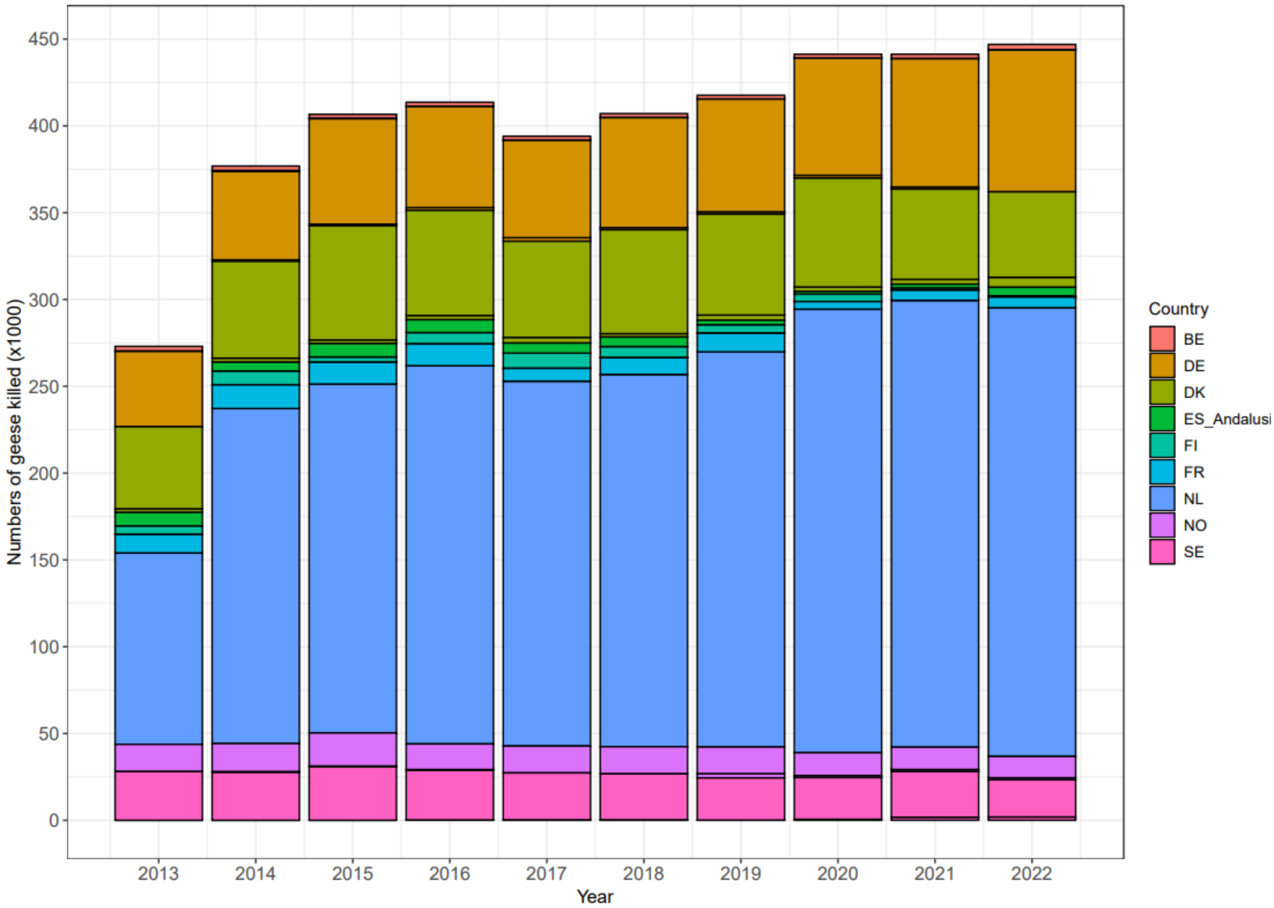



***Figure 3.3-8.*** Total number of Greylag Goose killed under derogation (per calendar year 2013-2022) and hunting (per season from 2013/2014-2022/2023). Derogation data from DE for 2022 are missing, as well as hunting bag data outside Andalusia, ES. Derogation numbers from Norway are estimates, based on information from county governors and municipalities.

II) Survival

A study using capture-mark-recapture data was 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

No updates based on monitoring of crippling rates.

As previously reported, data was collected in the Netherlands and Sweden in 2021, with a crippling rate of moulting Greylag Geese of 0.22 in both countries (based on, respectively, 26 and 31 X-rayed individuals). This rate is 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 have been carried out in three Range States, and information is now available from two regions in NO; Vesterålen (2020-2022) and Vestfold county in the Oslofjord-area (2020-2023), and a range of sites in Finland (2021-2023) and Sweden (2022-2023). In Vesterålen, the percentage of juveniles was assessed to be 4.1% in 2020, 22.1% in 2021, and 23.4% in 2022. In Vestfold county in the Oslofjord-area, juvenile percentages were assessed to be 36.5%, 28.1%, 32.3%. and 27.5% in 2020, 2021, 2022 and 2023, respectively (data from Tombre et al. 2020, 2021, 2023). In Finland the percentage of juveniles was 11.6% in 2022 and 19.4% in 2023. In Sweden, juvenile percentage was 5% in September 2022 (Haas et al. 2022), and 7,5% in August 2023.

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, 2023). After an initial peak in NL in the late 1990s, the proportion of juveniles has since declined and has stabilized at around 17% during the last 10 years in both DE and NL (Figure 3.3-9).

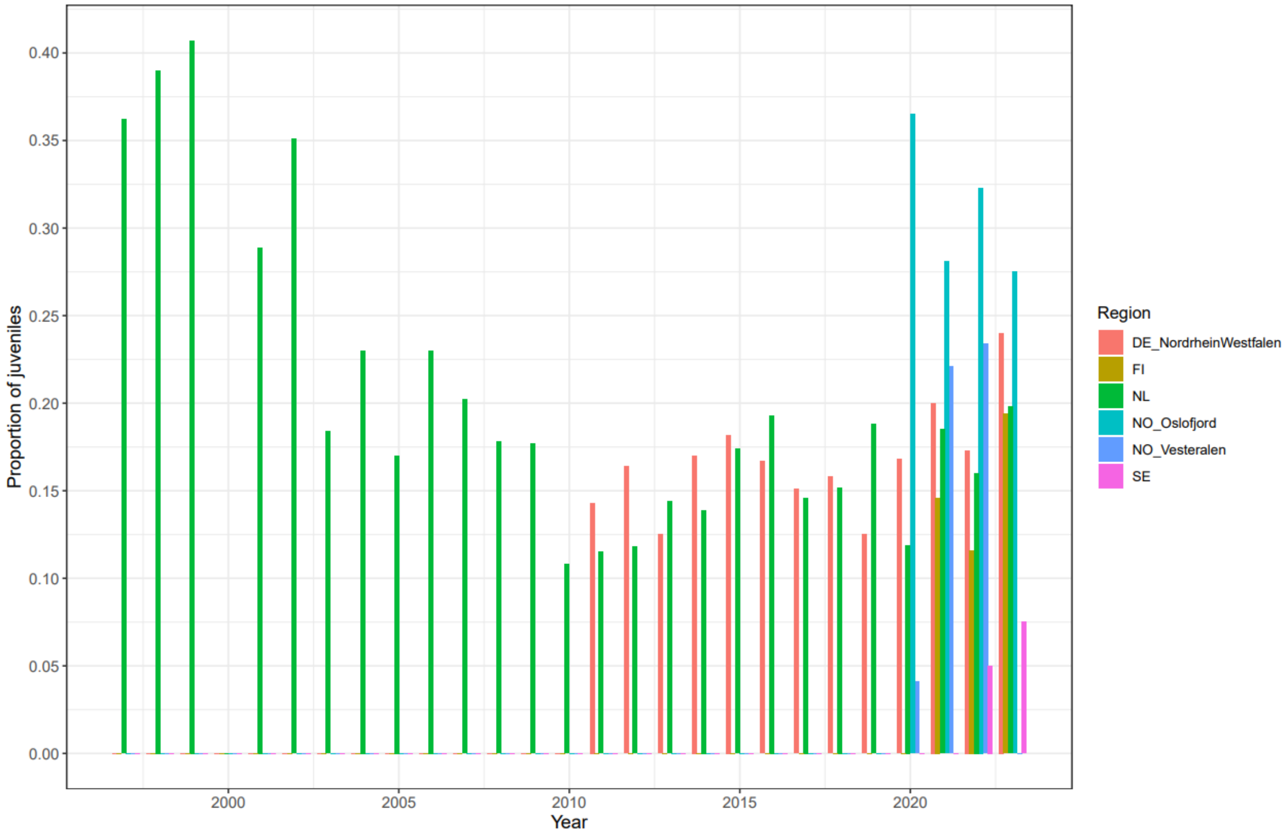



***Figure 3.3-9.*** Proportion of juveniles in the NW/SW European population of Greylag Goose at country level; Vesterålen, NO from 2020-2022, Oslofjord-area, NO from 2020-2023, FI from 2022-2023, NL from 1997-2023, North-Rhine Westphalia, DE from 2011-2023, and SE from 2022-2023.

### 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 a high probability of meeting both MU targets by the time the ISSMP is due for revision in 2030.

Simulations of the preliminary model 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 trade-offs and limitations associated with efforts to coordinate offtake can be better understood by the EGM IWG.

The 50 offtake strategies with high probability of meeting the MU targets are of two basic types: (a) those with relatively high spring/summer derogation and low winter offtake, and (b) those with low spring/summer derogation and relatively high winter offtake (Figure 3.3-10, Table 3.3-1). In June 2023, the IWG recommended that offtake be concentrated during the wintering period to the extent possible.

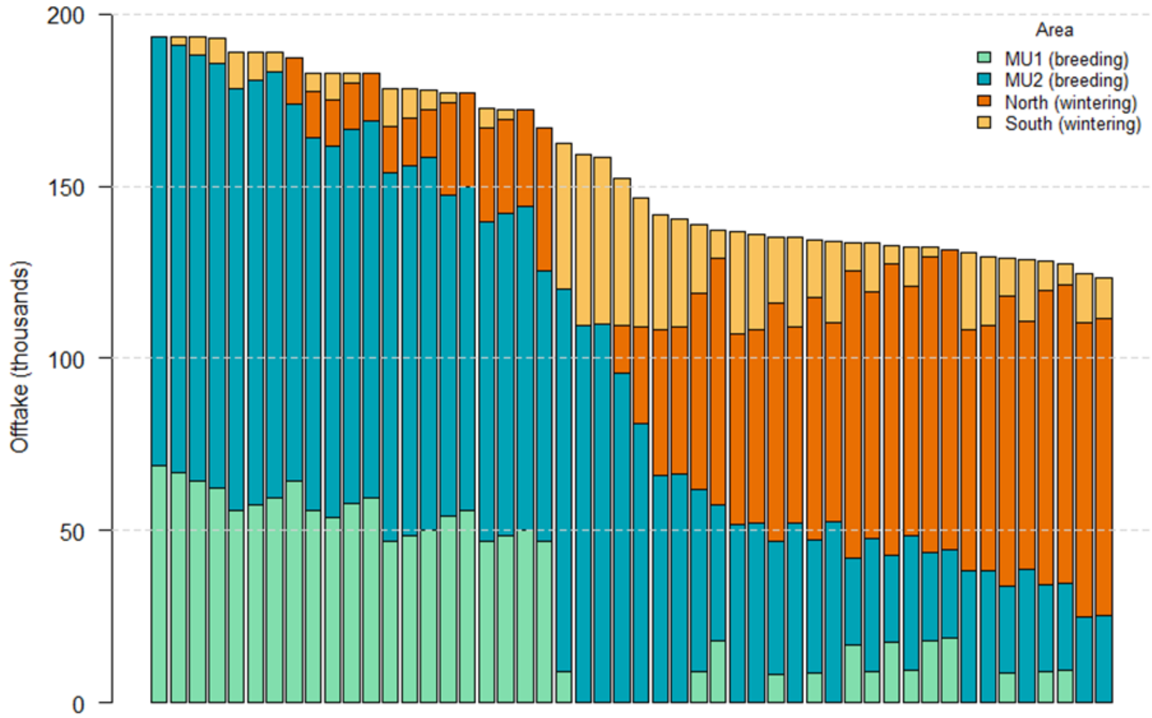



***Figure 3.3-10.*** Fifty alternative offtake strategies for Greylag Geese with high probability of meeting the MU targets by 2030, ordered by decreasing level of total offtake. Values of offtake are the means over the timeframe.

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

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

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

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

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

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

This chapter provides an intermediate assessment of the status of the *Russia/Netherlands and Germany population of Barnacle Goose*, covering 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). In 2022, it was extended to the Baltic and North Sea breeding populations 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 available monitoring data. This should be seen as an intermediate assessment. Results of a review made by the EGMP Data Centre and NINA (F. Johnson, K. Layton-Matthews) in autumn 2022 and included in the intermediate assessment for 2023 have been followed-up in 2024. The aim of this chapter is to assess the cumulative impact of derogation (and hunting, where legally allowed) on the status of the flyway population and the respective Management Unit-populations and provide a guidance for (future) management.

### 3.4.1 Range states and management units

The range states for the *Russia/Netherlands and Germany population of Barnacle Goose* include Russia, Finland, Estonia, Sweden, Norway, Denmark, 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 covered by the AFMP, as their populations have not been recognized as naturally occurring by the respective governments. Still, the birds from these small populations (altogether < 5,000 individuals and less than 1% of the flyway population) mix with the other birds in winter (without being separated), so they are included in the monitoring setup and in the IPM. 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, usually supporting about 75% of the flyway population present in January.

### 3.4.2 Population FRPs 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 flyway population size in 2000, when AEWA came into force (Nagy et al. 2021). Being an Annex 1 species of the EU Birds Directive, the AFMP does not define a target level for the population. Management is carried out by each single EU country under the conditions for derogation, lined out in Art. 9 of the EU Bird Directive. Birds in Norway (not an EU country) have a similar protective status according to Annex II of the Bern Convention. Hunting (harvest) is only carried out outside the EU-countries, mainly on the breeding grounds in Russia.

### 3.4.3 Management strategies

The AFMP aims to prevent the population or any of its MUs from declining below the specified FRPs (Nagy et al. 2021). Hence, the FRPs represent the lower limits of the legally acceptable population sizes, but as such do not reflect 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 Russia/Netherlands and Germany population of Barnacle Goose (see doc. AEWA/EGMIWG/7.14 from EGM IWG7 in 2022) and this coordination was in place in 2023.

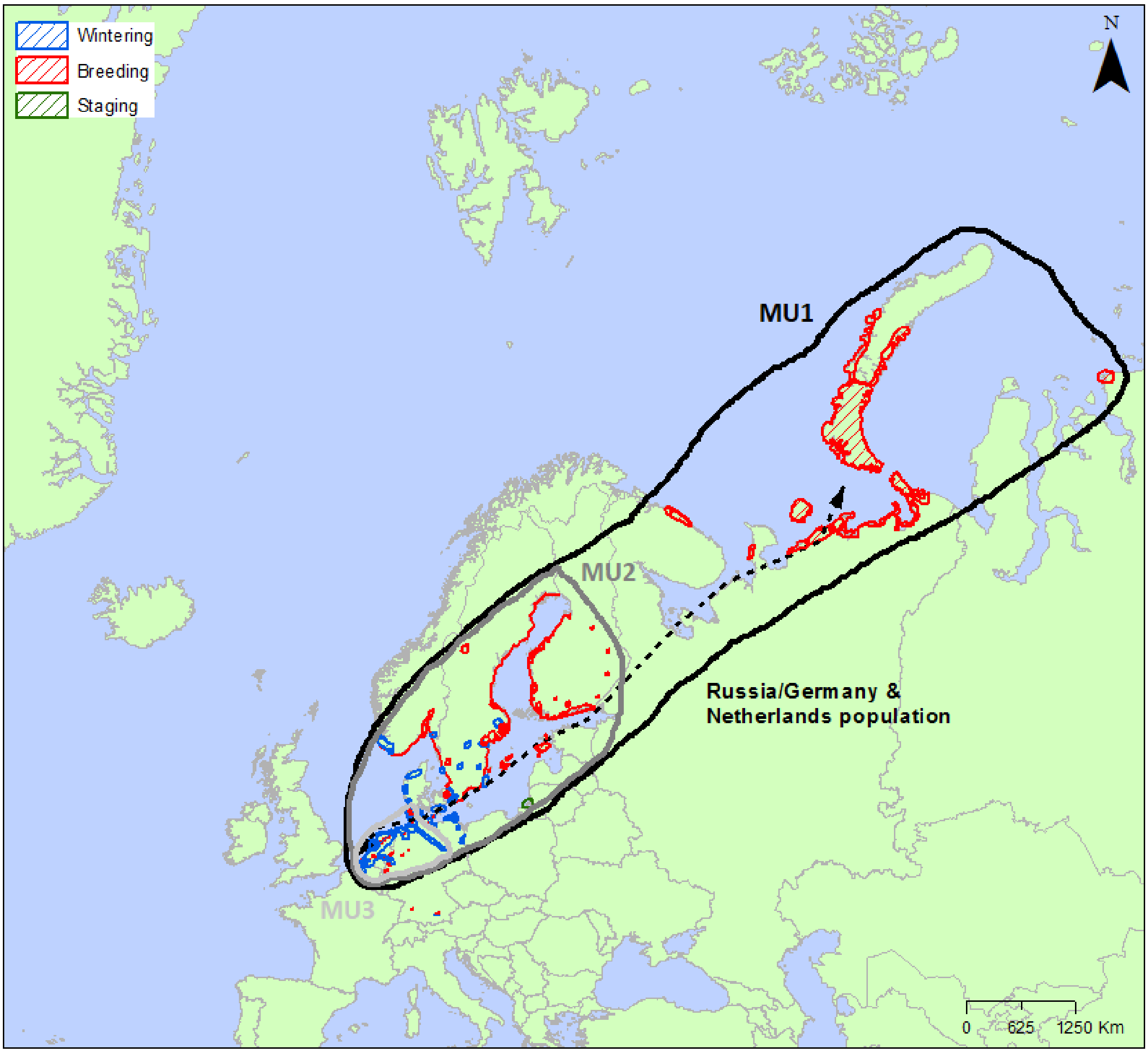



***Figure 3.4-1***. Management units of the Russia/Germany & Netherlands population of Barnacle Goose.

### 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, both for summer and winter situations (see Appendix A.4 for coverage in each country and the EGMP Database for overview of data used). The way the IPM framework accounts for the impact of offtake in the respective management units is shown in Figure 3.4-2. Monitoring data on abundance and productivity have been included up to January 2023 (winter flyway size) and summer 2022 (numbers per Management Unit). For derogation data the last year data was used was 2022. 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 https://gitlab.com/aewa-egmp for a full overview of input and output data). This was the case for Germany in January 2023 (data not published yet) and for Sweden in January 2021 and 2022 (due too very low coverage).

Because prior to 2005 summer counts are completely missing, results of the assessment shown in this chapter refer solely to the period 2005-2023. An overview of the longer time series is included in the EGMP Database and the status report 2021 (Heldbjerg et al. 2021). New compared to previous reports is the use of September counts as a proxy for the Swedish summer population. This count is carried out mid-September, before migratory birds from MU1 have arrived (F. Haas, pers. communication). Moreover, exchange with the Finnish summer population is considered low, as the Finnish count is done only two weeks earlier than the Swedish count. Nevertheless, this is an issue which needs to be investigated and confirmed by transmitter or ringing data (see below). A complete count in summer is still considered not feasible to cover all relevant parts of Sweden, so using September instead is regarded the second-best option here. In earlier assessments, the Swedish data were largely interpolated from few (old) available data points in the summer period.

Following a review by the EGMP in autumn 2022, the IPM was adapted in several ways. A reanalysis was performed of within-year variation in juvenile counts, and different approaches in defining the associated priors were tested. An approach for evaluating the goodness of fit, based on post-predictive checks, has been implemented as well, following the approach taken in the Pink-footed Goose IPM (Johnson et al. 2022). Several slightly different model versions were compared on their goodness of fit.

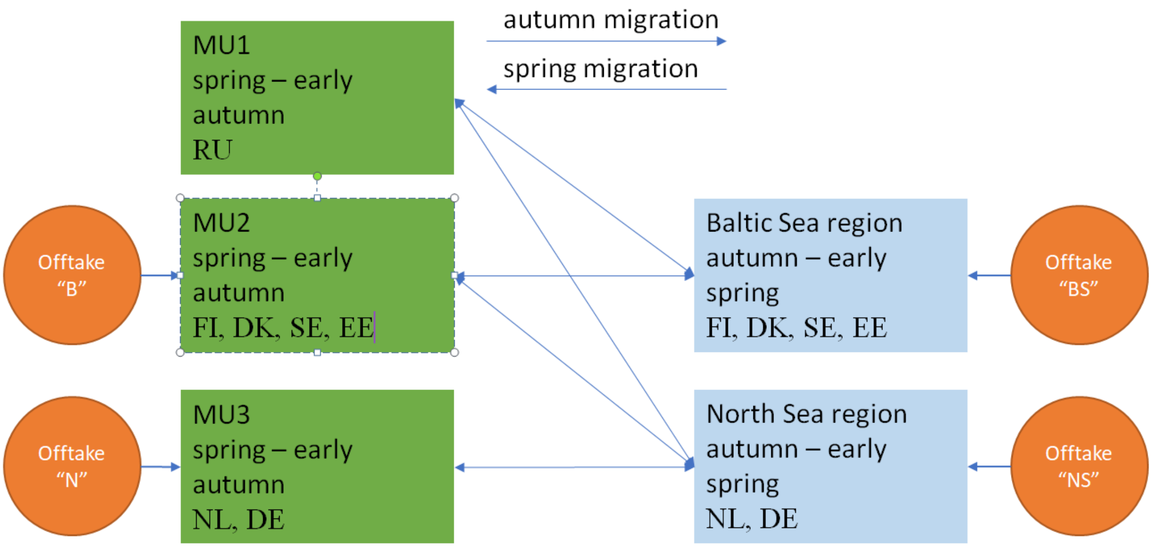



***Figure 3.4-2.*** Overview of the offtake in the different regions experienced by the birds belonging to the different MUs. Local breeding populations (green boxes) in the Baltic Sea and the North Sea areas experience offtake around the breeding period ("B" and "N" respectively). Outside this period (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 field counts correspond well (Figure 3.4-3). They show that the flyway population size has remained at a level of about 1.4 million individuals in January 2023. This is 3.8 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 has shown signs of a stabilization in the past four winters. Compared to the previous season, there even seems to be a slight decline, but note that 95% credibility intervals are large. More detailed monthly census data from The Netherlands point out that from September 2022 to May 2023 monthly numbers were on average about 20% lower compared to the previous three seasons (data Sovon Vogelonderzoek Nederland, Hornman et al. in prep.) and the January 2023 count was the lowest since 2010.

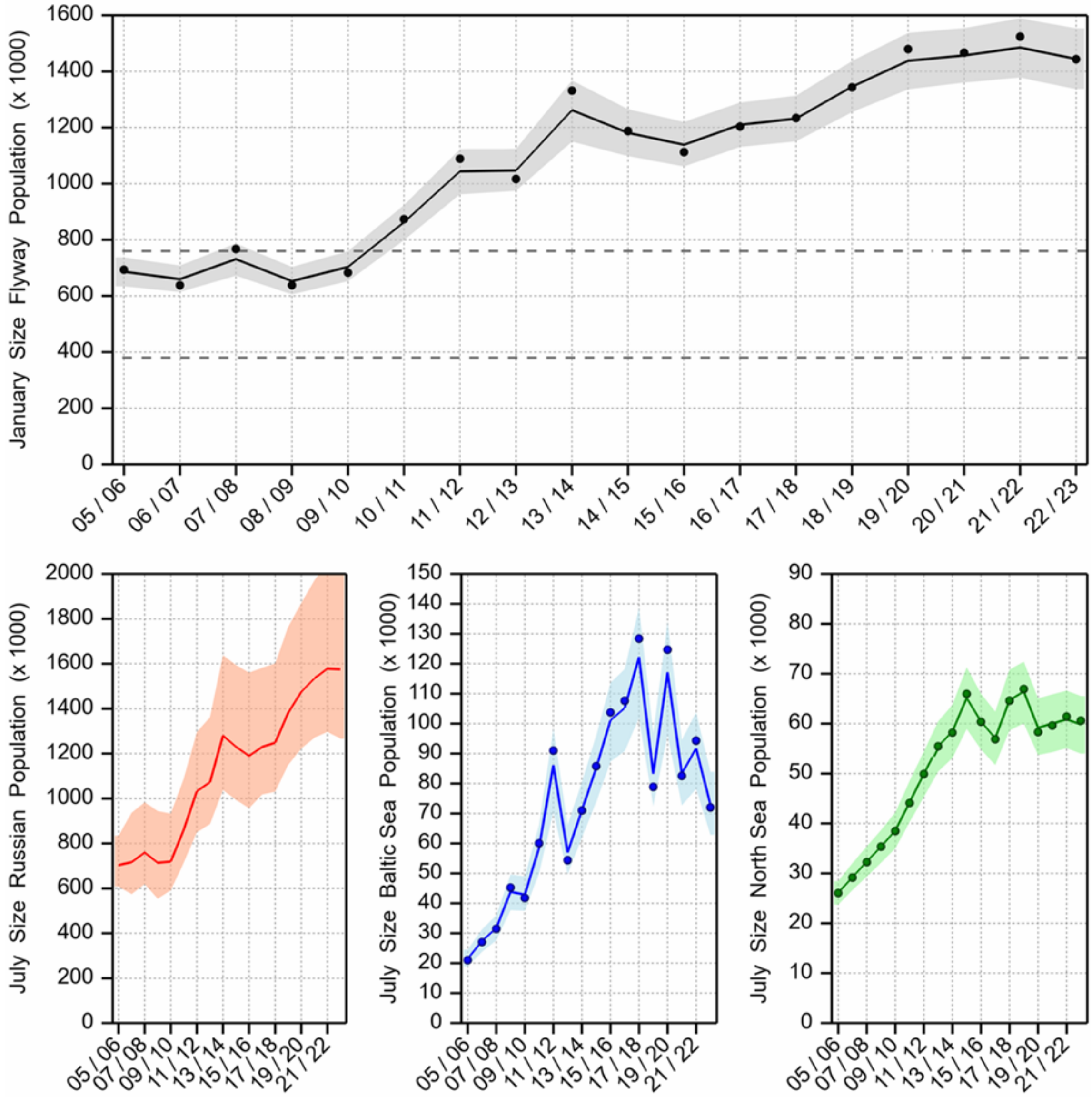



***Figure 3.4-3***. Top panel: January total flyway population counts (dots), posterior means based on the IPM (solid line), 95% credible intervals (shaded area) and FRP as well as the 200% of the FRP (dashed line). Bottom panels: July population sizes of the three MU-populations along with posterior means and 95% credible 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 (and come with large 95% credibility intervals).

Based on the posterior abundance estimates in July, the Russian population is by far the largest of all MUs, comprised of approx. 1.6 million individuals (rounded), 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 mortality (by offtake) occurring between July and January). The Russian MU1-population seems to have increased over the past years but has remained stable in the two last years. To the contrary, the Baltic MU2-population, which include new Swedish data (see above), has declined in the past four years, to about 70,000 individuals in July 2022. While the population in Finland has slightly declined in 2021-2022 (census data suggest a 15% decrease between 2021-2022 and the preceding five years), the Swedish post-summer counts show large fluctuations which eventually may point at some issues with coverage. Hence, results from Figure 3.4-3 should be treated with some caution for MU2. The North Sea MU3 population has not continued to increase since 2014 and did not change compared to the previous three years.

Converted into breeding pairs, the size of the Russian breeding population in MU1 (posterior estimated mean 573,000 breeding pairs in 2023) 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 well above the FRP as well (24,500 breeding pairs in 2023), but very now close to the 200% threshold, its credibility intervals even below 200%. The North Sea MU3-population (2022: 14,000 breeding pairs) is still very close to its FRP and clearly below the 200% threshold of the FRP (Figure 3.4-4).

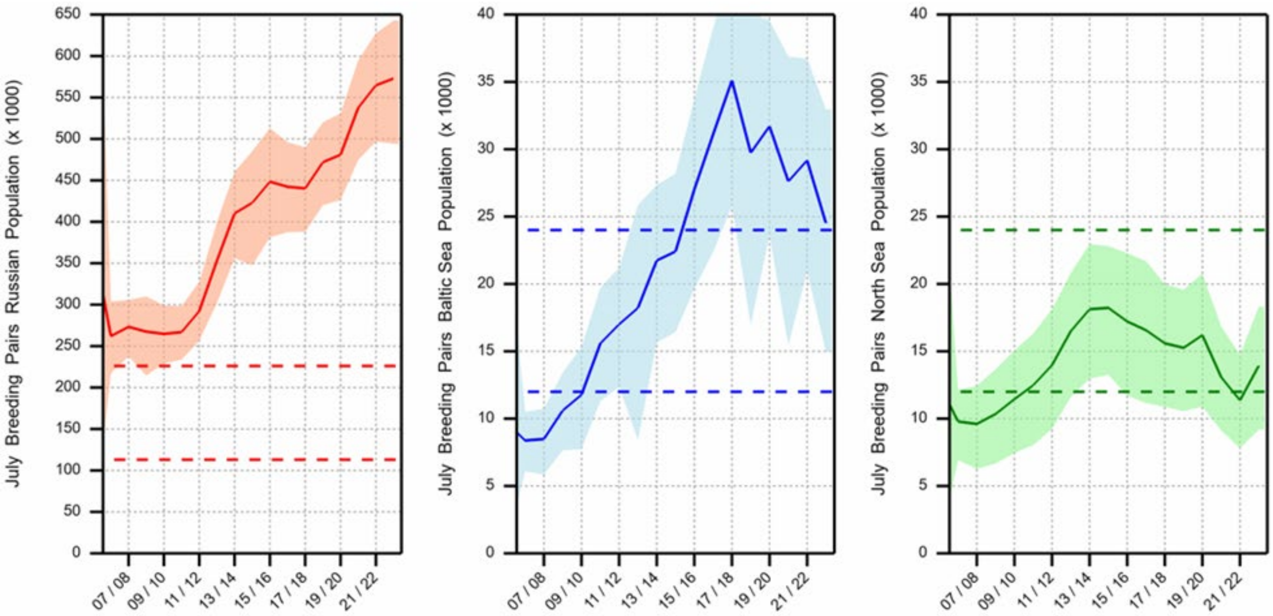



***Figure 3.4-4.*** Posterior means (solid line) and 95% posterior intervals (shaded areas) for the number of breeding pairs in July for the three MU-populations, derived from the IPM. Dashed lines are the FRP as well as the 200% of the FRP. Left in red MU1, centre in blue MU2, right in green MU3. In 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 between MU1 and MU2/3.

*b) <u>Mortality and offtake</u>*

Survival rates derived from the IPM and combined for summer and winter, show that adults have much higher survival rates than juveniles (Figure 3.4-5, note that last year of the time series is based on incomplete data). In all cases, the posterior credible intervals for juvenile survival are much wider than those for adult survival. 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 migratory Baltic MU2-population, juvenile survival is in the same order of magnitude as for MU1 while adult survival is lowest of all MUs (Russian MU1-population highest, North Sea MU3-population in-between). For the mainly sedentary North Sea population natural survival for juveniles has increased until 2020 whereas in the Baltic population it has declined in the past years.

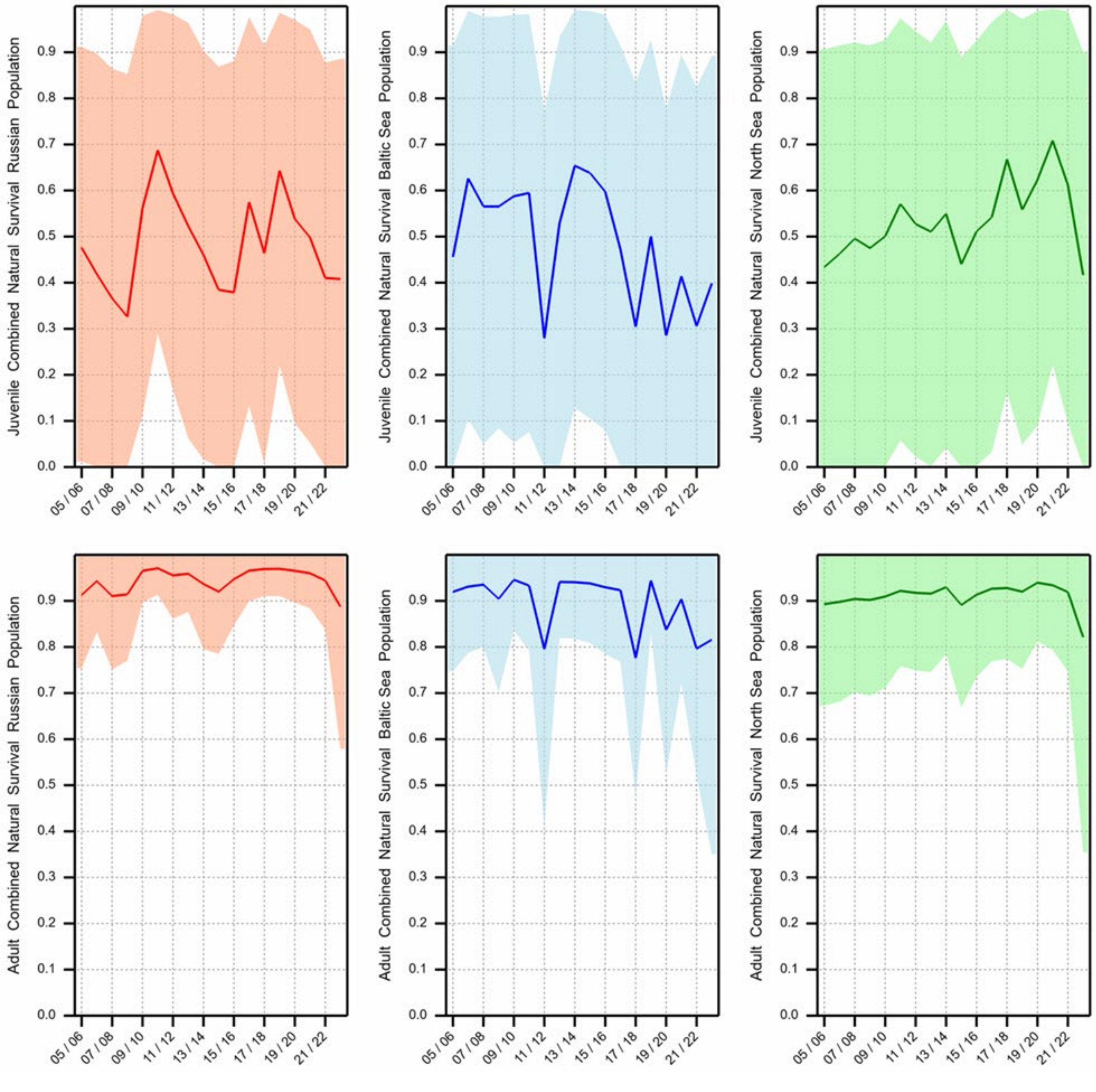



***Figure 3.4-5.*** Posterior means and posterior 95% interval for combined, i.e., summer and winter, juvenile (upper panel) and adult (lower panel) natural survival for the three MU-populations. Left in red MU1, center in blue MU2, right in green MU3. Note that his includes unknown offtake for the Russian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

Combined offtake rates for the Russian MU1- and Baltic MU2-populations are on average 3% and 5% for adults and 6% and 8% for juveniles, for the five most recent years (Figure 3.4-6). The difference between Russian and Baltic Sea population values likely stems from the Russian population's offtake around the breeding period being implicitly included in the natural survival estimate. Combined derogation offtake rates for the North Sea population have increased steeply after 2013, when coordinated management was taken up by the provinces in the Netherlands, including shooting and round-up during wing-moult in early summer. As a result, combined offtake rates were as high as approximately 34% for juveniles and 33% for adults in 2020/21. Following the outcome of the assessment in 2022, showing that numbers in the MU3-population were reaching its FRP, management effort in the Netherlands was reduced and derogation figures in 2022 went down with 43% compared to 2021. In 2022 within the entire EU-countries, at least 50,928 Barnacle Geese were killed under derogation, of which 83% in The Netherlands and Denmark (2021 it was 67,853, of which 89% in The Netherlands and Denmark). Data for Estonia have not been reported for 2022, but they accounted for only 3% of the annual derogation in the EU in the last years.

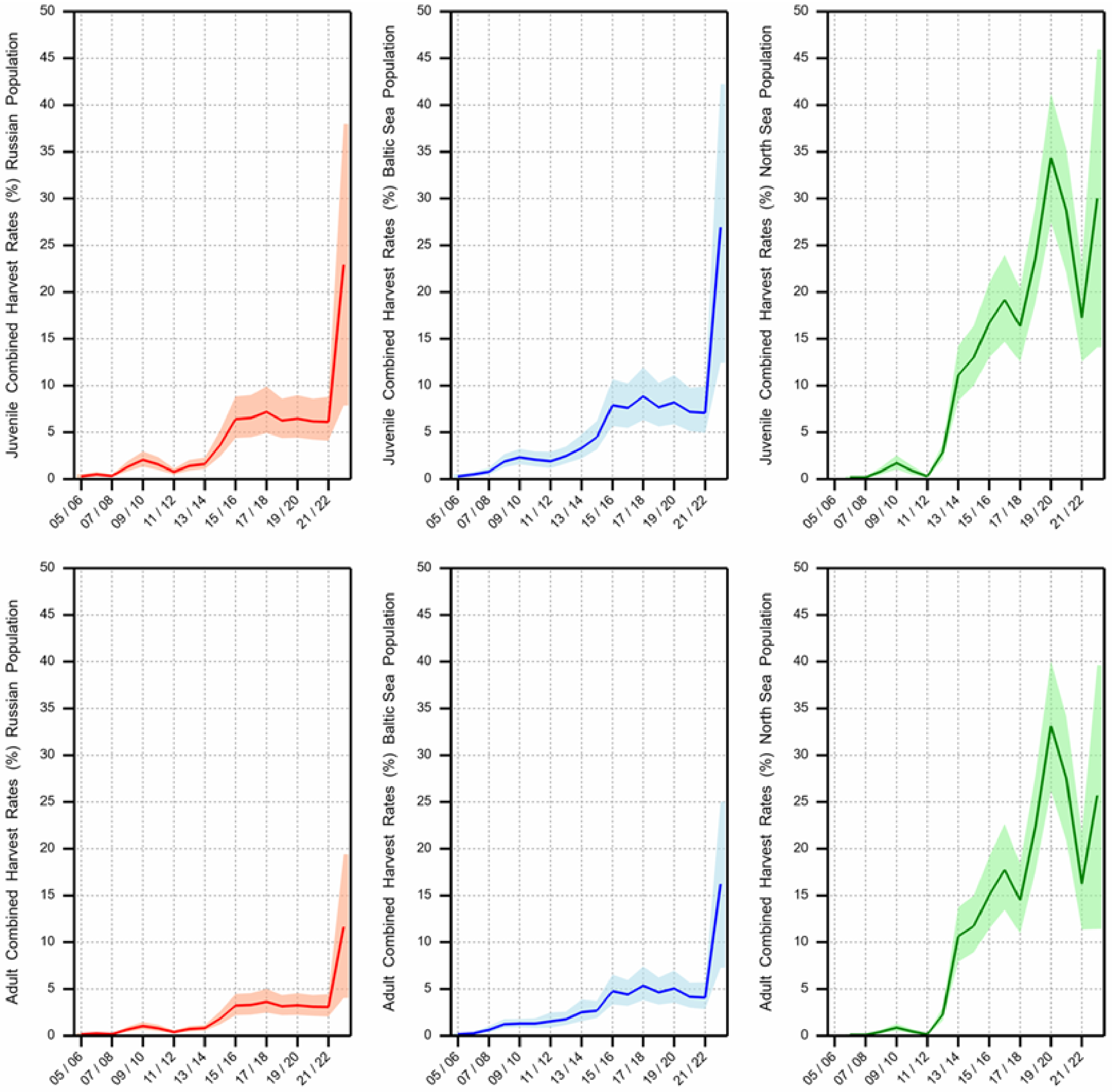



***Figure 3.4-6***. Posterior means (solid lines) and 95% posterior intervals (shaded area) for the combined derogation offtake rates of juveniles (top panels) and adults (bottom panels) for the three MU-populations. Left in red MU1, center in blue MU2, right in green MU3. Note that data for 2022/23 season were incomplete and IPM output comes with unrealistic means and large credibility intervals (2022 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). Results from the IPM consistently 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. To avoid bias in collection of field data (juveniles become more difficult to segregate from adults as autumn progresses), field effort has been slightly advanced in autumn 2022 and seems to be more in line with the IPM results in that year (but it remains to be seen if this pattern persists in future years). 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 28% in some years, but without a clear trend (Figure 3.4-7, lower panel). In the Baltic MU2-population productivity shows large fluctuations with a tendency to decline. The trend in field data and IPM results are partly different, the first suggesting increased productivity in recent years. As shown for autumn counts at flyway level, field data for MU2 show consistently lower juvenile percentages than the IPM estimates, some even outside the 95% posterior credible intervals. This is not an identification issue as has been hypothesized for the situation in autumn but is likely associated with the nature of the monitoring data used. This is mainly based on assessments made in the Helsinki region in Finland, which according to the local experts may be not fully representative as this population has been established for a long time and shows some saturation because of local density-dependent effects (M. Mikkola-Roos & A. Lehikoinen, pers communication). Hence, it may not reflect a representative sample, even more so as data from the large Swedish population is completely lacking.

### 3.4.6 Management guidance

The overall results of this year's assessment are highly similar to those for 2023. The MU3-population of Barnacle Geese in Belgium, the Netherlands and Germany is the only population which currently should be 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 just above the size of the FRP. Thus, derogation effort targeting the breeding population remains to be undertaken with caution. At present this is only applicable to The Netherlands, where derogations in summer take place. Derogations in Schleswig-Holstein in Germany only affect MU2 and (more likely) MU1-populations, given the time of the year in which they are undertaken. If derogations during the breeding period are considered in Germany, coordination should be in place between The Netherlands and Germany. Belgium does consider its small breeding population as non-naturally occurring (Nagy et al. 2021), so stays out of this coordination. In The Netherlands, a coordinated approach among the provinces (which each are responsible for goose management) has been installed in order to facilitate implementation of the AFMP and avoid numbers to drop below the FRP.

Given the close proximity of abundance in the Baltic MU2-population to the 200% threshold agreed upon in the AFMP, a significant increase in derogation effort in local breeding populations (in case this is considered at all) should be subject of a coordinated approach among the countries as well, especially as the lower credibility intervals of the IPM-estimate are below the 200% threshold. So far, offtake rates in MU2 have remained at a low but stable level. In this context it should also be noted that more precise derogation data could facilitate more precise offtake rates (see below).

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. However, it may (partly) have contributed to the stabilization of the flyway population during the past four years. Caliendo et al. (2024) estimated that in 2020/21 and 2021/22 (so the two winters preceding this assessment) up to 4.8% and 7.4% of the numbers of Barnacle Goose present in The Netherlands died of avian influenza. To our knowledge, no such estimates are available for other countries, in which casualties among wintering or migrating Barnacle Geese were reported as well. Breeding opportunities in the Russian Arctic are assumed to expand, as shown by Lameris et al. (2023) for Novaya Zemlya, as a result of climate change.

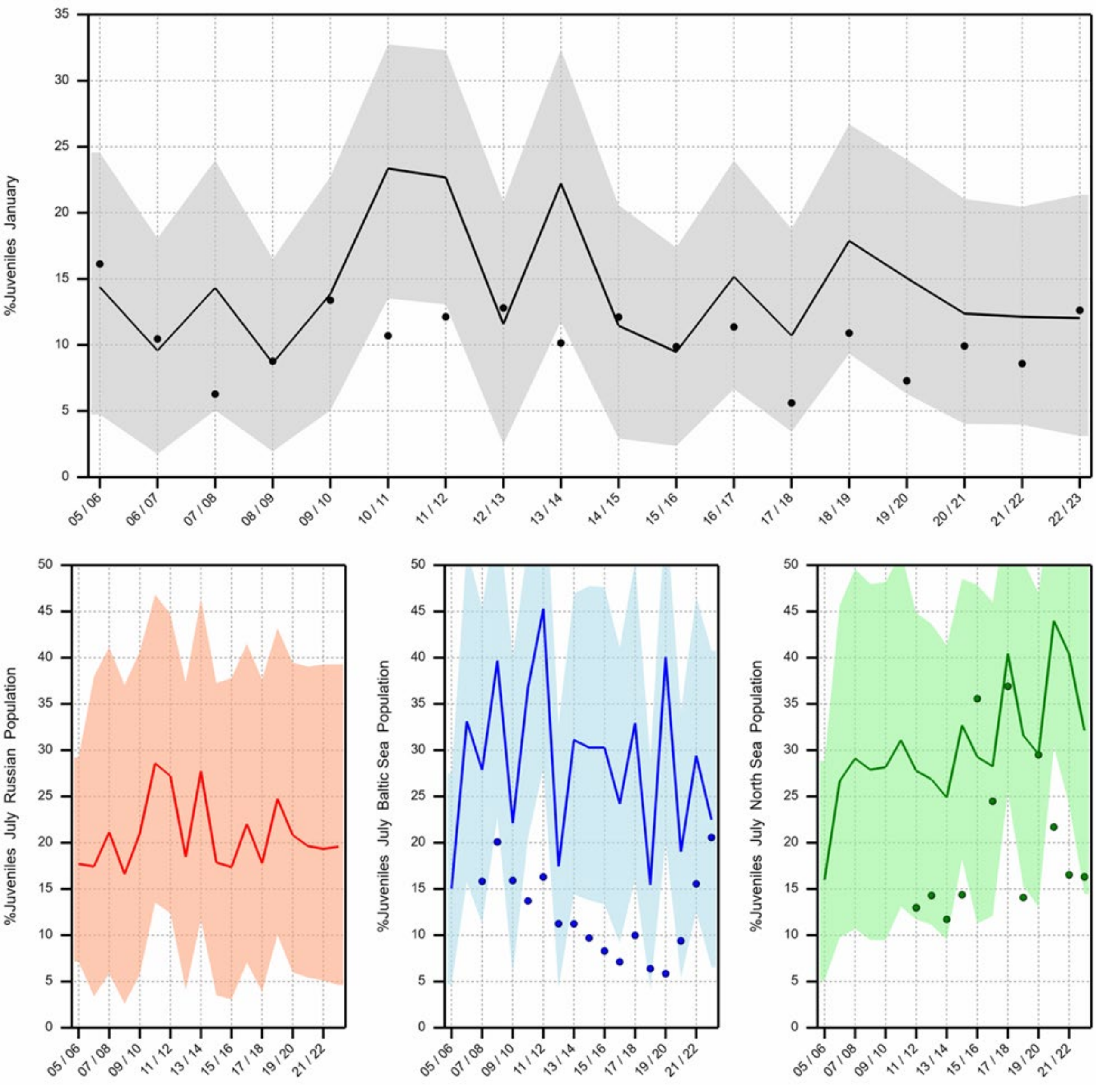



***Figure 3.4-7***. Top panel: Observed autumn percentage of Juveniles (dots), posterior means (solid line) and 95% posterior intervals (shaded area). Bottom panels: Observed summer percentage of Juveniles in the three MU-populations, along with posterior means and 95% posterior intervals. Left in red MU1, center in blue MU2, right in green MU3. Note that in MU1 there are no field data to compare with the IPM estimates.

In terms of monitoring data for the IPM, there are multiple issues. For the current assessment, there were no January census data available for Germany for 2023. Fieldwork was carried out, but not all data processed or published yet, so we recommend investigating possibilities to speed-up the process of publication of the data.

Secondly, gaps had to be filled for Swedish winter counts in 2021-2022 (very incomplete coverage) but coverage was restored in 2023 and it has been confirmed that this will continue to be the case in future years.

In case of census data from the summer period, to assess abundance in each single MU, larger gaps specifically occur in the Baltic MU2. Finland is the only country in which comprehensive (late) summer counts have had an established tradition since 2008. For Sweden, which had lacking summer census data for nearly the entire data series before, we have now used results from the mid-September count instead. This count is carried out before migratory birds from the Arctic MU1 arrive, and it is only two weeks after the summer count in Finland (which takes place by the end of August). It is assumed that in this short period, transition rates between the two countries are low, but this assumption should preferably be underpinned by data from ring resightings or tracking data. Moreover, given the large fluctuations in the count results for September in Sweden, it is recommended to check if the coverage of the counts does affect the final results, or what other explanations could be found for this pattern (e.g. emigration to e.g. Denmark or other countries further south). This is especially important, as the current data suggest that the numbers in MU2 are approximating 200% FRP.

So far, only periodically data have been collected in the Oslofjord area in Norway and in Denmark and it is recommended to continue these periodical counts (in Denmark, counts in future will be carried out in August).

Furthermore, assignment of offtake within a year and assignment to the respective MUs still involves a lot of 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, allowing us to make more precise assignment of derogation figures to each respective MU (and notably segregating migratory and sedentary populations to a large extent). Improved assignment to MUs for derogations in especially Denmark and Sweden would improve the use of derogation data and allow more precise offtake estimates for individual MUs. This does not necessarily have to be monthly data, as long it will be possible to improve assumptions about the MUs affected by the derogations issued, either by the period derogations were undertaken or the sites or regions where it was carried out.

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

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

### 3.5.1 Range states and management units

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

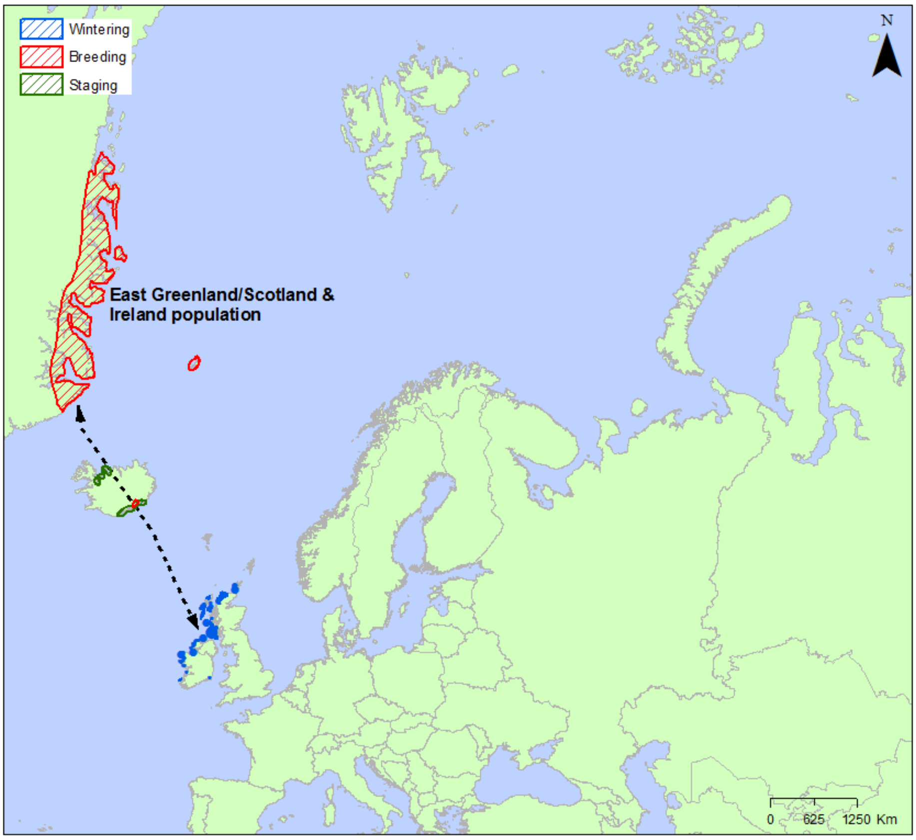



***Figure 3.5-1.*** Annual distribution and migration routes for the E. Greenland/Scotland & Ireland population of Barnacle Geese, including breeding (red), staging (green) and wintering (blue) areas.

### 3.5.2 Population FRP's and targets

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

### 3.5.3 Management strategies

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

Within this framework, it has also been agreed to coordinate monitoring of the population and offtake under derogations 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 but has not been finalized. Note, however, that the population size has perhaps never exceeded 200% of the FRP.

### 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 planned for 2023 using the IPM (see chapter 2.4 for details). Due to delays in data reporting, however, it was not possible to conduct an assessment. Those data are now available, and we present the results of the updated IPM here.

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

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

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

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

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

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

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

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

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

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

Number surviving Iceland harvest is:

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

Scottish harvest ($H^S$) is then

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

We estimated annual harvest rates for different age classes.

Adults ($h_t^A$):

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

Juveniles ($h_t^J$):

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

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

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

and juvenile survival rate is:

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

Raw data and the results of the 2024 update of the IPM are available from the EGMP Data Centre.

### 3.5.5 Status

*a)* *Abundance*

After a peak population of 80,000 in 2006 and in 2012, posterior estimates of flyway abundance declined to 56,994 (48,616 – 66,230) in March 2024 (Figure 3.5-2). For much of the period of record, abundance on Islay exceeded that in all other wintering areas, but that pattern has been reversed since 2018.

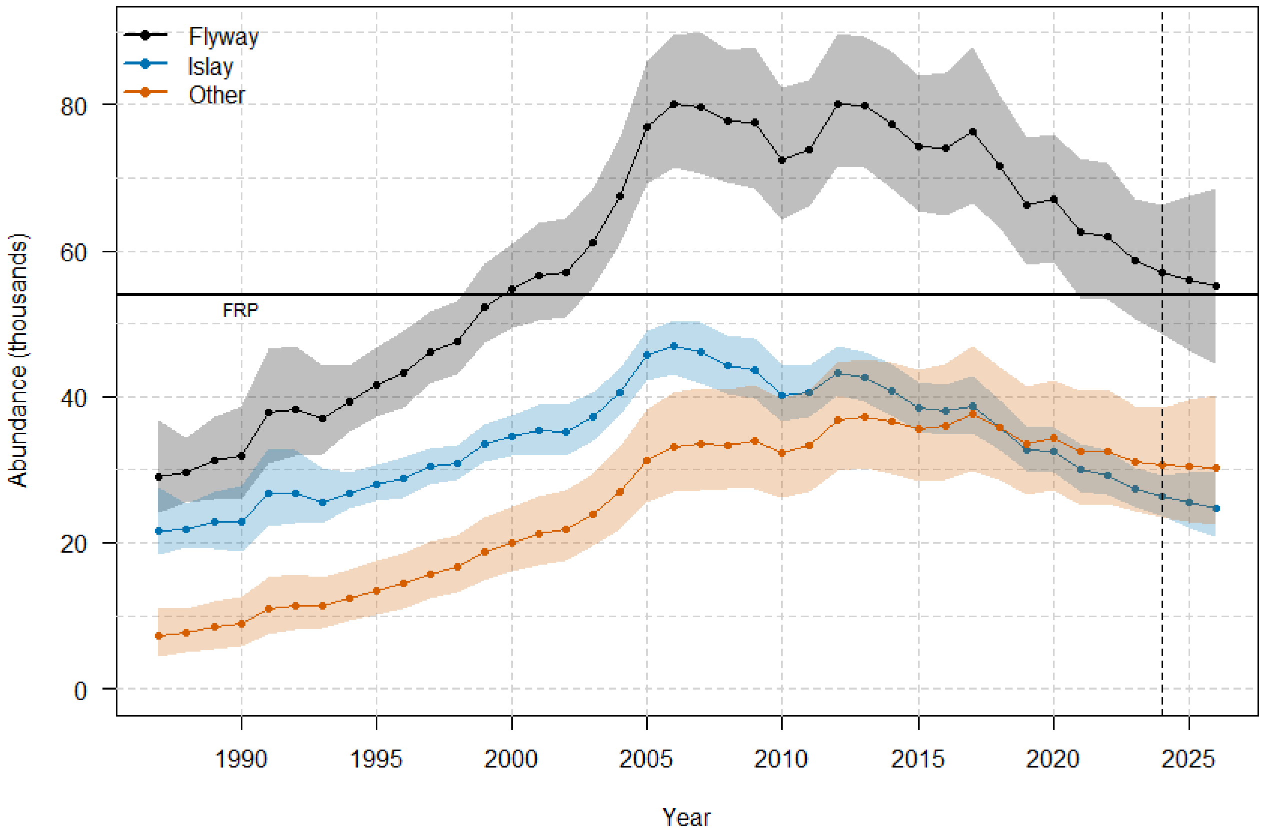



***Figure 3.5-2.*** Development of the March population size of E. Greenland/Scotland & Ireland Barnacle Geese as based on the IPM. The FRP = 54 thousand. The dashed vertical line represents the last empirical estimate. Two further years have been projected assuming harvest rates equal to the most recent 5-year means (see section 3.5.6). Shading represents the 95% credible intervals.

*b)* *Mortality and offtake*

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

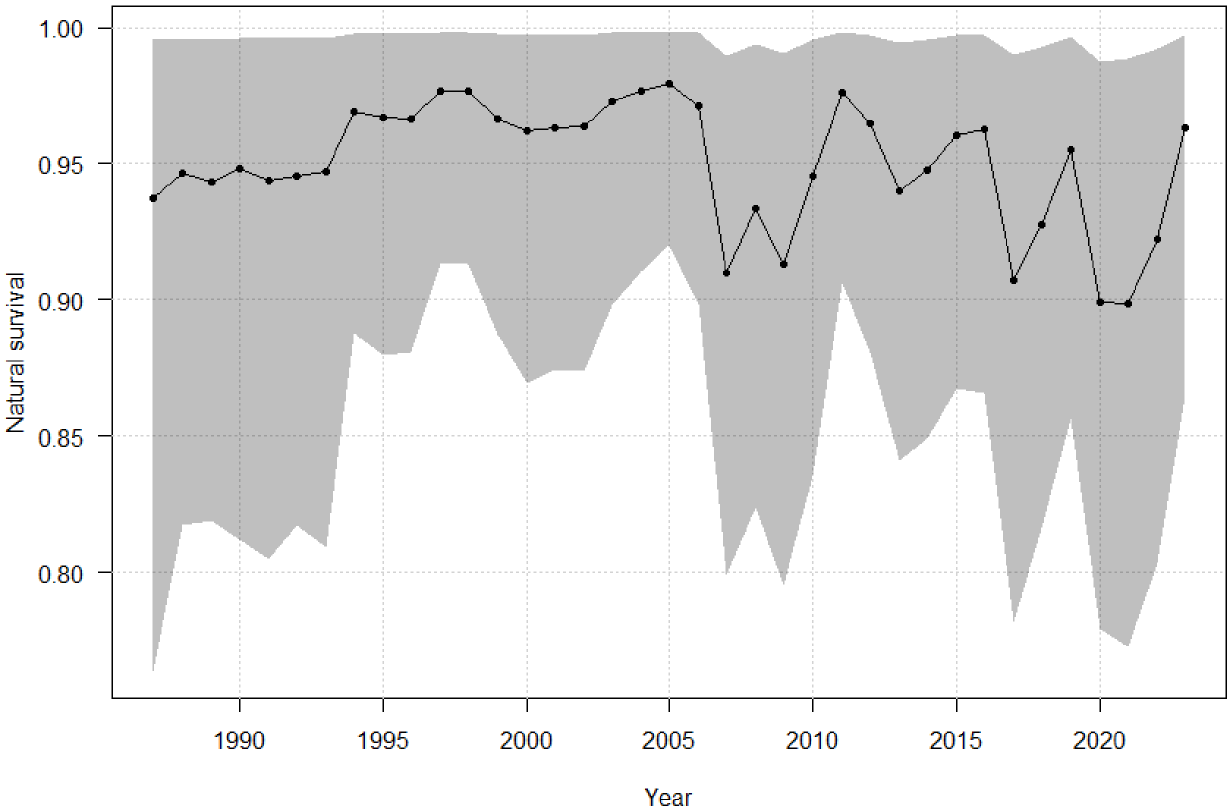



***Figure 3.5-3.*** Natural survival rates (i.e., 1 – the natural mortality rate) of E. Greenland/Scotland & Ireland Barnacle Geese as based on the IPM. Shading represents the 95% credible intervals.

The total harvest rate of adults has increased over the period of record, from around 0.01 to a peak of 0.05 (0.04 – 0.07) in 2017 (Figure 3.5-4). Thereafter, harvest rate declined to 0.03 (0.02 – 0.05) in 2023. Annual survival rate of adults (including both harvest and natural mortality) declined at the same time harvest rates were increasing, suggesting that harvest may have contributed to the decline in flyway abundance (although other factors cannot be ruled out).

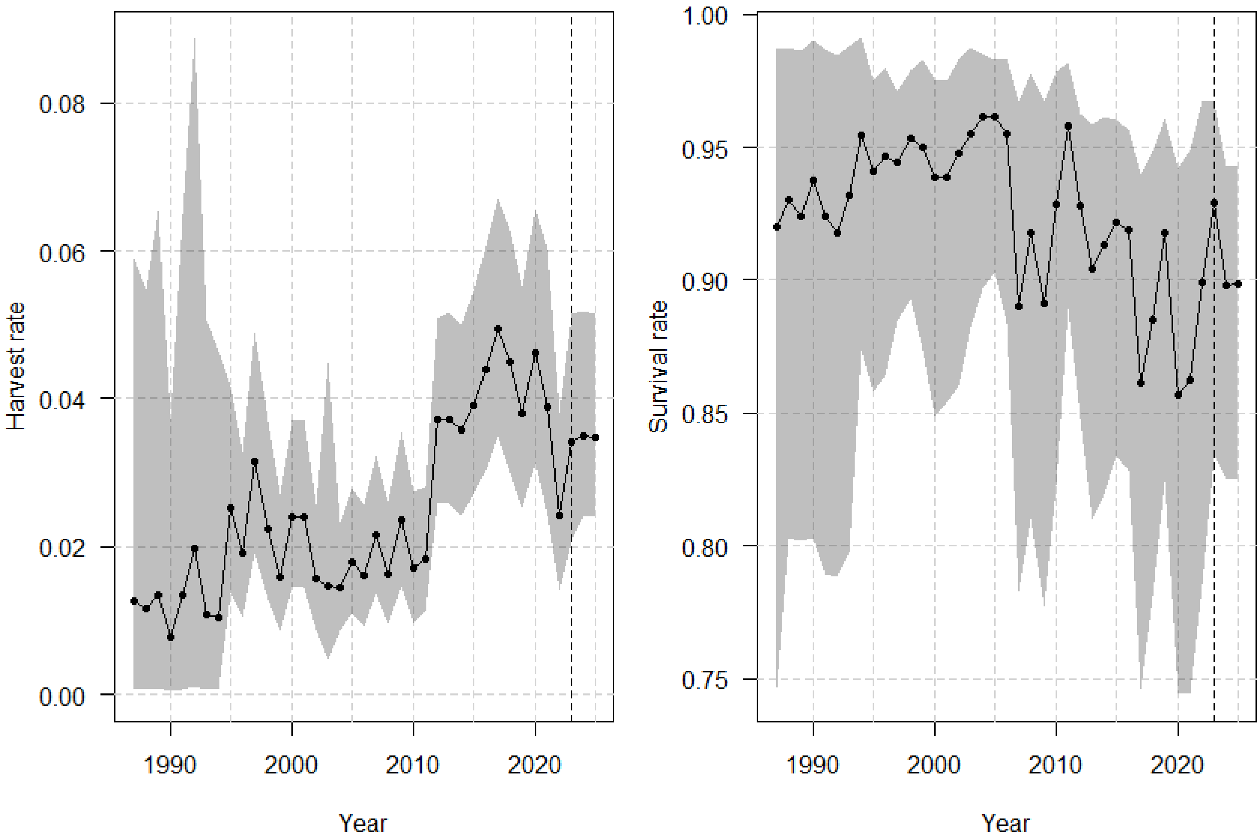



***Figure 3.5-4.*** Adult harvest rates (left) and annual survival rates (right) of E. Greenland/Scotland & Ireland Barnacle Geese as based on the IPM. The dashed vertical line represents the last empirical estimate. Two further years have been projected (see section 3.5.6). Shading represents the 95% credible intervals.

Recreational harvest in Iceland has generally increased over the period of record (Figure 3.5-5). In Scotland, derogations increased starting in 2012 in response to a plan to limit agricultural conflicts but has now been reduced to near zero in response to avian influenza. Harvest rates in the two countries have followed a similar temporal pattern (Figure 3.5-6).

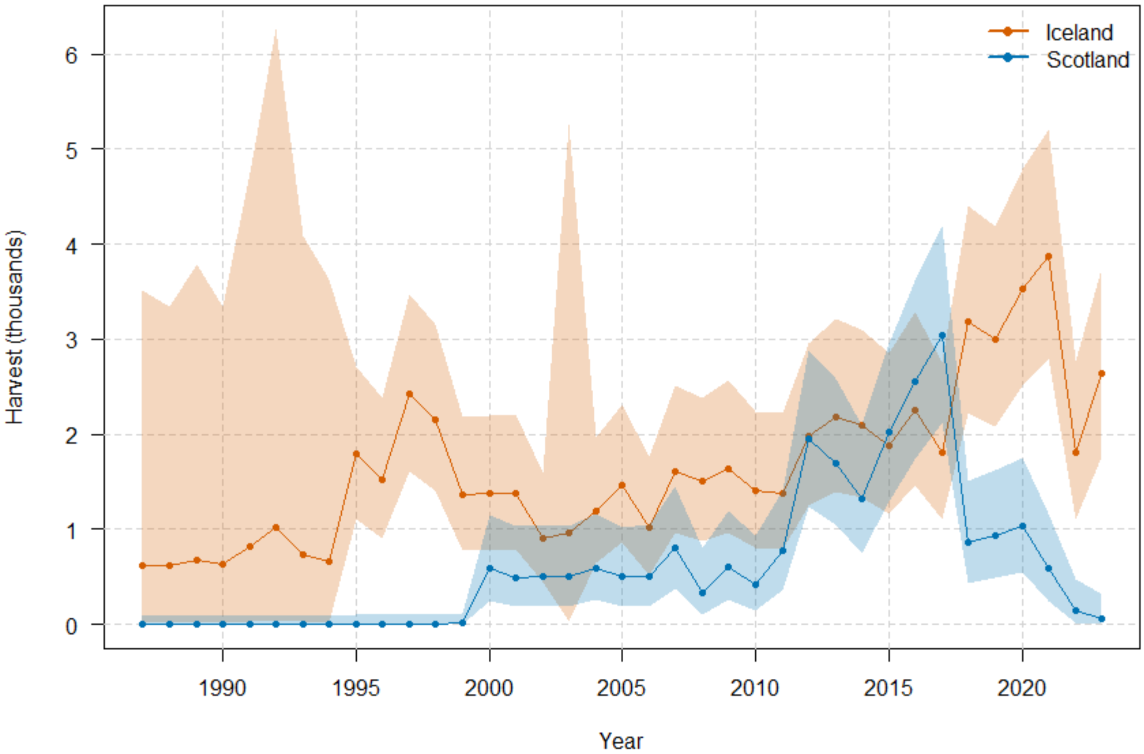



***Figure 3.5-5.*** Offtake of E. Greenland/Scotland & Ireland Barnacle Geese as based on the IPM. Shading represents the 95% credible intervals.

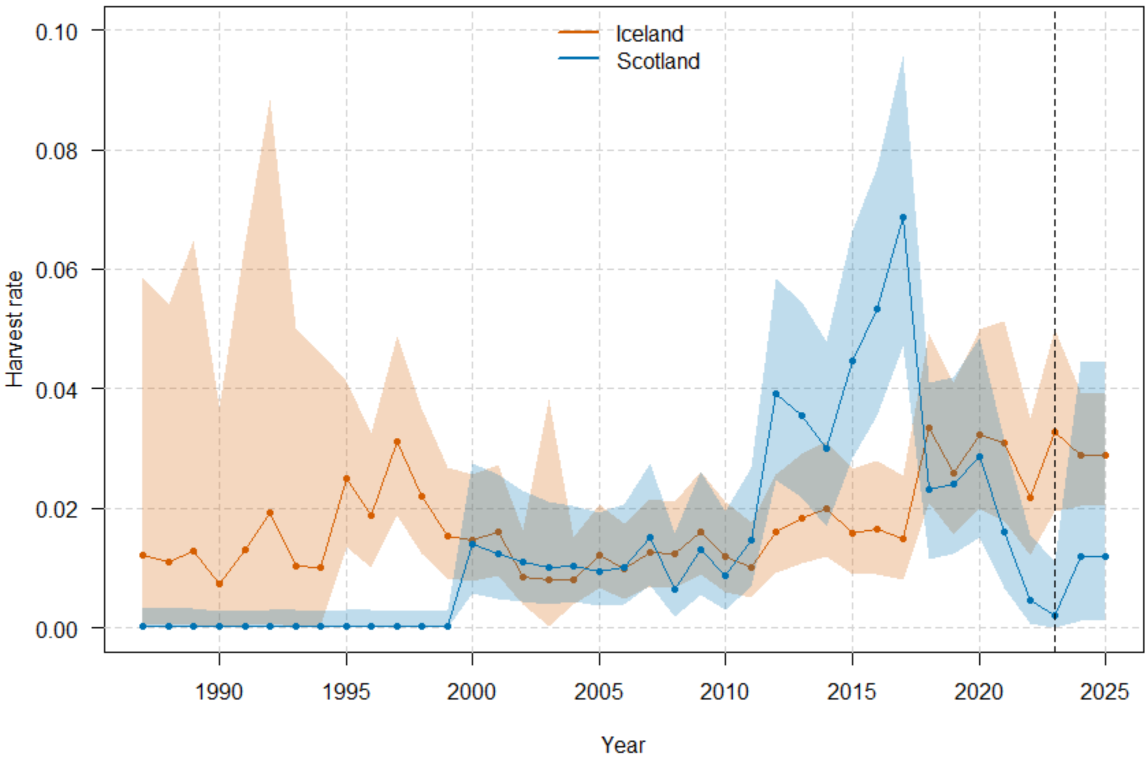



***Figure 3.5-6.*** Harvest rates (including derogations) of E. Greenland/Scotland & Ireland Barnacle Geese as based on the IPM. The dashed vertical line represents the last empirical estimate. Two further years have been projected assuming harvest rates equal to the most recent 5-year means (see section 3.5.6). Shading represents the 95% credible intervals.

*c) Reproduction*

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

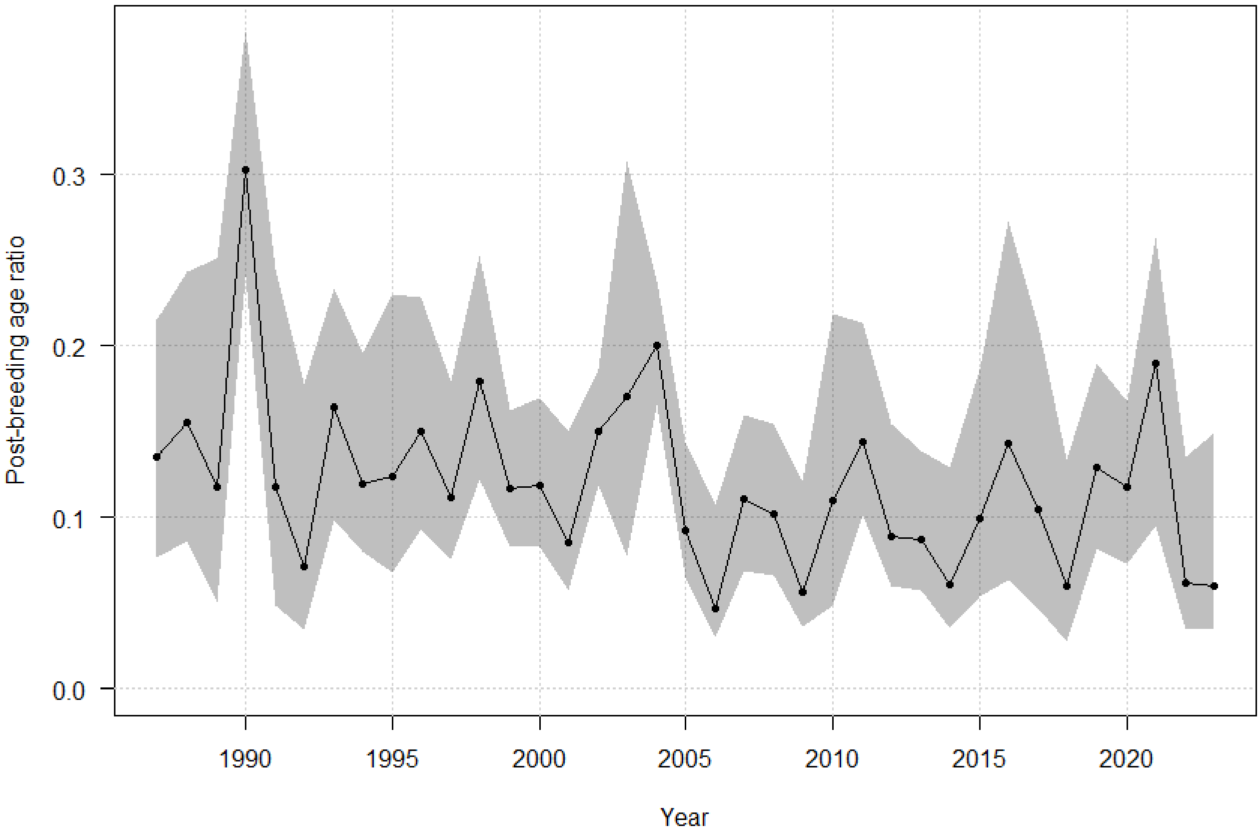



***Figure 3.5-7.*** Post-breeding age ratio of E. Greenland/Scotland & Ireland Barnacle Geese as based on the IPM. Shading represents the 95% credible intervals.

### 3.5.6 Management guidance

It appears that a contribution of factors, possibly including decreased productivity, as well as increased harvest and natural mortality rates, may have been responsible for the decline in flyway abundance over the last decade. There currently is a 24% probability that the March 2024 population is below the FRP of 54,000. Because of the proximity of the population to the FRP, the Adaptive Flyway Management Plan requires tighter coordination of offtake between Iceland and Scotland to ensure the population does not fall below the FRP. We evaluated several scenarios of varying levels of offtake to help inform policy decisions concerning the regulation of take. It remains uncertain, however, how productivity and natural mortality might vary in the near future. For our purposes here, we chose to use the mean of the last five years of natural mortality, reasoning that these show both relatively high years and relatively low years. We used a post-breeding age ratio set at its long-term mean because no clear temporal trends are apparent. We projected population size two years into the future, as 2026 is when the Adaptive Flyway Management Plan is to be reviewed. We evaluated several scenarios of offtake rates in Iceland and in Scotland and estimated the probability that the spring population size would be below the FRP of 54,000 in 2026 (Table 3.5-1). Only extremely low offtake rates resulted in relatively low probabilities of the population falling below the FRP.

**Table. 3.5-1.** Scenarios for offtake rates of E. Greenland/Scotland & Ireland Barnacle Geese in 2024 and 2025. Parameters are: $h_i$ = adult offtake rate in Iceland; $h_s$ = adult offtake rate in Scotland; $h$ = population-level offtake rate of adults; $H_i$ = total offtake in Iceland; $H_s$ = total offtake in Scotland, and $P(N_{2026} < 54k)$ = the probability that the spring population size in 2026 is less than the FRP.

| Scenario | $h_i$ | $h_s$ | $h$ | $H_i$ | $H_s$ | $P(N_{2026} < 54k)$ |
|---|---|---|---|---|---|---|
| hypothetical | 0.000 | 0.000 | 0.000 | 0 | 0 | 0.12 |
| hypothetical | 0.005 | 0.005 | 0.0070 | 471 | 158 | 0.16 |
| hypothetical | 0.010 | 0.010 | 0.0150 | 920 | 311 | 0.22 |
| Last 5-year mean | 0.028 | 0.015 | 0.0347 | 2,609 | 366 | 0.40 |
| Year 2023 | 0.034 | 0.003 | 0.0353 | 3,116 | 60 | 0.43 |

# Appendix A – Data overview

## A.1. Pink-footed Goose – Svalbard population

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

| | NO | SE | FI | DK | NL | BE |
|---|---|---|---|---|---|---|
| Population count in Autumn | X | X | X | X | X | X |
| Population count in Spring | X | X | X | X | * | * |
| Productivity | X | X | * | X | - | X |
| Hunting bag | X | * | * | X | * | * |
| Wings | - | * | * | X | * | * |
| Crippling | 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 | X | X | * | * | - | - | - | - |
| Population counts in mid-winter | * | X | * | X | - | * | - | - | - | - |
| Population counts in Spring | X | X | X | X | - | X | (x) | - | - | - |
| Productivity | * | X | - | - | - | - | - | - | - | - |
| Hunting bag | * | * | X | X | - | * | (x) | - | - | (x) |
| Derogation | - | X | X | X | - | X | (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 annually/regularly and reported to EGMP, x data collected annually/regularly, (x) data collected in part of the country and/or not annually, - no data collected or reported to the EGMP, * 0 or not relevant range state in this respect.

| | NO | SE | FI | DK | DE | NL | BE | FR | ES |
|---|---|---|---|---|---|---|---|---|---|
| Population counts in January. Received through IWC | X | X | * | X | (x)[1] | X | X | X | (x)[2] |
| Summer count | (x)[3] | (x)[4] | X[5] | X[6] | (x)[7] | X | X | (x)[8] | * |
| Productivity | (x)[9] | X | (x)[10] | - | (x)[11] | X | - | - | - |
| Hunting bag | X | X | X | X | x[12] | * | X | (x)[13] | (x)[14] |
| Split hunting data into March-Aug and Sep-Feb | (x)[15] | (x)[16] | (x)[17] | (x)[18] | - | * | (x)[19] | X | X |
| Derogation | (x)[20] | X | X | X | (x)[21] | X | X | * | * |
| Split derogation data into March-Aug and Sep-Feb | (x)[22] | (x)[22] | (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) Country-wide estimate from 2022 has been made available. Future count/estimate interval unknown.
4) September count is used. Coverage could be improved, and counts do not account for hunting and migration.
5) To estimate population size, organized counts have been carried out in 2022 and 2023. GPS-tracking has been used to distinguish between birds from the C and NW/SW European populations.
6) Counted every two years in August.
7) Available from Nordrhein-Westfalen (since 2011) and Niedersachsen (2018-2022). Data from Schleswig-Holstein is available for June and September 2018-2022.
8) Available every 6 years from 2022.
9) Available from Vesterålen (2020-2022) and Oslofjord-area (2020-2023).
10) Data available from 2022 and 2023.
11) Available from Nordrhein-Westfalen.
12) Data Source: 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 year, 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) Derogation period: 01.01-09.08, the majority takes place in July-Aug. Assume all derogation takes place between March-Aug.
24) Assume all derogation takes place between March-Aug.
25) Not collected annually, and only for part of the flyway.

**Table A.3.2** Overview of model parameters and their source

| Parameter | Description | Value | Source |
|---|---|---|---|
| $\phi$ | 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 & Bacon (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 & Bacon (2022), recognizing that lack of fidelity is typically temporary |
| $\begin{bmatrix} n_{1,1} \\ n_{2,1} \\ n_{3,1} \\ n_{1,2} \\ n_{2,2} \\ n_{3,2} \end{bmatrix}$ | initial population sizes (in thousands) in fall 2022, where the first subscript denotes age and the second denotes MU | $\begin{bmatrix} 72.2 \\ 56.4 \\ 201.1 \\ 120.3 \\ 94.0 \\ 334.9 \end{bmatrix}$ | derived based on estimates of breeding pairs in 2018 (Szabolcs Nagy, pers. comm.) and the stable age distribution of the matrix model in the absence of harvest |
| $h_{ijk}$ | rate of offtake of age $i$, season $j$, and area $k$ | 0.0 to 0.4 in increments of 0.02 | simulated to project population sizes in 2030 |
| $\nu_s$ | 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[2] | (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[3] | X | X | X | X | Mostly annual totals (apart from monthly data in NL), more detailed data requested especially from DK and SE in order to improve estimates for individual MUs. |

[1] note that Germany only submits data once every six years (latest full dataset up to 2016, next 2025), and recent years are based on published data only.
[2] For Sweden, the national count mid-September is used as a proxy for numbers in summer.

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

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