


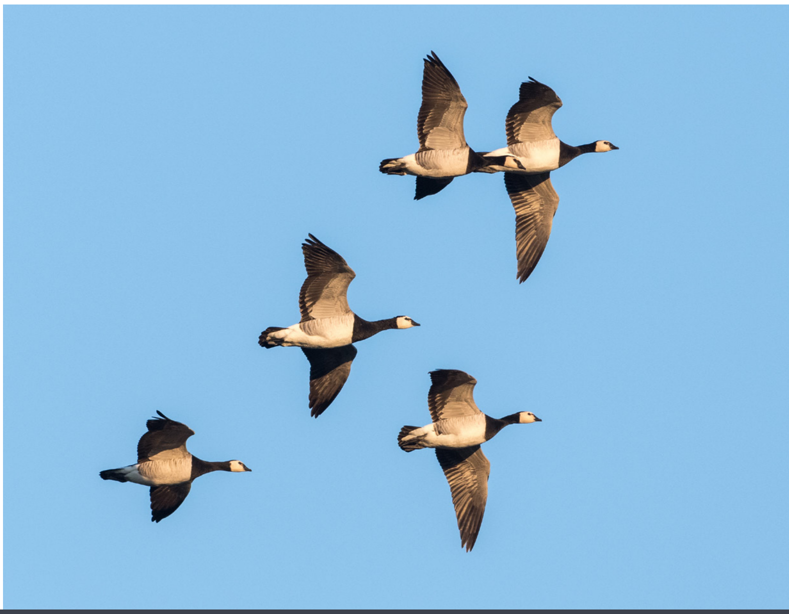

Population Status and Assessment Report

AEWA European Goose Management Platform

EGMP Technical Report No.20

Population Status and Assessment Report 2022

AEWA European Goose Management Platform

UNEP AEWA

AEWA European Goose Management Platform

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EGMP Technical Report No. 20

Prepared by the AEWA European Goose Management Platform Data Centre

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Preface

This report provides the 2022 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.

Contents

Summary
This report provides the 2022 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
The May 2022 population estimate was 71,393 (59,753 – 86,621), which is lower than the May 2021 estimate of 79,122 (60,785 – 91,169). Population size has been relatively stable since implementation of the adaptive harvest management program in 2013. Harvests and harvest rates were increasing prior to the implementation of the adaptive harvest management program in 2013, but have been somewhat stable since. In 2021, the estimated post-breeding proportion of young was a near-record-low of 0.15 (0.13 – 0.16), following only 2 days above freezing in May in Svalbard. The recommended harvest quota for the 2022/2023 hunting season, based on the estimated population size and 11 days above freezing in Svalbard in May 2022 is 19,400. Using an agreed upon allocation of the total quota, harvest quotas for Norway and Denmark this year would be 5,820 and 13,580, respectively.

Taiga Bean Goose
There are four recognized Management Units for Taiga Bean Geese: Western, Central, and Eastern 1 and Eastern 2. For the Western MU, the population counts gave a total of 2,186 birds in January 2022. This is remarkably higher than in the preceding winters, but still far below the short-term target of 4,000 individuals. For the two Eastern MUs, there is no information concerning population status beyond that which was reported last year. For the Central MU, the March 2022 population estimate was 66,472 (59,976 – 71,654), which is similar to the March 2021 estimate of 64,877 (60,142 – 69,396). If the interim harvest strategy were followed, the total allowable harvest during the 2022/2023 season would be 2,000 (1,913 – 2,089) and the country-specific allocations of this harvest are: Finland – 1,160 (1,094 – 1,227); Sweden - 600 (553 – 648); and Denmark - 240 (210 – 271).

Greylag Goose – NW/SW European population
Until 2023, Greylag Geese are managed to achieve an annual finite growth rate between 0.96 – 1.00 using mid-winter population counts. Using IWC imputed values a growth rate of 0.994 (0.963-1.025) was achieved including estimates from Spain, and 1.014 (1.002-1.026) when excluding estimates from Spain. Given the large uncertainty in the estimates from Spain, it is difficult to make a firm conclusion on the population trend. In total, a minimum of about 383,000 Greylag Geese were reported killed in 2020. From 2023 onwards, we will move to a dynamic and model-based management of the population, after a number of preconditions have been fulfilled in relation to offtake data, summer counts, and development of a flyway decision model.

Barnacle Goose – Russia/Germany and Netherlands population
This report provides the first full offtake assessment of all management units (MUs) in the Russian/Germany and Netherlands population for the period 2005/06-2020/21. The estimated flyway population size is about 1.4 million individuals in midwinter 2020/21, thus 3.7 times the FRP. Converted into breeding pairs, Russian MU1 and Baltic MU2 are beyond the 200% threshold level set above the FRP, and for the North Sea MU3, numbers are below this 200% threshold, and approaching the FRP. Thus, the results indicate that a reduction in derogations is needed in MU3, which under the current derogation rate will decline in the next years and fall below the FRP. MU1 and MU2 are still above the 200% threshold set in the AFMP and their future developments give no concern for similar management adaptations as suggested for the MU3-North Sea population.

Barnacle Goose – Greenland/Scotland and Ireland population
The first offtake assessment of the Greenland/Scotland and Ireland population will take place in 2023. Thus, for 2022 only an update on the raw data is available. In 2022, population size is only available from winter counts on Islay, the most important wintering site in the UK, where 28,759 birds were counted in March (flyway census of performed every third year; next in 2023). A total of 4,550 Barnacle Geese were killed in Scotland and Iceland. Derogation shooting was suspended on 1/2/22 on Islay as the result of an avian influenza outbreak.

Executive summaries

Svalbard population of Pink-footed Goose

The population target for Svalbard Pink-Footed Geese is 60,000 individuals in spring to help reduce agricultural conflicts, particularly in Norway, as well as tundra degradation due to grazing in Svalbard. 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. An integrated population model is used to assess population size and demographic rates, and is updated each year using all available data (thus, the reader is cautioned that historic estimates may differ from those presented previously). Beginning in May 2021, the population estimate was 79,122 (60,785 – 91,169). In November 2021, the population size was estimated as 80,816 (68,988 – 93,771). The May 2022 population estimate was 71,393 (59,753 – 86,621), which is lower than the May 2021 estimate. Population size has been relatively stable since implementation of the adaptive harvest management program in 2013. Harvests and harvest rates were increasing prior to the implementation of the adaptive harvest management program in 2013, but have been somewhat stable since. Estimates of annual survival have generally decreased during the entire period of record. 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 – 0.15) occurred in 1998, following 0 days above freezing in May in Svalbard. In 2021, the estimated post-breeding proportion of young was 0.15 (0.13 – 0.16), following only 2 days above freezing in May in Svalbard. The recommended harvest quota for the 2022/2023 hunting season, based on the estimated population size and 11 days above freezing in Svalbard in May 2022 is 19,400. Using an agreed upon allocation of the total quota (30% for Norway, 70% for Denmark), harvest quotas for Norway and Denmark this year would be 5,820 and 13,580, respectively. For comparison, the realized harvest has averaged about 12,900 (*se* = 1,100) during the last five years (66% of this year's quota).

Taiga Bean Goose

There are four recognized Management Units for Taiga Bean Geese: Western, Central, and Eastern 1 and Eastern 2. For the Western MU, the January 2022 population counts gave a total of 2,186 birds. This is remarkably higher than in the preceding winters (mean of 1,343 during 2019-2021), perhaps because Denmark succeeded with a detailed count this year (Bean Geese in North Jutland are usually very difficult to locate). Nevertheless, the population level remains far below the short-term target (for the next 20 years) of 4,000 individuals, specified in the ISSAP. For the two Eastern MUs, there is no information concerning population status beyond that which was reported last year. For the Central MU, we used an integrated population model to estimate abundance and demographic rates, and to explore the implications of an interim harvest strategy intended to achieve the population target of 70,000 birds by 2025. The March 2022 population estimate was 66,472 (59,976 – 71,654), which is similar to the March 2021 estimate of 64,877 (60,142 – 69,396). Harvest rates declined dramatically following the Finnish harvest moratorium in 2014, and this decrease in harvest rate coincides with strong growth in the population. Harvest rates during the five years of the interim harvest strategy (2017 – 2021) averaged 4.5% (sd = 1%). Estimates of apparent survival rate (i.e., absent any density-dependent effects that may have been operative) increased markedly with implementation of the Finnish harvest moratorium, and have averaged 88% (sd = 1%) since implementation of the interim harvest strategy. Posterior estimates of the intrinsic reproductive rate (i.e., absent any density-dependent effects) have varied little over the timeframe of the IPM and have averaged 0.32 (sd = 0.05). If the interim harvest strategy were followed, the total allowable harvest during the 2022/2023 season would be 2,000 (1,913 – 2,089) and the country-specific allocations of this harvest are: Finland – 1,160 (1,094 – 1,227); Sweden - 600 (553 – 648); and Denmark - 240 (210 – 271). For comparison, the estimated total harvest averaged 2,955 (sd = 781) during the years of the interim harvest strategy (2017 – 2021). At the median population target of 70,000 birds, the harvestable surplus would be 3,668 (0 – 6,504).

NW/SW European population of Greylag Goose

In the face of deep uncertainty related to estimates of population size and offtake at the flyway level, range states have agreed on a management criterion of a 15% reduction in population over 10 years, which means an annual growth rate of 0.96 < lambda < 1.00, until more reliable monitoring information is available (in 2023). Growth rate is assessed based on 10-year trends calculated from the latest available data using IWC imputed values and/or additional country-specific data in January.

Population sizes for 2021, based on EGMP national totals, are not available from Germany and Sweden. Due to these limitations, it is not possible to derive a reliable total population size and thereby calculate a growth rate based on EGMP national totals. The IWC imputed values for the population produced a total of 1,131,525 individuals including estimates from Spain, and 865,582 individuals excluding estimates from Spain. The corresponding growth rate is, 0.994 (0.963-1.025) and 1.014 (1.002-1.026) respectively. However, given the large uncertainty in the estimates from Spain due to uncertainties about spatial coverage, it is difficult to make conclusion on the population trend.

Growth rates have, however, been produced based on the Common Breeding Bird Index for Norway, Sweden, Finland, Denmark, and The Netherlands. An increase in the long-term trend is seen in all countries. This increase has slowed down in the short-term trend and even seems to have stabilized in the Fennoscandian countries in the last few years. Summer (post-breeding) counts from MU2[1] are available from Belgium and the Netherlands, and two states in Germany (Nordrhein-Westfalen and Niedersachsen), resulting in a minimum MU2 summer population size of 571,457 individuals in 2021. Summer counts for MU1[2] are expected to be ready by 2023.

In 2020, 261,668 Greylag Geese were reportedly killed under derogation, plus a minimum of 121,611 killed during hunting (data are missing from France and Germany with the exception of Schleswig-Holstein). Thus, in total a minimum c. 383,000 Greylag Geese were reported killed in 2020. This is considerably higher than last year's reported minimum total of 261,157. However, evidence suggests that the reported offtake is biased high, perhaps severely so (Johnson & Koffijberg, 2021).

Range states are encouraged to collect and submit:

- Mid-winter counts to IWC and/or EGMP Data Centre in a timely manner and before March 1 in the year after the count took place. Furthermore, it is recommended that the accuracy of the Spanish population estimates and trend is investigated and analyzed before the assessment in 2023.
- Summer counts to the EGMP Data Centre (for MU1 as soon as these become available). The interval of the summer counts remains to be agreed upon.
- Common Breeding Bird Index to the EGMP Data Centre on an annual basis.
- Hunting bag data to the EGMP Data Centre on an annual basis. If the hunting bag is based on estimates, the method of deriving these estimates should be provided to the EGMP Data Centre.
- Derogation data to the EU or the EGMP Data Centre at the MU level, split between April-July and August-March.

[1] MU2: European population of Greylag Goose – resident population.
[2] MU1: European population of Greylag Goose – migratory population

Russia/Germany and Netherlands population of Barnacle Goose

Based on an Integrated Population Model (IPM), this report gives a first full offtake assessment of all management units (MUs) in the Russian/Germany and Netherlands population for the period 2005/06-2020/21. These MUs represent the Russian breeding population (MU1), the Baltic breeding population (MU2) and the North Sea breeding population (MU3). In winter, these birds mix in Sweden, Denmark, Germany, The Netherlands and Belgium.

IPM estimates point at a total flyway population of about 1.4 million individuals in midwinter 2019/2020 and 2020/21, which is 3.7 times the FRP from the AFMP. Estimates from the IPM show that the MU1-population is by far the largest in size and still experiencing an increase, while numbers in the MU2-population tend to level off and numbers in the MU3-population show first signs of a decrease. Converted into breeding pairs, both the MU1 and MU2 breeders are beyond the 200% threshold level set above the FRP. In case of the MU3-population, numbers are below this 200% threshold and also approaching the FRP. Caution is needed for estimates of abundance in MU2 as current summer counts do not cover the large Swedish population and a complete count is also missing for Norway. Moreover, estimates for summer abundance of the MU1-population are entirely estimated from the IPM and come with large credibility intervals.

Adult survival is much higher than in juveniles, but the assessment of juvenile survival comes with large confidence intervals. In the MU2-population, juvenile survival tends to decline over time. Since 2005/06, productivity based on autumn data (mainly representing MU1 and MU2) does not show a clear trend. In the MU2-populaiton, a clear decrease in productivity has been observed

Over recent years, offtake rates for the MU1- and MU2-populations amount to around 4 and 5% for adults and 6 and 8% for juveniles. Baltic Sea offtake rates from the local breeding MU2-population are estimated to sum up to approximately 2% in recent years. Derogation rates for the MU3 population appear to have increased steeply after 2013, up to approximately 35% for juveniles and 30% for adults in the last year with complete offtake data (2020). In recent years, offtake in MU3 in summer (so only affecting MU3) has been 8,000 to 10,000 individuals while in winter (when other MUs are present as well) it amounted up to 15,000-20,000 individuals (all MUs).

If recent current derogation effort is maintained, the MU1-population is predicted to increase further, whereas the MU2-population is predicted to decrease temporarily, followed by an increase (all predictions until the next full assessment in 2024). For the MU3-population, this scenario will lead to a continuous decrease to a population below FRP. Scenario simulations suggest that the derogation rate in MU3 should at least be halved to stop the decline, but it needs to be more than halved to recover to a size well above the FRP. Simulations including mortality of avian influenza, show that under different mortality rates, the populations in the respective MUs need multiple years to recover (under the current derogation rates).

These results indicate that a reduction in derogations is needed in the MU3-population, which under the current derogation rate will decline in the next years and fall below FRP. The MU1- and MU2-populations are still above the 200% threshold set in the AFMP and their future developments give no concern for similar management adaptations.

In terms of monitoring data, the lack of summer counts in Sweden is still a major gap, suggesting the estimates for MU2 should be treated with caution. Moreover, timely delivery of recent data from Denmark is an issue, both regarding January counts (2020-2021 still provisional data) and derogation data (2021 not available yet). Furthermore, assignment of offtake within a year and assignment to the respective MUs still involves some assumptions, as most data are only available as a total figure for the entire calendar year. Data with a higher resolution would allow more precise data for the IPM. In 2022, protocols for productivity assessments in autumn will be analysed, as the IPM suggests that age counts may be biased low. Productivity assessments in MU2 in summer preferably should be extended to Sweden to achieve a more representative sample for this MU.

Greenland/Scotland and Ireland population of Barnacle Goose

The first offtake assessment of the Greenland/Scotland and Ireland population will take place in 2023. Thus, this year only an update on the raw data is available.

No census for the total population was carried out in 2021/22 (next in 2023), but there is information from annual winter counts from Islay, the most important wintering site in the UK from both 2021 and 2022. In March 2021, 29,798 birds were counted and in March 2022, 28,759 birds, which is the lowest since 1994/1995. Updates on hunting bags and derogation shooting are available from the season 2020/2021, where 1,121 were shot in Scotland under derogation and 3,429 were harvested in Iceland. No birds were taken in Ireland. However, shooting was suspended on 1/2/22 on Islay as the result of an avian influenza outbreak. The proportion of juveniles on Islay was 16.7% in early November 2020, thus the second highest since the start of the recording, only surpassed by of 24% in 1990. There are no updates on survival or crippling rate.

1. Introduction

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

In 2013, plans for the first iterative cycle were published in the form of a population status report and a harvest assessment report. In May 2016, the European Goose Management Platform (EGMP) was established, following a resolution adopted by the Meeting of the Parties of the African-Eurasian Migratory Waterbird Agreement (AEWA). The platform functions under the framework of AEWA, which provides for the conservation and sustainable use of the migratory waterbird populations it covers. The platform addresses the conservation and management of declining, as well as growing, goose populations in Europe. This is achieved by a coordinated flyway approach amongst all Range States concerned. The setup of EGMP benefited from experiences with Svalbard Pink-footed Geese, and was extended to Taiga Bean Geese in 2015. In 2017, four more populations were added to the EGMP; the NW/SW European population of Greylag Goose, as well as the three populations of Barnacle Goose: the Russia/Germany and Netherlands population, E. Greenland/Scotland & Ireland population and the Svalbard/SW Scotland population. In some specific populations, management units have been established to delineate subpopulations, which are considered to have their own demography and/or dispersal and thus need a specific management and conservation approach. Thus, four goose species and their respective management units are currently part of the EGMP (Table 1-1).

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	2024	Not developed	-	-
Taiga Bean Goose consisting of 4 MUs; Western, Central, Eastern1 and Eastern2	ISSAP	2015	2025	Not developed	-	-
NW/SW European population of Greylag Goose consisting of 2 MUs; MU1 (migratory) and MU2 (sedentary)	ISSMP	2018	2028	AFMP	2020	2026
Russia/Germany and Netherlands population of Barnacle Goose consisting of 3 MUs; MU1 (Arctic), MU2 (Baltic) and MU3 (North Sea)	ISSMP	2018	2028	AFMP	2020	2026
E. Greenland/Scotland & Ireland population of Barnacle Goose	ISSMP	2018	2028	AFMP	2020	2026
Svalbard/SW Scotland population of Barnacle Goose	ISSMP	2018	2028	Not developed	-	-

This report, together with the EGMP Database, replaces the individual population status and harvest assessment reports produced previously. The EGMP Database provides a shared platform for the most up-to-date monitoring information on each population managed under the EGMP (including data sources), whereas this report focuses on the assessment results and management guidance, to be reviewed at the meeting of the International Working Group in June 2022.

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

For populations/species where the cumulative impact of derogation and legal hunting is assessed and/or management guidance provided, input and output files of the assessment runs are available at: https://gitlab.com/aewa-egmp.

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

1.1. The assessment process

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

1) *Monitoring.*

A major component of the process for setting hunting regulations and assessing the impact of derogation consists of periodic monitoring and other data collection. Monitoring data refer to measures of abundance (counts or indices based on samples), data on productivity (counts of young and adults), survival and data to describe offtake (either hunting bags or derogation data). Monitoring and data collection are ongoing activities, which take place throughout the year, and are conducted according to agreed protocols. Data from monitoring activities are compiled by the EGMP Data Centre, by Sovon Vogelonderzoek Nederland for the Russian Barnacle Goose population, and by NatureScot for the Greenland Barnacle Goose population. See Appendix A for coverage in each country and population and the EGMP Database for overview of data used.

2) *Assessment.*

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

For populations/species where population models have been developed, demographic information like population size, productivity and survival rates are based on model estimates, and updated as new data are received. This is the case for Pink-footed Goose, Taiga Bean Goose (Central MU) and two of the Barnacle Goose populations (Greenland and Russia). For populations/species without population models (Greylag Goose and Taiga Bean Goose (western and eastern MUs)), the most current information received from the range states and their monitoring networks is presented. Due to delays in acquiring certain data, some information presented in this report will differ from that in previous reports and may also be subject to updates in future reports.

For populations/species where only derogation is allowed, the cumulative impact of offtake is assessed through retrospective and prospective analyses, investigating the effect of derogation at the population and at the MU level. The effect of the current level of derogation and environmental variables (e.g. avian influenza) is also projected into the future. This assessment process takes place every third year, and in the intervening years estimates of population abundance and other demographic information are presented.

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

Greylag Geese, where up-to-date and reliable monitoring data on abundance and offtake are unavailable, range states have agreed to use an information-gap ("info-gap") decision model until 2023, when a dynamic and model-based management process is expected to be in place (Johnson and Koffijberg 2021).

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

3) *Decision-making.*

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

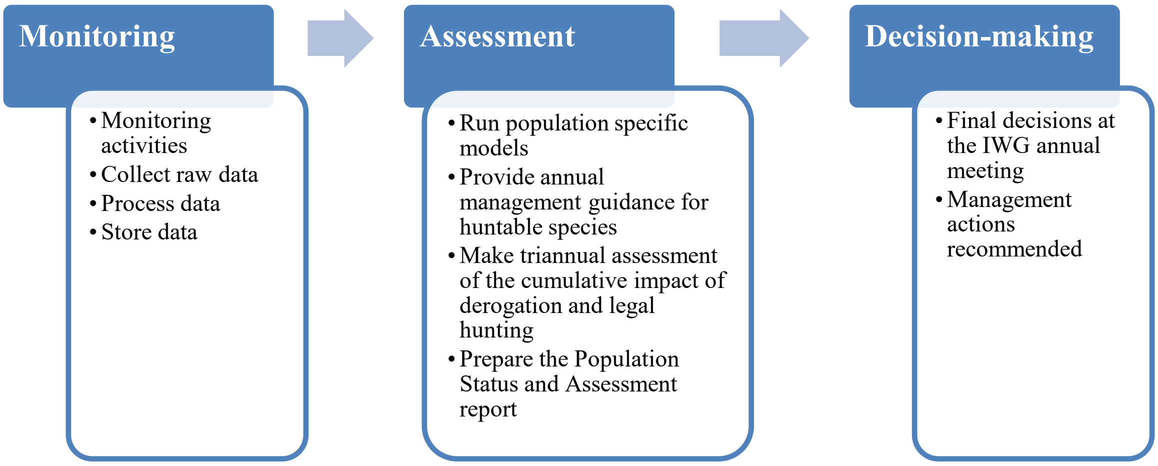

Figure 1.1-1. The EGMP assessment process, including annual activities related to monitoring, assessment and decision-making.

2. Monitoring and assessment methods

2.1. Population size

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

January census: All goose populations managed under the EGMP are covered by the International Waterbird Census (IWC), which takes place during mid-winter in January and has been implemented in most countries that are part of the respective Eurasian flyways. These counts focus on counts in wetland areas, but in some countries include schemes specifically for geese as well, covering occurrence in farmland areas. Field work is usually carried out by a large network of volunteers during daytime on feeding sites or dawn/dusk at roost sites, but precise methods, and especially coverage may vary slightly between countries. In addition, some countries (e.g. The Netherlands, Belgium) account for missing geese in the network of counting sites by estimating missing counts ("imputed") with algorithms that account for the long-term trend and the phenology in similar census areas within the region (Hornman et al. 2021; Onkelinx, Devos, and Quataert 2017). That way the data used for trend calculations represent a complete dataset and is not subject to variation in counting effort. Goose counts are collected by national coordinators and reported to Wetlands International (which coordinates the IWC survey, (van Roomen et al. 2018)).

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

Autumn census: In continental Europe, special population counts have been made for all grey geese (*Anser sp.*) in November, as well as in September for Greylag Goose (Madsen, Cracknell, and Fox 1999). Some countries have added extra months, like Sweden where goose counts are performed in September-November and January each year, or The Netherlands and Belgium, where counts are carried out from September to March/May and cover the entire wintering season. A general issue with the autumn counts is that for huntable species, the count will occur after the start of the hunting season, which from a modelling and assessment perspective complicates the assessment process.

Spring census: Counts during spring, just before the assessment process in May/June and before the next hunting season starts, is on the other hand the best time of the year to provide knowledge on the population size of huntable species shortly before breeding. For the Svalbard population of Pink-footed Goose a total count is organized in early May, just before they leave for the breeding areas and are highly concentrated in only 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.

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

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

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

2.2. Reproduction

In migratory geese, productivity is typically expressed as the proportion of young in the autumn population and is assessed at the autumn staging and wintering grounds by observing the number of young vs. adults in flocks of geese – also called age-ratio counts. Such age counts have been performed for many European goose populations for several decades by skilled experts, providing a long-term time series of their breeding performance (Madsen, Cracknell, and Fox 1999; Hornman et al. 2022). Counts are usually done from October to late December. Assessing productivity at the staging and wintering grounds is, however, likely to be affected by a number of 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 is currently being investigated, with the Svalbard Pink-footed Goose as a case study.

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 only every 12th year in France. However, since 2022, a new volunteer online declaration system has been in place in France. Furthermore, in most countries, data are gathered for each huntable waterbird species, whereas in Germany data is usually collected at a group level (e.g. “wild geese”). 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).

Derogation: EU Member States are obliged to report all derogations to the European Commission in annual derogation reports (according to Article 9 in the Birds Directive; (Eu 2020)). However, for a number of Member States, the data are 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 have also been provided by the countries themselves.

Wings and heads: In Denmark, hunters may, on a voluntary basis, submit wings from shot geese to the Danish Wing Survey. These wing samples contribute to the knowledge of the temporal variation in the hunting bag, as well as knowledge of age ratio among shot birds. In Denmark, Sweden, Finland, and Latvia, hunters have been invited to send a picture to the national hunting organisations for sub-species identification for estimating the proportion of Taiga Bean Goose among all bean geese.

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

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

2.4. Population assessment methods

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

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

3. Results and Discussion

3.1. Pink-footed Goose

3.1.1 Range states and management units

This chapter compiles monitoring data on the population status of Svalbard Pink-Footed Geese (*Anser brachyrhynchus*), as well as providing guidance for the upcoming hunting season (2022/2023). The range states for the Svalbard population of Pink-footed Goose include Norway, Denmark, Belgium and the Netherlands (Figure 3.1-1). More recently, Pink-footed Geese have established stopover sites in Sweden and western Finland (J. Madsen, personal communication).

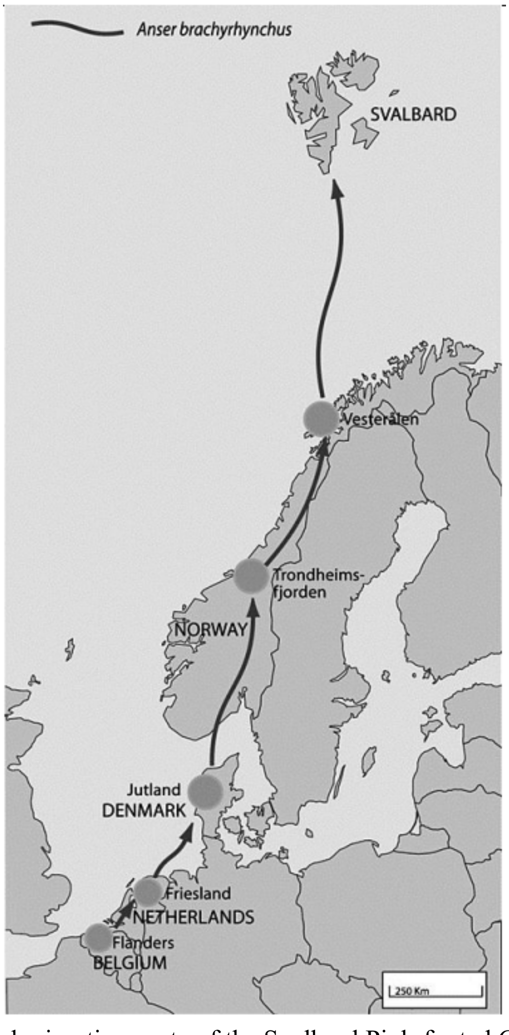

Figure 3.1-1. Annual distribution and migration route of the Svalbard Pink-footed Goose (copyright NINA, Norway).

3.1.2 Population FRP and target

No FRP has been set for Svalbard Pink-Footed Geese. The population target is 60,000 individuals in spring to help reduce agricultural conflicts, particularly in Norway, as well as tundra degradation due to grazing in Svalbard.

3.1.3 Management strategies

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

3.1.4 Assessment protocol

We used the integrated population model described by (Johnson et al. 2020), except that we now include capture-mark-recapture estimates of survival as prior information. Annual changes in population size in May are described by a difference equation:

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

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

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

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

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

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

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

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_τ) and resource-dependent (x_τ) and is defined as:

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

where N_{t+1} is the population size (in thousands) expected due to the realized harvest quota and the population target is 60 (thousand). The 10 (thousand) in the equation for population utility represents the difference from the population target when utility is reduced by one half. Thus, the objective function devalues harvest quotas that are expected to result in a subsequent population size different than the population target, with the degree of devaluation increasing as the difference between population size and the target increases.

Data are available at EGMP (calm-dune-07f6d4603.azurestaticapps.net) and R code for running the IPM is provided at: https://gitlab.com/aewa-egmp/svalbard-population-of-pink-footed-goose. The optimal harvest strategy was computed using the publicly available software MDPSolve (© 2010 – 2011 Paul L. Fackler, https://github.com/PaulFackler/MDPSolve), which is a set of SDP tools written in the proprietary MATLAB® programming language. The optimization code can be found at the same location as the IPM.

3.1.5 Status

a) Abundance and trends

Posterior estimates of population size at two times of the year are depicted in Figure 3.1-2. The reader is cautioned that historic estimates may differ from those presented previously (see Methods section 2.4). Beginning in May 2021, the population estimate was 79,122 (60,785 – 91,169). In November 2021, the population size was estimated as 80,816 (68,988 – 93,771). The May 2022 population estimate was 71,393 (59,753 – 86,621), which is lower than the May 2021 estimate (with probability 0.93). Population size has been relatively stable since implementation of the adaptive harvest management program in 2013.

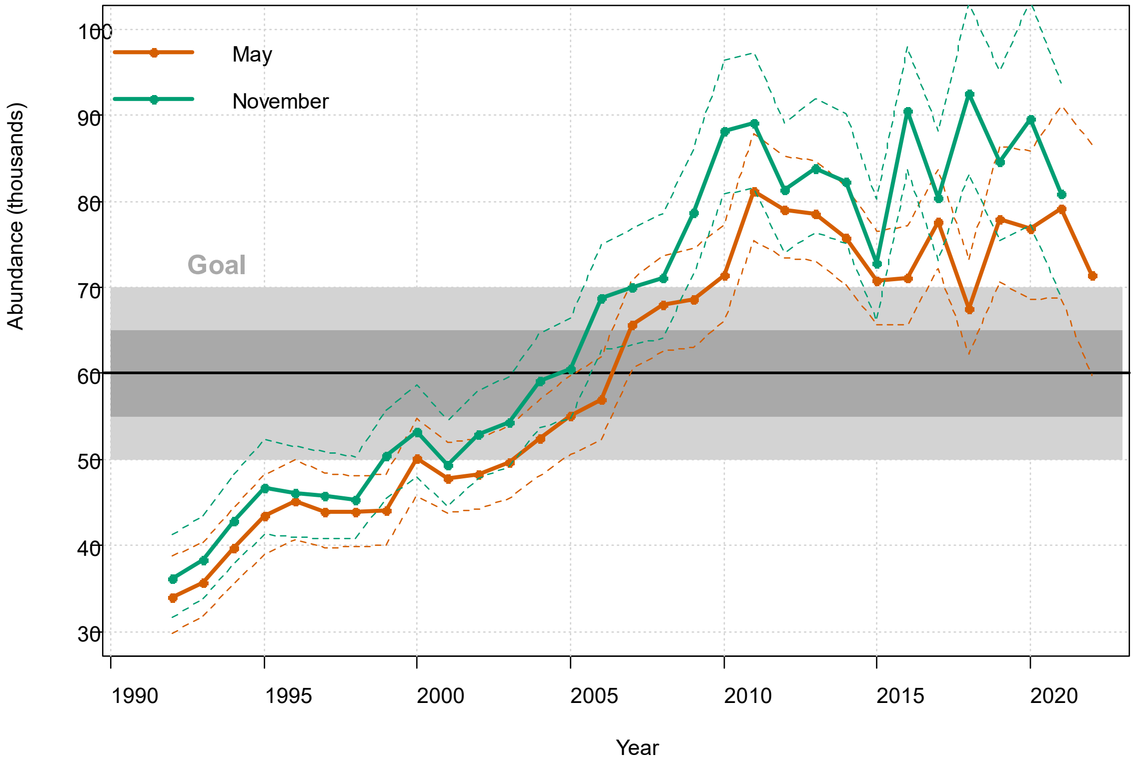

Figure 3.1-2. IPM-based estimates of abundance of Svalbard Pink-footed Geese in May and November, relative to the goal of 60,000 (95% credible intervals are indicated by the dashed lines). The dark grey band centered on the goal defines near-complete stakeholder satisfaction with population sizes, while the light grey band exhibits ≥ ½ of maximum satisfaction.

b) Mortality and trends

Posterior estimates of country-specific harvests Svalbard Pink-Footed Geese are provided in Figure 3.1-3. Posterior estimates of annual harvest and survival rates of the flyway population are provided in Figure 3.1-4. Harvests and harvest rates were increasing prior to the implementation of the adaptive harvest management program in 2013, but have been somewhat stable since. Estimates of annual survival have generally decreased during the entire period of record.

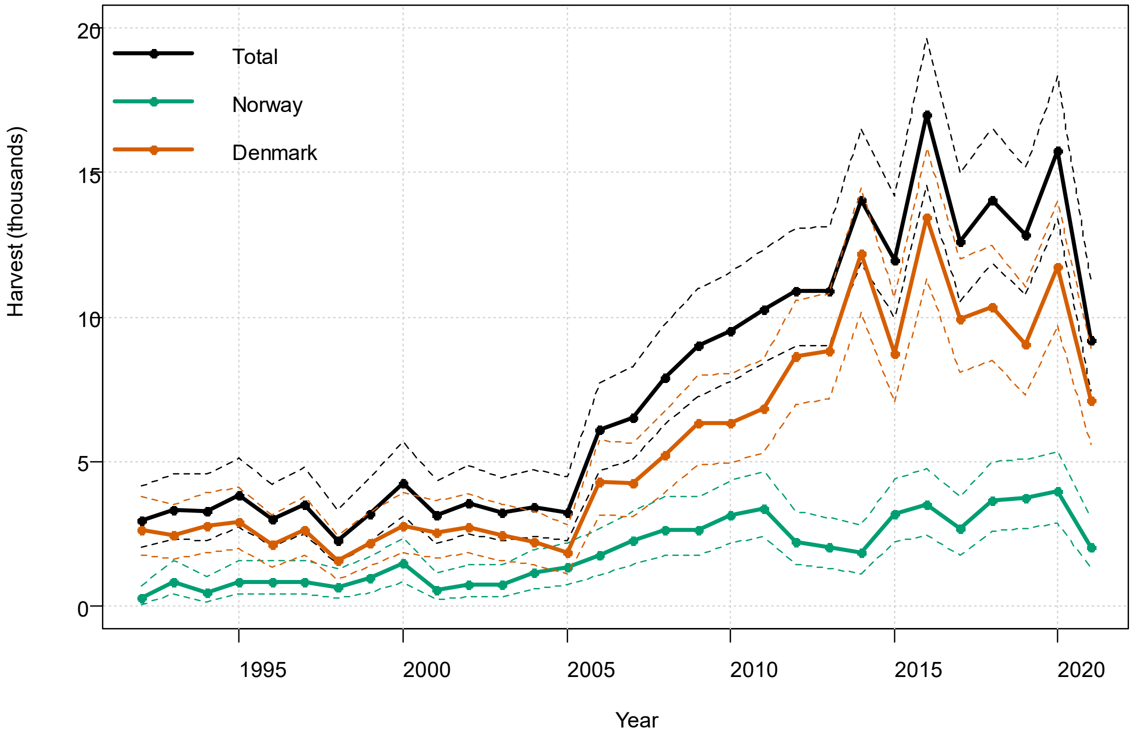

Figure 3.1-3. IPM-based estimates of harvests of Svalbard Pink-footed Geese (95% credible intervals are indicated by the dashed lines).

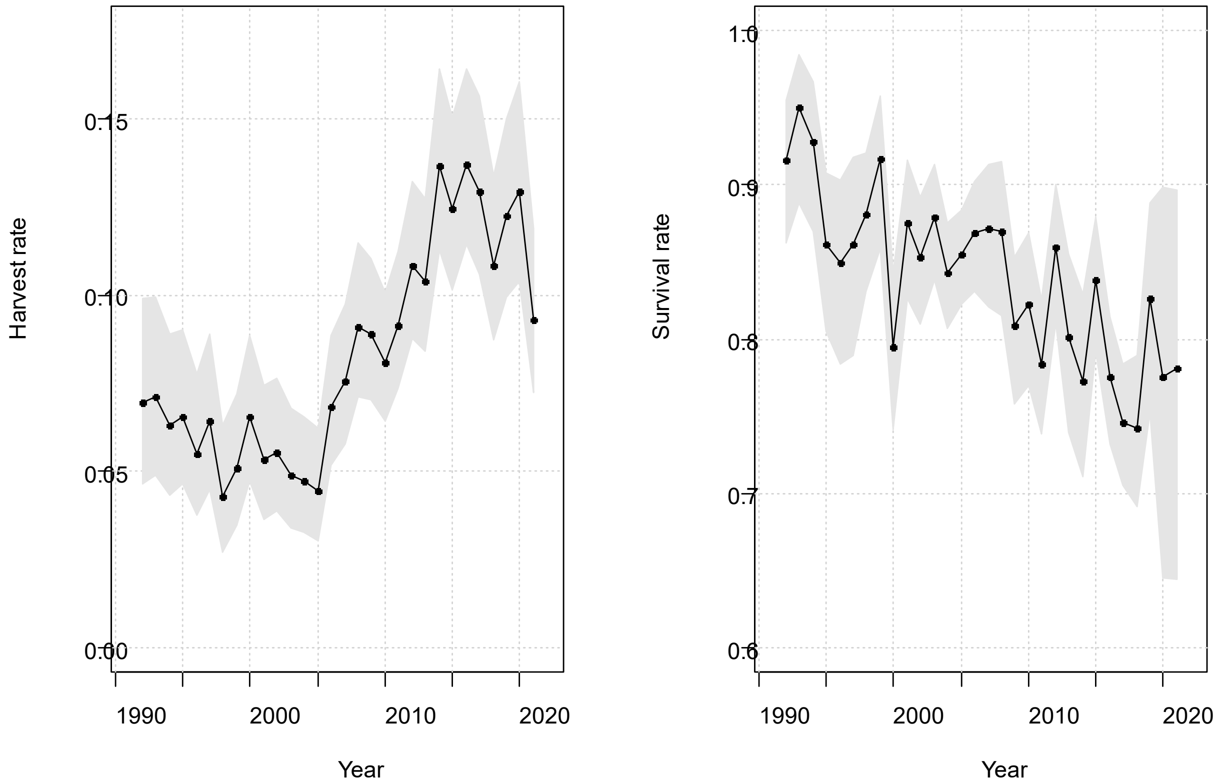

Figure 3.1-4. IPM-based estimates of harvest and annual survival rates of adult Svalbard Pink-footed Geese (95% credible intervals are indicated by the shaded polygons).

c) Reproduction and trends

Estimates of productivity, as indicated by the post-breeding proportion of young in the population, have been variable, with an average proportion of 0.20 (*se* = 0.01) young (Figure 3.1-5). 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 – 0.15) occurred in 1998, following 0 days above freezing in May in Svalbard. In 2021, the estimated post-breeding proportion of young was 0.15 (0.13 – 0.16), following only 2 days above freezing in May in Svalbard.

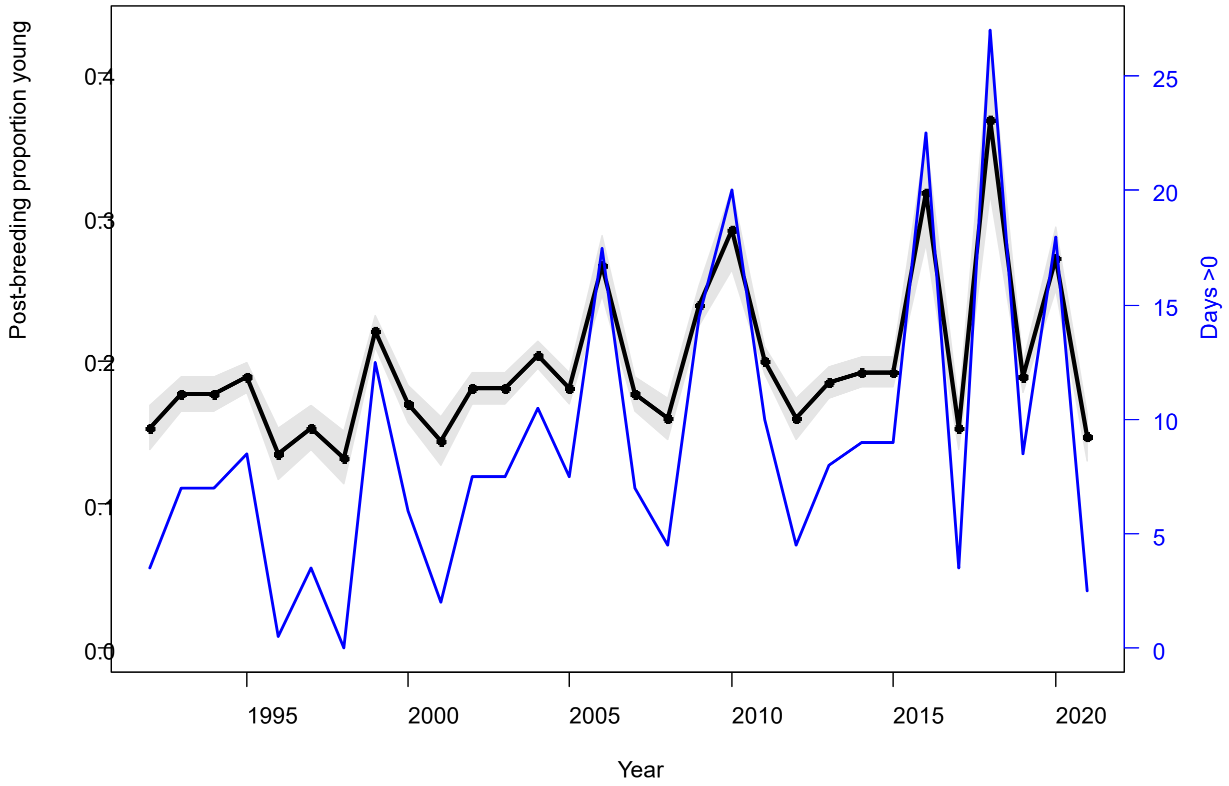

Figure 3.1-5. IPM-based estimates of the post-breeding proportion of young for Svalbard Pink-footed Geese (95% credible intervals are indicated by shaded polygon). In blue are the number of days above freezing in May in Svalbard.

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 35,000 within the most desirable range of population sizes (i.e., 55,000–65,000) (Figure 3.1-6). 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 (10), the harvest quota is 5,000. The management strategy in Figure 3.1.5 also depicts the evolution of May population size, days above freezing in May, and harvest quotas since implementation of AHM in 2013.

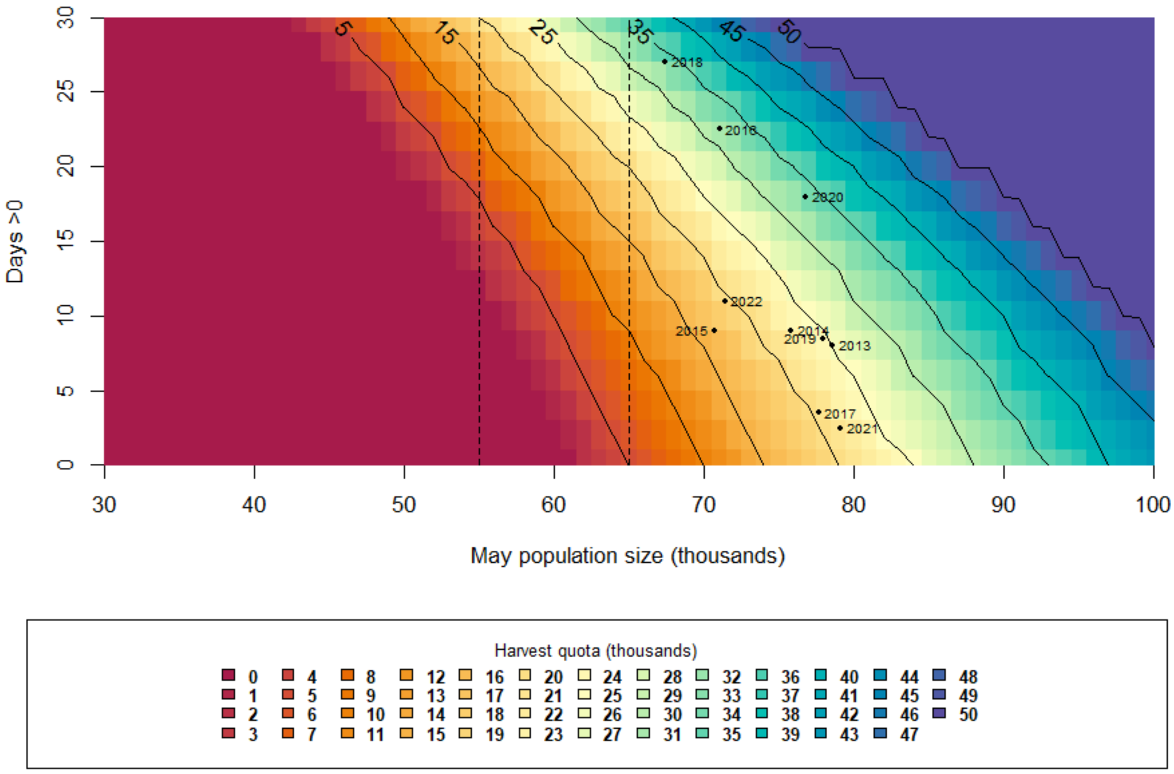

Figure 3.1-6. Optimal harvest quotas for Svalbard Pink-footed Geese based on an IPM and an objective to maintain population size near 60,000. Days >0 represents the number of days above freezing in May in Svalbard. The vertical dashed lines depict near-complete stakeholder satisfaction with population sizes. Also depicted are population sizes and days above freezing for the years in which AHM has been in place (2013–2022).

The harvest quota for the 2022/2023 hunting season, based on the estimated population size of approximately 71,400 and 11 days above freezing in Svalbard in May 2022, is 19,400. Using an agreed upon allocation of the total quota (30% for Norway, 70% for Denmark), harvest quotas for Norway and Denmark this year are 5,820 and 13,580, respectively. For comparison, the realized harvest has averaged about 12,900 (*se* = 1,100) during the last five years (66% of this year's quota).

3.2. Taiga Bean Goose

3.2.1 Range states and management units

This chapter compiles monitoring data on the population status of the Western and Eastern Management Units (MU) of Taiga Bean Goose for the season 2021/2022, as well as an assessment of the population development and management guidance for the Central Management Unit for the coming hunting season (2022/2023). There are four recognized Management Units for Taiga Bean Geese:

- *Western MU:* Breeding in Northern and Central Sweden and Southern and Central Norway, wintering in Northern Denmark and Northern and Eastern United Kingdom;
- *Central MU*: Breeding in Northernmost Sweden, Northern Norway, Northern and Central Finland and adjacent North-western parts of Russia, wintering mostly in Southern Sweden and South-east Denmark;
- *Eastern 1 MU*: Breeding in upper Pechora region and western parts of west Siberian lowlands of Russia, wintering mostly in North-east Germany and North-west Poland;
- *Eastern 2 MU:* Breeding in eastern parts of west Siberian lowlands of Russia, wintering in North-west China, South-east Kazakhstan and east Kyrgyzstan (Figure 3.2.1).

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.

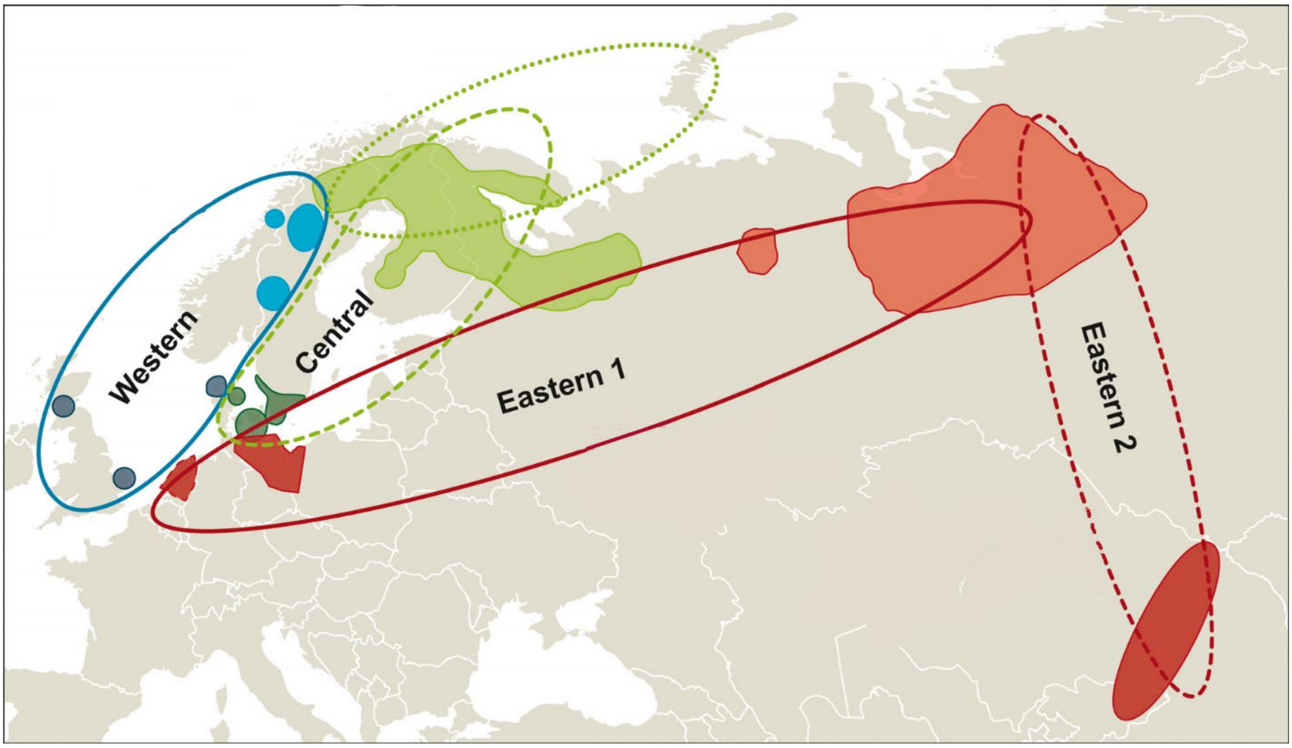

Figure 3.2-1. The four Management Units of Taiga Bean Goose (green dotted line indicates linkages between breeding areas in norther Fennoscandia and known moulting areas in Novaya Zemlya and the Kola Peninsula)

3.2.2 Population FRP(s) and target(s) (if any)

To restore and maintain the total population at a favourable conservation status of 165,000 – 190,000 geese, population targets have been specified for each management unit: 5,000 – 10,000 individuals in the Western MU, 60,000 – 80,000 individuals in the Central MU, and 100,000 individuals total in the Eastern 1 and Eastern 2 MUs, with stable or increasing trends in all (Marjakangas et al., 2015).

3.2.3 Management strategies

The abundance of Western MU geese is currently considered too small to support hunting and are protected from hunting in UK and in Denmark by a regional hunting ban. Taiga Bean Geese from the Eastern 1 MU are hunted in Germany, 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. For the CMU, the EGMP is operating under an interim harvest strategy intended to allow population size to reach the median target of 70,000 by March 2025, while still providing limited hunting opportunity.

3.2.4 Assessment protocol

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

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

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

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

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 α represents the proportion of the Swedish harvest occurring prior to January (i.e., the regular hunting season). Abundance in the following March is thus:

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

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

To evaluate the current, interim harvest strategy, we projected population size three 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 the average). Total harvest is to be allocated among Russia (15%), Finland (49%), Sweden (26%), and Denmark (10%) based on an agreement among Range States. 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.

We note that some historical data for Taiga Bean Geese have been updated or corrected since the stock assessment in 2021. This includes counts in March (2019 – 2021) and October (2004 – 2006, 2016 – 2019) in Sweden, and January counts in Denmark (2007 – 2008). It also includes several years of Swedish (1996, 1998, 2006, 2016 – 2019) and Danish (1996, 1998, 2006, 2016 – 2019 and 2004 – 2006, 2011 – 2013, 2016 – 2020) harvest estimates. Note also that we have decided to use the maximum of the October or November count in Sweden as the best indicator of fall population size (the November count was the maximum of the two counts in 2004 – 2006, 2012, and 2021). We alert the reader that these revisions to the historical data have resulted in some changes to the past estimates of population abundance and demography. We also remind the reader that historic estimates can also change when the IPM is updated each year, absent any changes to the historical data (see Section 2.4). Finally, we note that Sweden has recently changed its methodology for estimating harvests (Lindstrom and Bergqvist 2020), and revisions to historical estimates are quite substantive. We have not incorporated those new estimates here, however, deferring their use until we can study and understand the potential implications for Taiga Bean Goose demography and harvest management. Current data and code for running the 2022 stock assessment can be found at: https://gitlab.com/aewa-egmp/taiga-bean-goose.

3.2.5 Status – Western MU

a) Abundance

The IWC count in 2022 took place in Denmark on and around the weekend of 15-16 January. For this population we made a dedicated Bean Goose count on 16 January, where we managed to get a more comprehensive count in the main area in NE Jutland. This was mainly because of improved coverage, but may have also been because the flocks were less dispersed than usually. It was conspicuous that some flocks had moved out from the wetlands and lower lying wetter grassland areas throughout their winter range onto more intensive farmland areas, where they were more conspicuous than in previous years. This count resulted in a total of 1,940 birds (Figure 3.2-2), and on 18 January a small flock of 24 birds was found in the Lundergård Mose area west of Pandrup, which is known to be used as a stop-over by birds wintering in Slamannan, UK. Hence, 1,964 Taiga Been Geese but no Tundra Bean Geese was found in Western Management Unit parts of Denmark. Bean Geese in North Jutland are notoriously very difficult to locate, but this year's number is the highest on record in this century, and perhaps even longer back, although we still need a dedicated analysis of all data for this region, that include other months than January, to conclude this.

In Scotland, the peak winter count during 2021/2022 was 217 (which was achieved on 1 January 2022); this was an increase of seven birds relative to the previous winter. In England, five Taiga Bean Geese were recorded almost daily between 04/12/2021 and 17/01/2022 at RSPB Buckenham Marshes in the Yare Valley in Norfolk (England). There have been no other records of Taiga Bean Geese in England this winter. Thus, the total population estimate for the United Kingdom was 222 individuals in 2021/2022 (Figure 3.2-2).

Adding the Danish and British gives a total for the Western Management Unit of 2,186 birds in January 2022 (Figure 3.2-2). This is remarkably higher than in the preceding winters (mean of 1,343 during 2019-2021), perhaps mostly because Denmark succeeded in getting a detailed count this year. Bean Geese in North Jutland are usually very difficult to locate. Nevertheless, the population level remains far below the short-term target (for the next 20 years) of 4,000 individuals, specified in the ISSAP (Marjakangas et al. 2015).

We still consider mid-winter to be the best period of the year to count the Western MU Taiga geese. Although Western MU geese may be more concentrated during other times of year (e.g. in the Östen/Ymsen area in Sweden in autumn and spring), data from telemetry tagged Western MU Taiga show them intimately mixed with (and therefore inseparable from) Central MU birds at these staging areas.

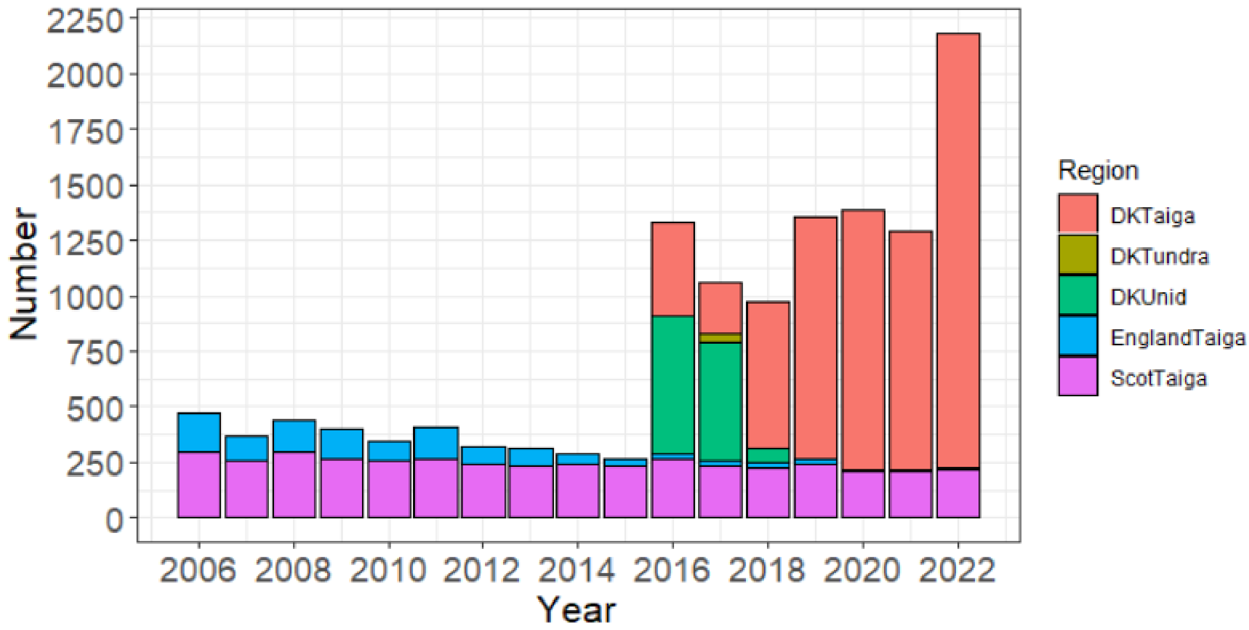

Figure 3.2-2. Population size of the Western MU of Taiga Bean Goose during mid-winter since 2006 in the UK and since 2016 in Denmark. The number of Tundra Bean Geese and unidentified Bean Geese are included for Denmark.

b) Mortality

No survival information exist for the Western MU of Taiga Bean Goose. It is protected from hunting.

c) Reproduction

Four separate age assessment counts were made during October – December 2021. In summary, the percentage of juveniles identified was considered to be 12.0% (of a total of 151 birds aged) (Figure 3.2-3). This was broadly comparable with the figures calculated for winter 2020/2021, which averaged 12.0%, and 2019/2020, which averaged 11.3% (compared to just 7.0% in winter 2018/2019).

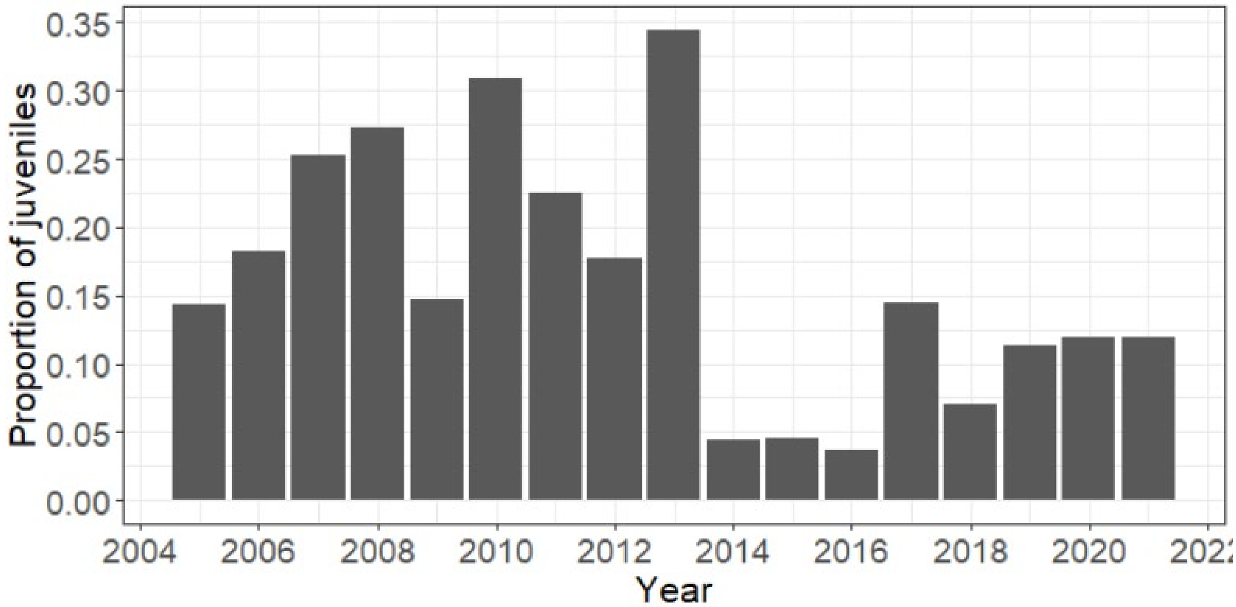

Figure 3.2-3. Annual proportion of juveniles in the Western MU of Taiga Bean Goose 2005-2021.

3.2.6 Status – Eastern 1 and 2 MU

There is no information on the status and demography of Eastern Management Units beyond what was reported in the 2021 Population Status and Assessment Report.

3.2.7 Status – Central management unit

a) Abundance and trends

Posterior estimates of population size at three times of the year are depicted in Figure 3.2-4. Beginning in March 2021, the population estimate was 64,877 (60,142 – 69,396). In October 2021, the population size was estimated as 71,127 (65,249 – 76,791). The January 2022 population size, for which there was no corresponding count in Sweden, was estimated as 68,016 (61,885 – 73,189). Finally, the March 2022 population estimate was 66,472 (59,976 – 71,654), which is similar to the March 2021 estimate. March and October population estimates tend to be less than the counts (in red in Figure 3.2-4) because counts include both the taiga and tundra subspecies, while the posterior estimates are restricted to the taiga subspecies. The January population estimates tend to be greater than the counts because Germany does not provide January count data. The IPM suggests that on average about 11,000 (*sd* = 9,000) Central MU Taiga Bean Geese are in Germany during winter.

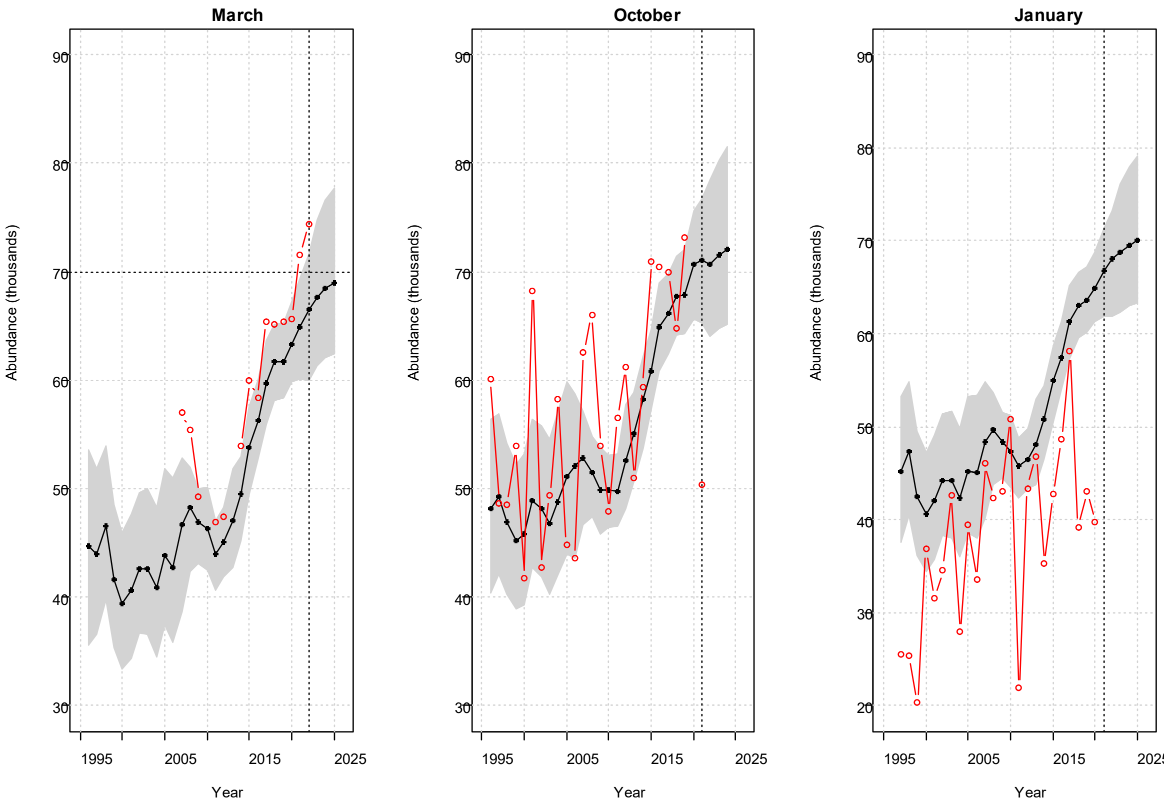

Figure 3.2-4. Posterior estimates of population size (in black, with 95% credible intervals in gray) based on an IPM for Taiga Bean Geese in the Central Management Unit. Raw counts are in red. The vertical, dashed lines represent the last year of data. Future abundances were projected based on the interim harvest strategy intended to reach the median population target of 70,000 by March 2025. The horizontal line at 70,000 in the left panel represents the median population target.

b) Mortality and trends

Posterior estimates of country-specific harvests of Central Management Unit Taiga Bean Geese are provided in Figure 3.2-5. Posterior estimates of annual harvest rates and apparent survival of the flyway population are provided in Figure 3.2-6. Harvest rates declined dramatically following the Finnish harvest moratorium in 2014, and this decrease in harvest rate coincides with strong growth in the population. Harvest rates during the five years of the interim harvest strategy (2017 – 2021) averaged 4.5% (*sd* = 1%). Estimates of apparent survival increased markedly with implementation of the Finnish harvest moratorium, and have averaged 88% (sd = 1%) since implementation of the interim harvest strategy. We refer to these estimates as apparent survival because they do not account for any density-dependent effects that may have been operative.

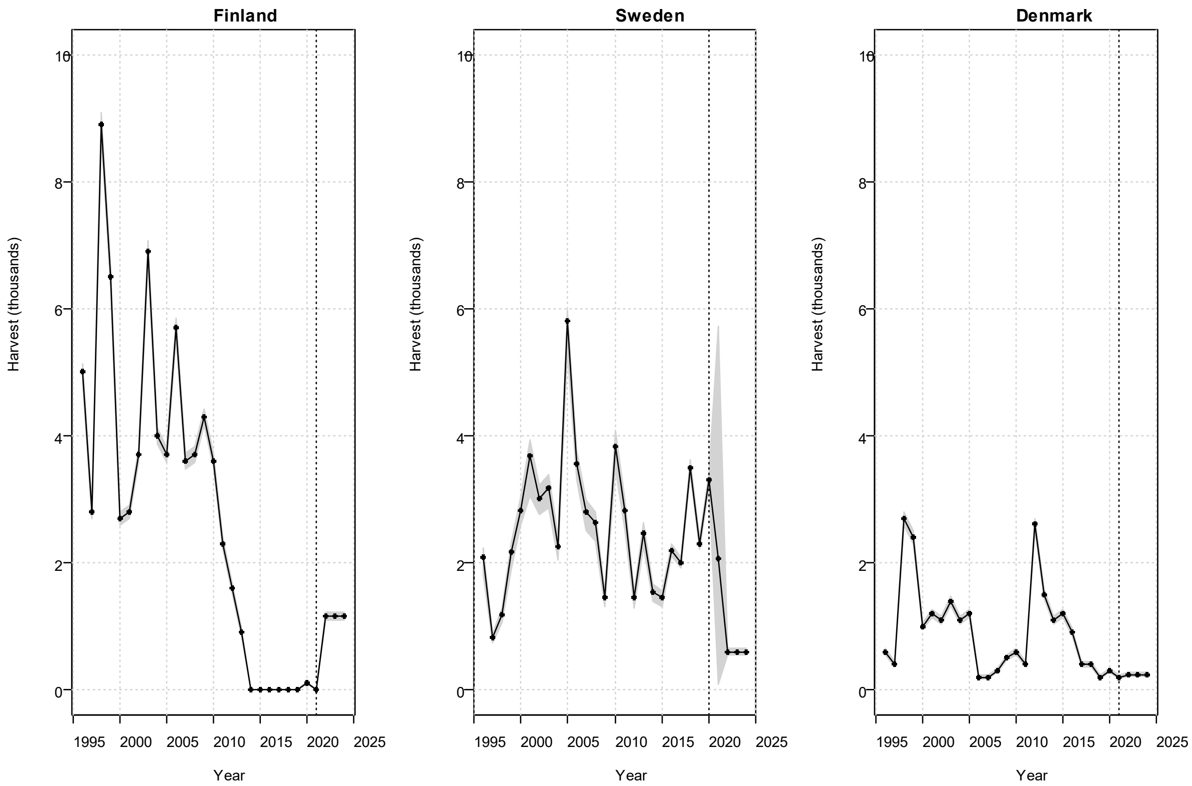

Figure 3.2-5. Estimated harvests (in thousands, with 95% credible intervals in grey) based on an IPM for Taiga Bean Geese in the Central Management Unit. The vertical, dashed lines indicate the last year of data. Future harvests were projected based on the interim harvest strategy intended to reach the median population target of 70,000 by March 2025, with country-specific allocations as agreed upon. The unusually large credible interval for the 2021 Swedish harvest is due to the fact that there is a one-year lag in obtaining harvest estimates from Sweden.

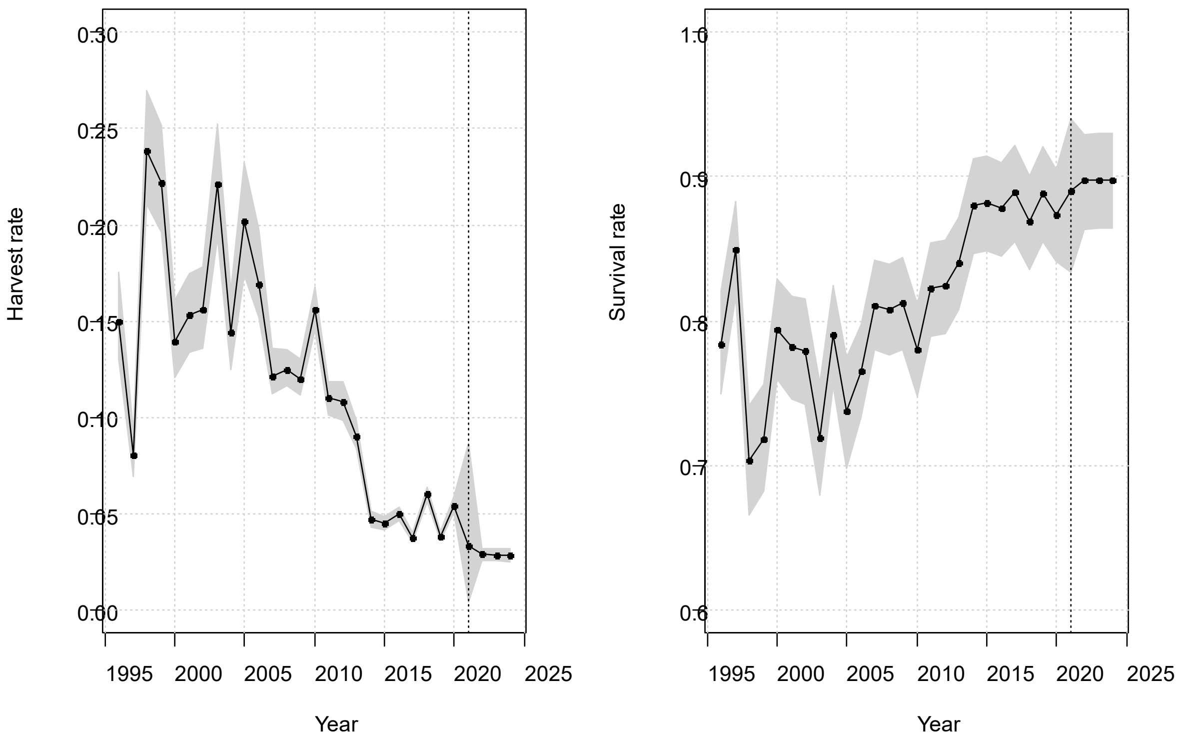

Figure 3.2-6. Posterior estimates of harvest and apparent survival rate based on an IPM for Taiga Bean Geese in the Central Management Unit, with 95% credible intervals in grey. The vertical, dashed lines represent the last year of data. Future rates were projected based on the interim harvest strategy intended to reach the median population target of 70,000 by March 2025. The unusually large credible interval for the 2021 harvest-rate estimate is due to the fact that there is a one-year lag in obtaining harvest estimates from Sweden.

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* = 0.05). It should be mentioned that these posterior estimates are very similar to their informative prior mean, albeit more precise.

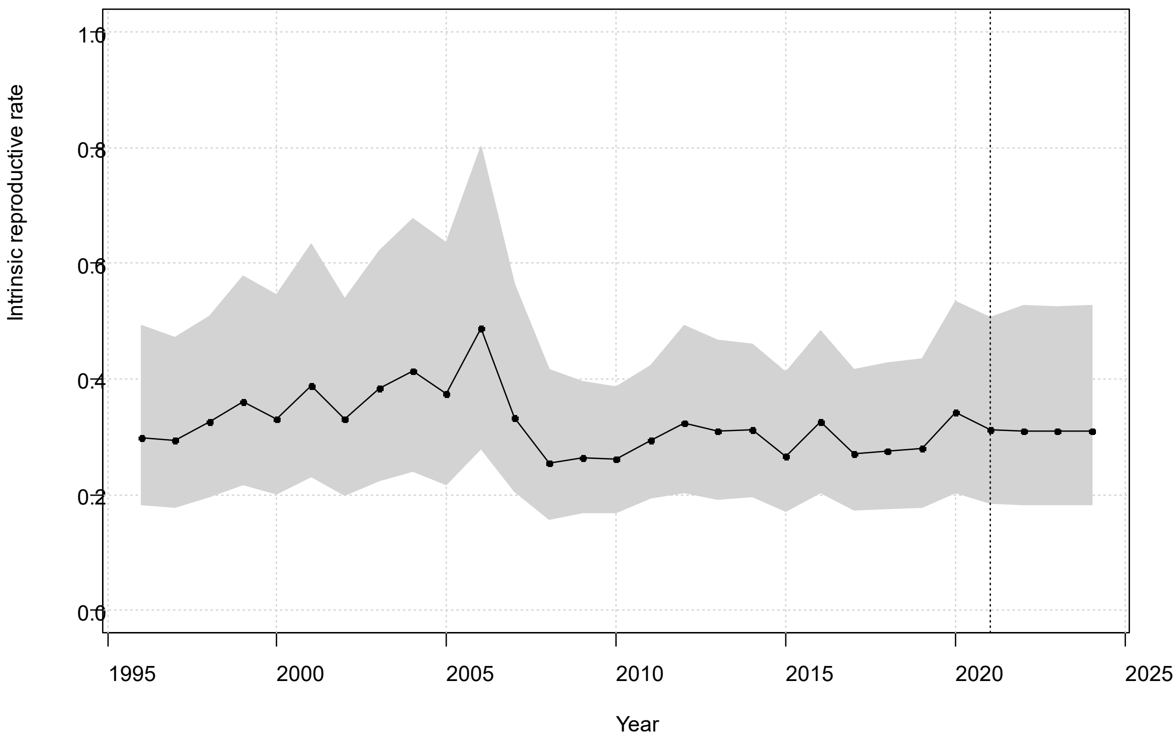

Figure 3.2-7. Posterior estimates of the intrinsic reproductive rate (in black, with 95% credible intervals in gray) based on an IPM for Taiga Bean Geese in the Central Management Unit. The vertical, dashed lines represent the last year of data. Future reproductive rates were projected based on an informative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

3.2.8 Management guidance

For the Central Management Unit, the forecasts of harvests for the years 2022 – 2024 are those needed to attain a population size near 70,000 in March 2025 (on the average). Moreover, the country-specific harvests for these future years are in accordance with the agreed-upon allocation of total harvest among the three countries. The total allowable harvest is 2,000 (1,913 – 2,089) and the country-specific allocations of this harvest are: Finland – 1,160 (1,094 – 1,227); Sweden - 600 (553 – 648); and Denmark - 240 (210 – 271). For comparison, the estimated total harvest averaged 2,955 (*sd* = 781) during the years of the interim harvest strategy (2017 – 2021). Notice that the projected harvests in Figure 3.2-5 are quite different in Finland and Sweden than they have been during the years of the interim harvest strategy. At the median population target of 70,000 birds, the harvestable surplus would be 3,668 (0 – 6,504).

3.3. Greylag Goose

This chapter compiles monitoring data on the current population status of the NW/SW European population of Greylag Geese *Anser anser* and provides an update on the establishment of the necessary monitoring frameworks outlined in the AFMP to set the stage for a dynamic and model-based assessment at the MU level in 2023 (Nagy et al. 2020).

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). Based on the recognition of regional differences in migratory behaviour and the human-wildlife conflicts involved with this population, it has been agreed to define two MUs (Nagy et al. 2020).

MU1 includes the breeding populations from Norway, Sweden, Finland and Denmark that subsequently stage and winter in areas in The Netherlands, Germany and Belgium. Some birds migrate to the southernmost wintering sites in France and Spain. MU2 is the mainly sedentary populations of The Netherlands, Belgium and Germany, and include a small French population of c. 200 breeding pairs (Bacon et al. 2019; Nagy et al. 2020). The German population is regarded as sedentary, although it is known that breeders in the eastern part of the country are showing more migratory behavior (Bairlein et al. 2014) (Figure 3.3-1).

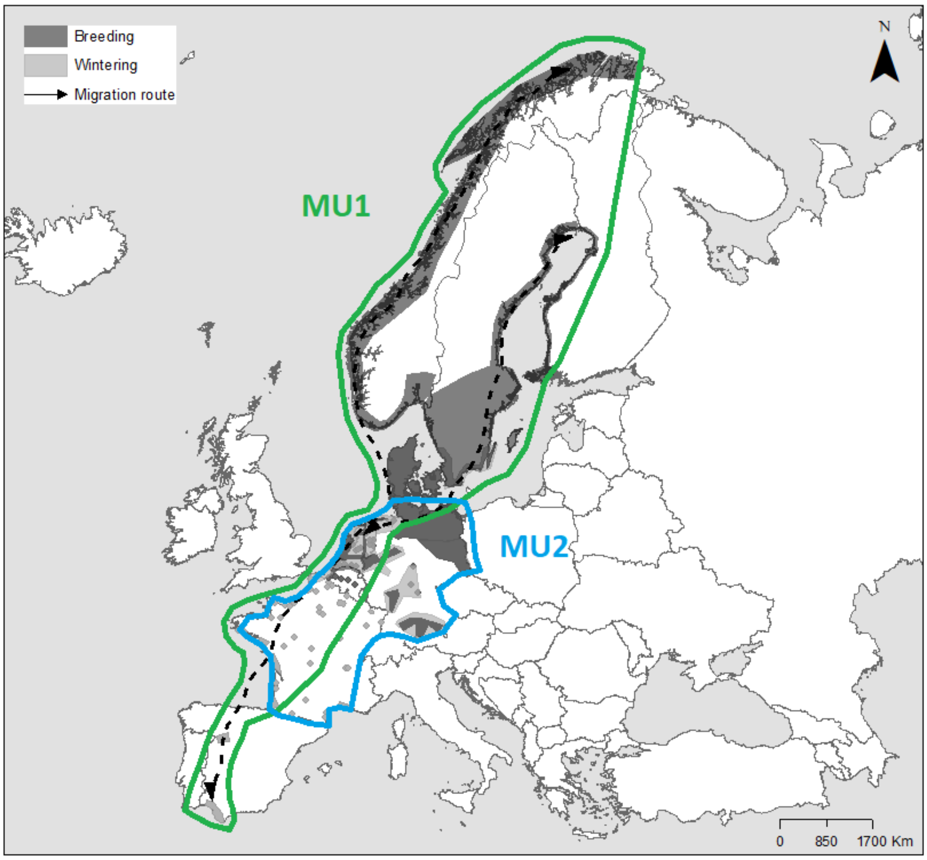

Figure 3.3-1. Annual distribution and main migration routes for the NW/SW European population of Greylag Goose including breeding (grey) and wintering (light grey) areas, as well as areas, which are both used during the breeding and wintering period (dark grey) as presented in Powolny et al (2018). The 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. 2020). 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. 2020; Johnson and Koffijberg 2021). During this process, range states have 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). Because the propensity of evidence suggests that current estimates of offtake are biased high, perhaps severely so, Therefore, countries may increase their nominal offtake by a maximum of 40% over offtake values provided in the ISSMP (Table 9) (however, this is optional and not an obligation). This management guidance is to be used until a dynamic, model-based management strategy is developed and implemented, hopefully in 2023/2024.

3.3.4 Assessment protocol up until 2022

Growth rate is assessed based on 10-years trend calculated from the latest available data using IWC imputed values or additional country-specific data from January.

3.3.5 Population status

a) Abundance

a. Winter population size and growth rate.

Winter abundance of Greylag Geese are represented by three different values; EGMP national totals, IWC total using respectively, IWC imputed values and IWC observed values for NO, SE, NL, DE, BE, FR, PT, ES as well as values from a special goose count scheme in Denmark. The IWC observed values cannot be interpreted as representing the entire population in a range state, and are only included for comparisons to the numbers submitted to the EGMP Data Centre.

The IWC imputed values for the population produced a total of 1,131,525 individuals (Figure 3.3-2). However, as mentioned in Heldbjerg et al. (2021), the IWC total should be viewed critically. Due to major data gaps in Spain at site level after 2010, the estimates from Spain include a high degree of imputing, and as a consequence, the IWC imputed totals may overestimate the actual population size by some 200,000 birds in the period of 2011-2013 and 2021 (Figure 3.3-2 and 3.3-3). The IWC total without imputed values from Spain, produced a total of 865,582 individuals (Figure 3.3-2).

The corresponding growth rate based on a 10-year trend from 2012-2021 using IWC imputed values and including estimates from Spain is 0.994 (0.963-1.025), and when excluding estimates from Spain the growth rate is 1.014 (1.002-1.026). Thus, using values including estimates from Spain, the management criterion of an annual growth rate of 0.96 < lambda < 1.00, thus a decreasing population, is achieved, whereas when using values excluding estimates from Spain, the growth rate continues to be above 1 and the population size continues to increase. However, given the large uncertainty in the estimates from Spain it is difficult to conclude if the population in Spain is in fact decreasing, or the decrease is a result of missing counts. Furthermore, it is important to note that the potentially observed population decrease is mainly a result of a decreasing population in Spain (Figure 3.3-3). Thus, it is primarily, the migratory segment of the population, which appears to be declining.

EGMP national totals for 2021 are available from all range states with the exception of Germany, where data have not been made available to the EGMP Data Centre (and neither published information was available), and Sweden, where the count was not performed in SW Scania (the most important area in January) due to Covid travel restrictions. Due to these limitations, it is not possible to estimate a reliable total population size and to calculate a growth rate based on EGMP national totals. Furthermore, as the EGMP national totals to a large extent is similar to the IWC observed values (Figure 3.3-3), the use of the numbers should be further investigated.

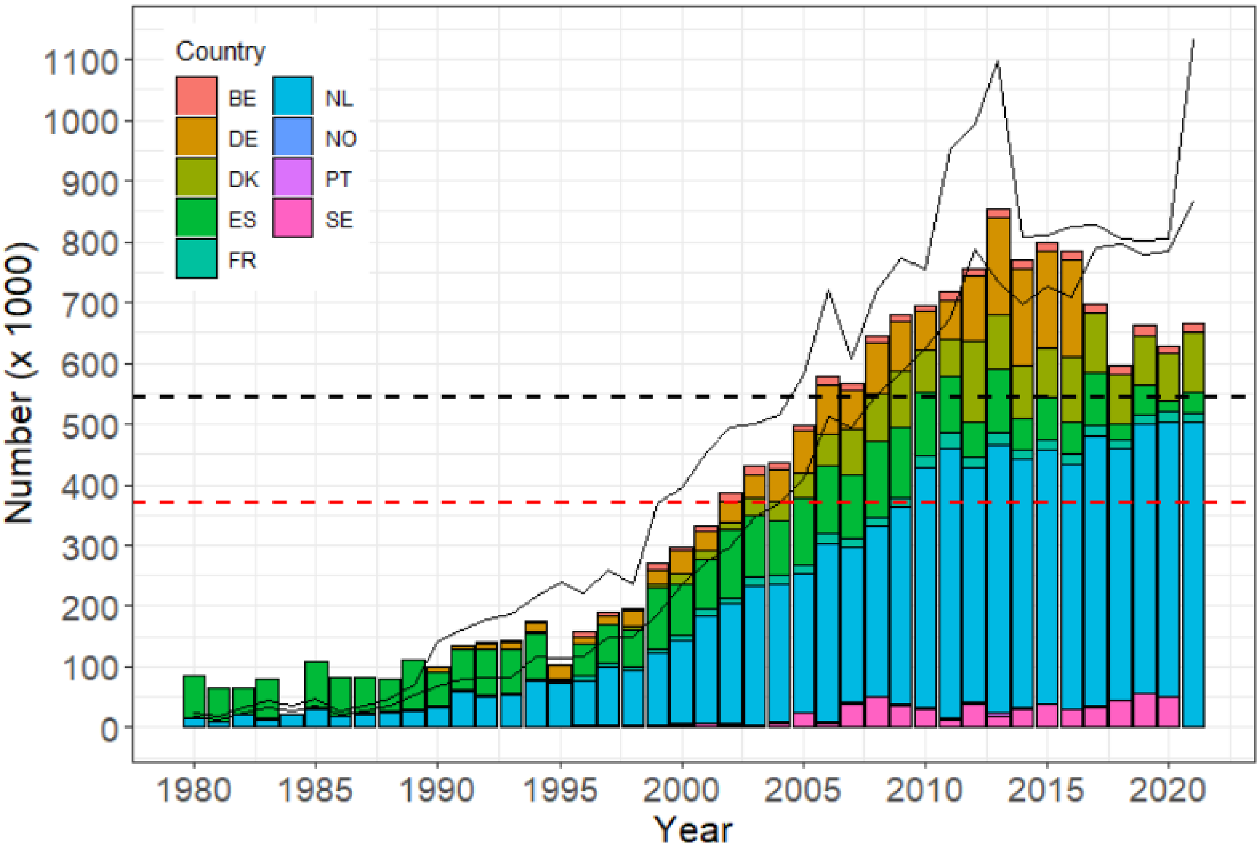

Figure 3.3-2. Development of the size (individuals) of the NW/SW European mid-winter population of Greylag Geese at a country level based on EGMP counts (bars) and at the population level based on IWC imputed values including (upper black line) and excluding (lower blackline) imputed values from Spain. EGMP count data is missing from Germany from 2017-2021 and Portugal from 2018-2021, and no count was performed in Sweden in 2021. IWC imputed values are available from 1980-2021. The dashed black line represents the target for the wintering population, and the red dashed line represents the FRP.

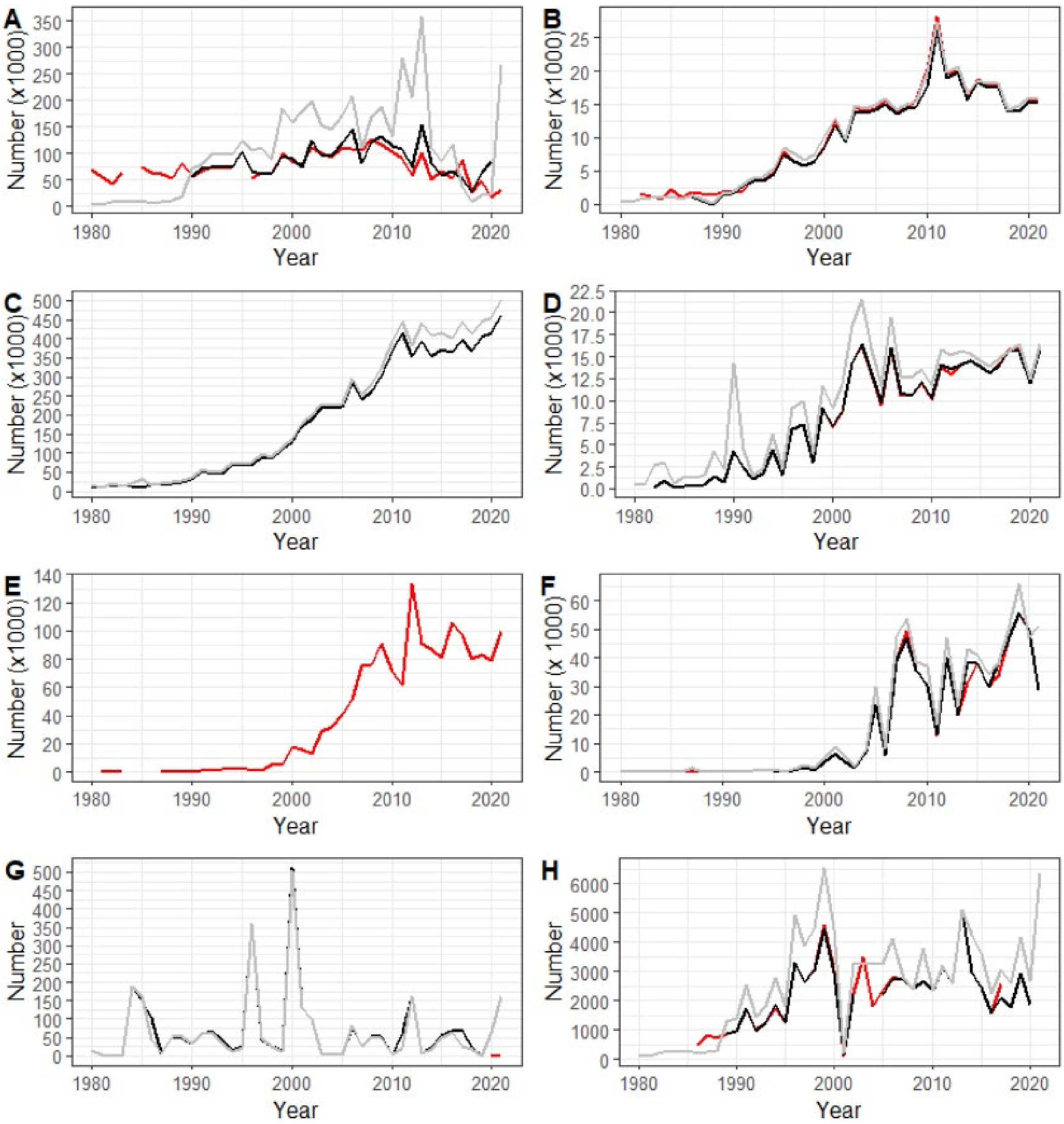

Figure 3.3-3. Development of the size (individuals) of the NW/SW European mid-winter population of Greylag Geese at a country level based on EGMP counts (red), IWC imputed values (grey) and IWC observed values (black). A) Spain, B) France, C) The Netherlands, D) Belgium, E) Denmark, F) Sweden, G) Norway and H) Portugal. Access to the German data have not been granted to the EGMP Data Centre.

a. Summer counts and common breeding bird index

For MU1, post-breeding summer counts are currently being explored within the Fennoscandian Greylag Goose Initiative (FGGI), including projects in Norway, Sweden, Finland, and Denmark. The results from these projects will be presented in 2023. For MU2, counts are carried out in parts of Germany, The Netherlands and Belgium. Data is however only available from Belgium and the Netherlands, and two states in Germany (Nordrhein-Westfalen and Niedersachsen). Numbers from France and Spain are regarded as not essential due to small breeding populations. Using these data sources, the size of MU2 is minimum 571,457 individuals in 2021, which is the highest numbers recorded so far, even without numbers in Germany in 2021 (Figure 3.3-4). It is important to note, however, that the summer counts provide information on the number of individuals, whereas the FRP for the breeding population is set in numbers of breeding pairs.

The Common Breeding Bird Index is presented from Norway, Sweden, Denmark, Finland and the Netherlands. For Germany, data have not been made available to the EGMP Data Centre, and in Belgium, the species is considered too scarce and with too much an aggregated distribution to produce a reliable index. Finally, the indices for Denmark have been recalculated and now only include years back to 1987. Especially for the Netherlands, Denmark and Sweden with the longest time-series going back to 1984, 1987 and 1981, respectively, the growth rates have slowed down in recent years when comparing the long-term data vs the 10-year period. In The Netherlands, the growth rate has gone down from a mean of 1.053 to 1.016, in Denmark from 1.022 to 1.005 and in Sweden from 1.015 to 1.007 (Figure 3.3-5).

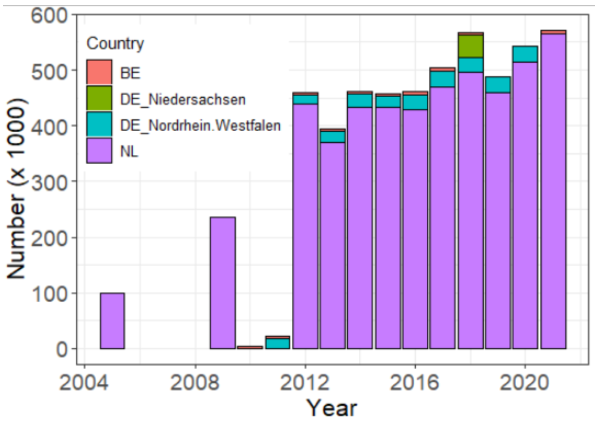

Figure 3.3-4. Development of the size (individuals) of the NW/SW European summer population of Greylag Goose at the MU2 level: Belgium 2010-2018, 2021, The Netherlands 2005, 2009, 2012-2021, Nordrhein-Westfalen, Germany 2011-2020 and Niedersachsen, Germany 2018.

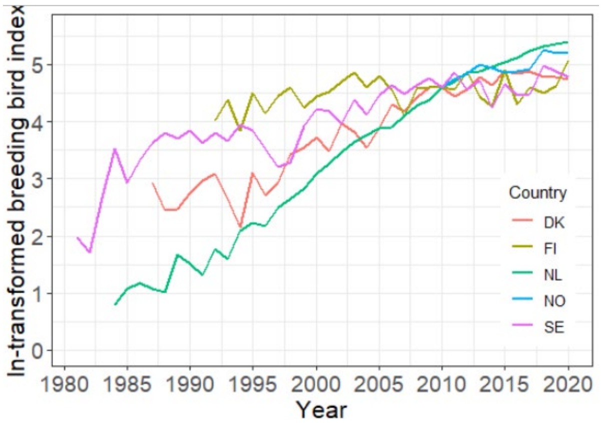

Figure 3.3-5. National ln-transformed breeding bird indices for Greylag Goose provided by the different national Common Bird Monitoring programmes: Norway 2010-2021, Sweden 1981-2021, Finland 1992-2021, Denmark 1987-2021 and The Netherlands 1984-2020. The index is set to ln(100) in year 2010.

b) Mortality

a) Offtake at population level

There is no total hunting bag estimate available for 2020, as estimates are only available from part of the range states and regions; Norway, Sweden, Finland, Denmark, Belgium, Spain and Schleswig-Holstein in Germany, giving a total of 121,611 from these range states and regions. Data is missing from France in 2020 and the remaining states in Germany. Derogation data is available from all range states in 2020 where derogations have taken place, giving a total of 261,668 killed (Table 3.3-1). Thus, in total a minimum c. 383,000 Greylag Geese were killed in 2020 (Figure 3.3-6). This is considerably higher than last year's reported minimum total of 261,157, but about in line with years like 2014 and 2015. Evidence suggests offtake is biased high, perhaps severely so (Johnson & Koffijberg, 2021).

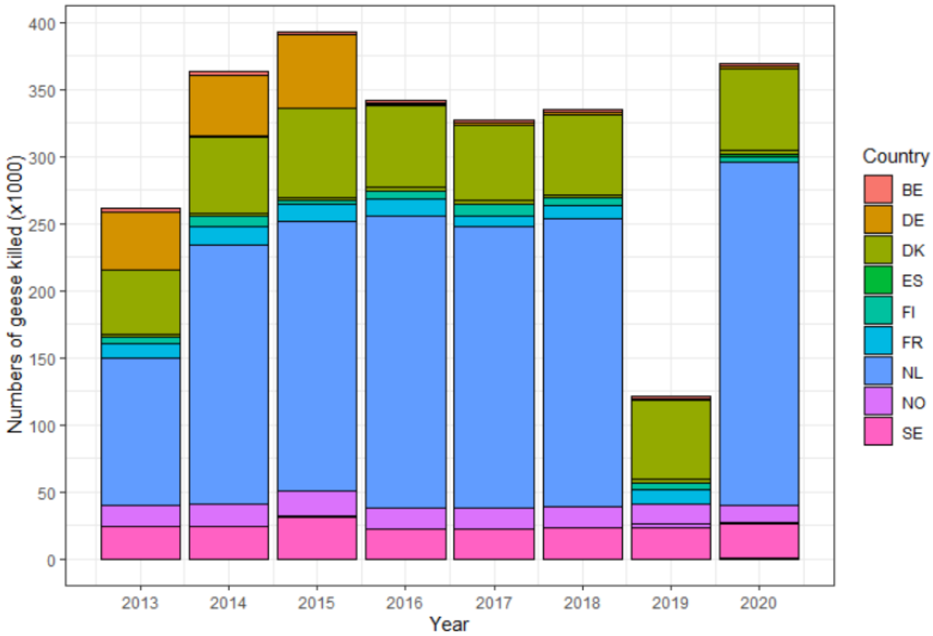

Figure 3.3-6. Total number of Greylag Geese killed under derogation and hunting from 2013-2020. Hunting bag data are missing from France in 2020 and only provided for Schleswig-Holstein, Germany from 2016-. Furthermore, derogation data are missing from the Netherlands in 2019. Data from before 2013 are partly available but need to undergo a quality review.

b) Survival

No assessment of survival rates has been carried out since those provided in Powolny et al. (2018), by work is in progress by Office Français de la Biodiversité (OFB).

c) Crippling

At present, there are data collected only in the Netherlands and Sweden, with a crippling rate of moulting Greylag Geese of respectively 22.03 (based on 26 X-rayed individuals) and 22.30 (based on 31 X-rayed individuals). These rates are comparable to the stabilized crippling rate in Pink-footed Goose after actions had been taken to lower the rate (Clausen et al. 2017).

c) Reproduction

In MU1, age counts continue to be limited. However, a pilot study performed in Finland in 2021 found a proportion of young of 14.6%. The survey will continue in 2022. Furthermore, the proportion of juveniles has been assessed in Vesterålen, Norway in 2020 and 2021, resulting in a proportion of young of 12.1% in 2020 and 33.5% in 2021. In Vestfold county in the Oslofjord-area juvenile percentages were assessed to be 36,1 % and 24,4% in 2020 and 2021 respectively (Tombre et al. 2020; Tombre et al. 2021). No or limited surveys have been conducted in Denmark and Sweden. For MU2, more extensive age counts are available from the Netherlands (Hornman et al. 2021) and North Rhine Westphalia in Germany (Nipkow 2019; Koffijberg and Kowallik 2020). In the Netherlands in 1999, the proportion of juveniles was as high as 41%, but during the last 10 years, it seems to have stabilized in both Germany and the Netherlands at about 15% (Figure 3.3-7). Recent data from The Netherlands, Germany and Finland show the same order of magnitude regarding the proportion of young birds in summer flocks.

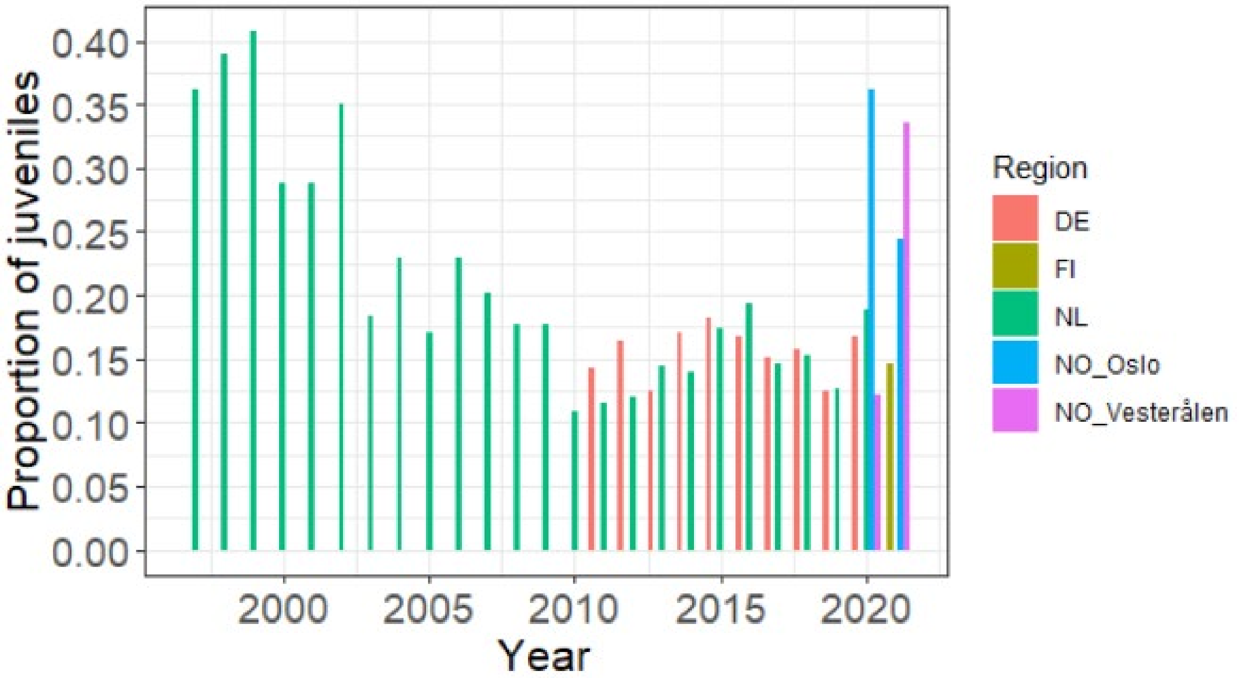

Figure 3.3-7. Proportion of juveniles in the NW/SW European population of Greylag Geese at a country level; Finland from 2021, Vesterålen and Oslofjord-area, Norway from 2020-2021, the Netherlands from 1997-2020 and North Rhine Westphalia, Germany from 2011-2020.

3.3.6 Management guidance

Population growth rate based on IWC imputed values or additional country-specific data in January

EGMP national totals for 2021 are not available from Germany and Sweden. Due to these limitations, it is not possible to calculate a reliable total population size based on EGMP national totals.

The IWC imputed values for the population produced a total of 1,131,525 individuals including estimates from Spain, and 865,582 individuals excluding estimates from Spain. The corresponding growth rate is respectively, 0.994 (0.963-1.025) and 1.014 (1.002-1.026). However, given the large uncertainty in the estimates from Spain, it is difficult to make a conclusion on the population trend.

Range states are encouraged to submit data to IWC in a timely manner and before March 1 in the year after the count took place. Furthermore, it is recommended that the situation in Spain is investigated and analyzed before the assessment in 2023.

Preconditions for the dynamic, model-based management of the population

At the IWG6 in 2021, it was stated that in order to establish the preconditions for the dynamic, model-based management of the population in the long term, the following actions need to be implemented before the 2023/2024 hunting season:

1. Establish the necessary monitoring frameworks outlined in the AFMP, particularly:
    a) reliable and up-to-date offtake data (both derogation and harvest) which in terms of derogation, can be assigned to MUs;
    b) summer counts to estimate the population size at the MU level.
2. Acquire fiscal and/or personnel resources to develop population models by 2023.

Monitoring-wise, offtake data (1a) continue to be in poor condition, particularly in terms of hunting bag reports, which continue to be missing from Germany (with the exception of Schleswig-Holstein) and from

France in 2020. Additionally, for several range states it is still not possible to distinguish between derogation during the "breeding/summer" period (April-July) and "post-breeding/winter" period (August-March) seasons.

Range states are encouraged to collect and submit hunting bag data to the EGMP Data Centre on an annual basis. If the hunting bag is based on estimates, the method of deriving these estimates should be provided to the EGMP Data Centre. Furthermore, Range states are encouraged to provide derogation data to the EU or the EGMP Data Centre at the MU level, split between April-July and August-March.

In terms of point 1b, progress has been made on summer counts to estimate the population size at the MU level. This is particularly so in MU1, where projects have been funded in Norway, Denmark, Finland and Sweden. For MU2, summer counts already exist in the Netherlands and have been resumed in Belgium in 2021. In Germany, counts are performed in Northrhine-Westphalia, Niedersachsen and Schleswig-Holstein, but as the Greylag Goose is spread over most of the country, the coverage for Germany as a whole continues to be incomplete. Finally, in France breeding population estimates will be available in 2023 for France, based on surveys carried out during springs 2021 and 2022. The estimates will hereafter be when available every sixth year.

Range states are encouraged to submit summer counts as well as the Common Breeding Bird Index to the EGMP Data Centre on an annual basis. Furthermore, MU1 range states are encouraged to submit summer counts as soon as these become available.

In terms of modeling (2) progress has been made towards moving to a dynamic and model-based management in 2023 as fiscal and personnel resources are now in place to develop population models by 2023.

3.4. Russian/Netherlands and Germany population of Barnacle Goose

This chapter provides the first full assessment of the population status of the Russian/Netherlands and Germany population, including all three management units (see below). In line with the framework set out in the AFMP (Nagy et al., 2021), it is based on an Integrated Population Model (IPM). This was initially developed for the Russian breeding population only and presented during IWG5 in 2020 (Baveco et al. in Nagy et al. 2021), and now has been extended to the Baltic and North Sea breeding populations. This extension has not been fully reviewed yet (due autumn 2022), but results are presented here to assess the cumulative impact of derogations (and hunting, where legally allowed) on the status of the populations. Moreover, a number of offtake scenarios have been simulated to help guide management actions.

3.4.1 Range states and management units

The range states for the Russian/Netherlands and Germany population of Barnacle Goose include Russia, Finland, Estonia, Sweden, Norway, Germany, the Netherlands and Belgium. Within this range, three management units have been delineated, covering the Russian breeding population (MU1, migratory), the Baltic breeding population in Finland, Sweden, Estonia, Norway and Denmark (MU2, migratory) and the North Sea breeding population in Germany, the Netherlands and Belgium (MU3, sedentary) (Figure 3.4-1). Formally, the Norwegian population in MU2 (breeding in the Oslofjord region) and the Belgian population in MU3 are not part of the AFMP, as their populations have not been recognized as naturally occurring by the respective governments. Still, the birds from these populations mix with the other birds in winter (without being separated), so they have been included in the monitoring setup and the IPM (in any case, their numbers are less than 1% of the flyway population). During winter, birds from all management units mix in Sweden, Denmark, Germany, The Netherlands and Belgium.

3.4.2 Population FRP's and targets

The FRP for the breeding season is 112,927 pairs for MU1, 12,000 pairs for MU2 and 12,000 pairs for MU3 (Nagy et al. 2021). The FRP for the entire population has been set at 380,000 individuals, reflecting the situation in 2000 when AEWA came into force (Nagy, Heldbjerg, Jensen, Johnson, Madsen, Therkildsen, et al. 2021). Being an Annex 1 species of the EU Bird Directive, the AFMP does not aim to maintain or bring the population at pre-defined target level. Management is carried out by each EU country under the conditions for derogation, lined out in Art. 9 of the EU Bird Directive. Hunting (harvest) is only carried out outside the EU-countries, mainly in Russia.

3.4.3 Management strategies

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

Within this framework, it has also been agreed to coordinate monitoring of the population and offtake under derogations or hunting when the size of the populations (for single MUs or for the entire population) is below 200% of the FRP. This includes monitoring of population size, offtake, prediction of population development (by the IPM), and coordination of offtake and conservation measures where necessary. A protocol for this coordination has been subject to discussions in the Task Force for the Russian/Netherlands and Germany population of Barnacle Goose (see doc. AEWA/EGMIWG/7.14 from EGM IWG7 in 2022).

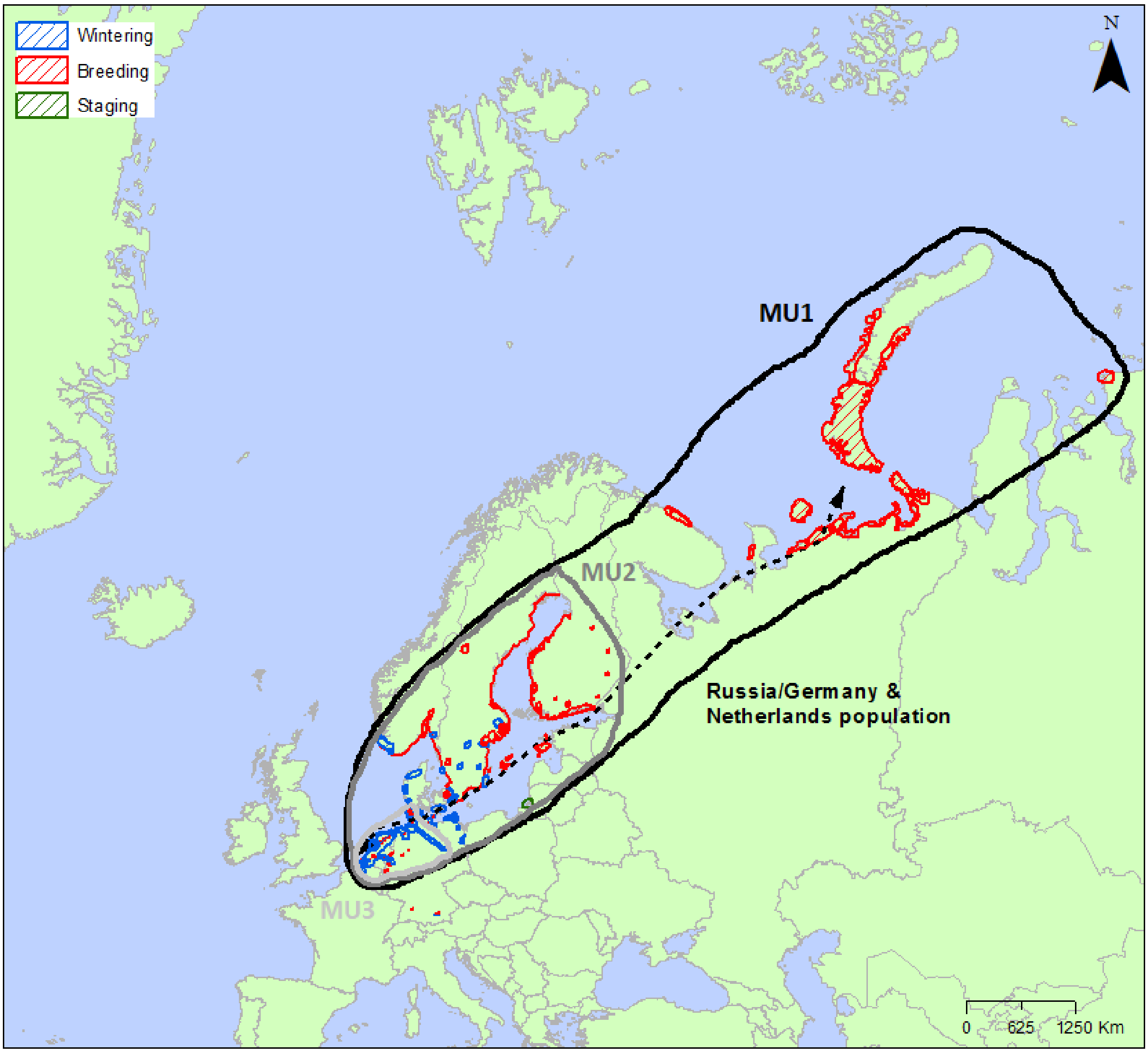

Figure 3.4-1. Management units of the Russia/Germany & Netherlands population of Barnacle Goose.

3.4.4 Assessment protocol

The assessment of the status of the Russia/Germany & Netherlands population is carried out using an Integrated Population Model (IPM). Input for the model was derived from monitoring data on abundance, productivity and offtake under derogation (see Appendix A.4 for coverage in each country and the EGMP Database for overview of data used). The way how the IPM framework accounts for the impact of offtake in the respective management units is shown in Figure 3.4-2. Monitoring data have been included up to 2021, but show some gaps for the last year. In case of missing abundance data or incomplete time series, annual growth rates or estimates have been used to estimate the missing count information (see Gitlab EGMP for a full overview of input and output data). Especially in the last season 2020/21 some monitoring data was still missing, so results from this season (usually also coming with large credibility intervals in the graphs) should be treated with caution. Because prior to 2005 summer counts are completely missing, results of the assessment shown below refer solely to the period 2005-2021. An overview of the longer time series is included in the EGMP Database and the status report 2021 (Heldbjerg et al. 2021).

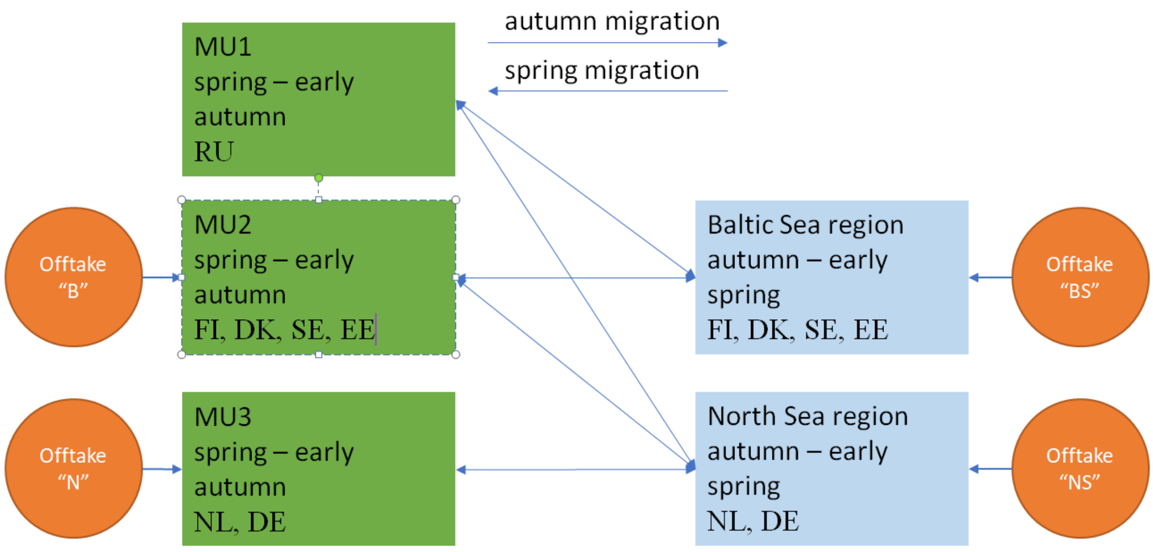

Figure 3.4-2. Overview of the offtake in the different regions experienced by the birds belonging to the different MUs. Local breeding populations (green boxes) in the Baltic Sea and the North Sea areas experience offtake around the breeding period ("B" and "N" respectively). Outside this period (blue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

3.4.5 Status

a) Abundance

For the size of the flyway population in January (so combining all MUs), results from the IPM and from the counts correspond well (Figure 3.4-3). They show that the flyway population size has reached a level of about 1.4 million individuals in 2019/20 and 2020/21. This is 3.7 times the FRP (100% and 200% levels shown by the dashed line in Figure 3.4-3). This population level has been achieved after a long period of continuous growth (see Heldbjerg et al., 2021).

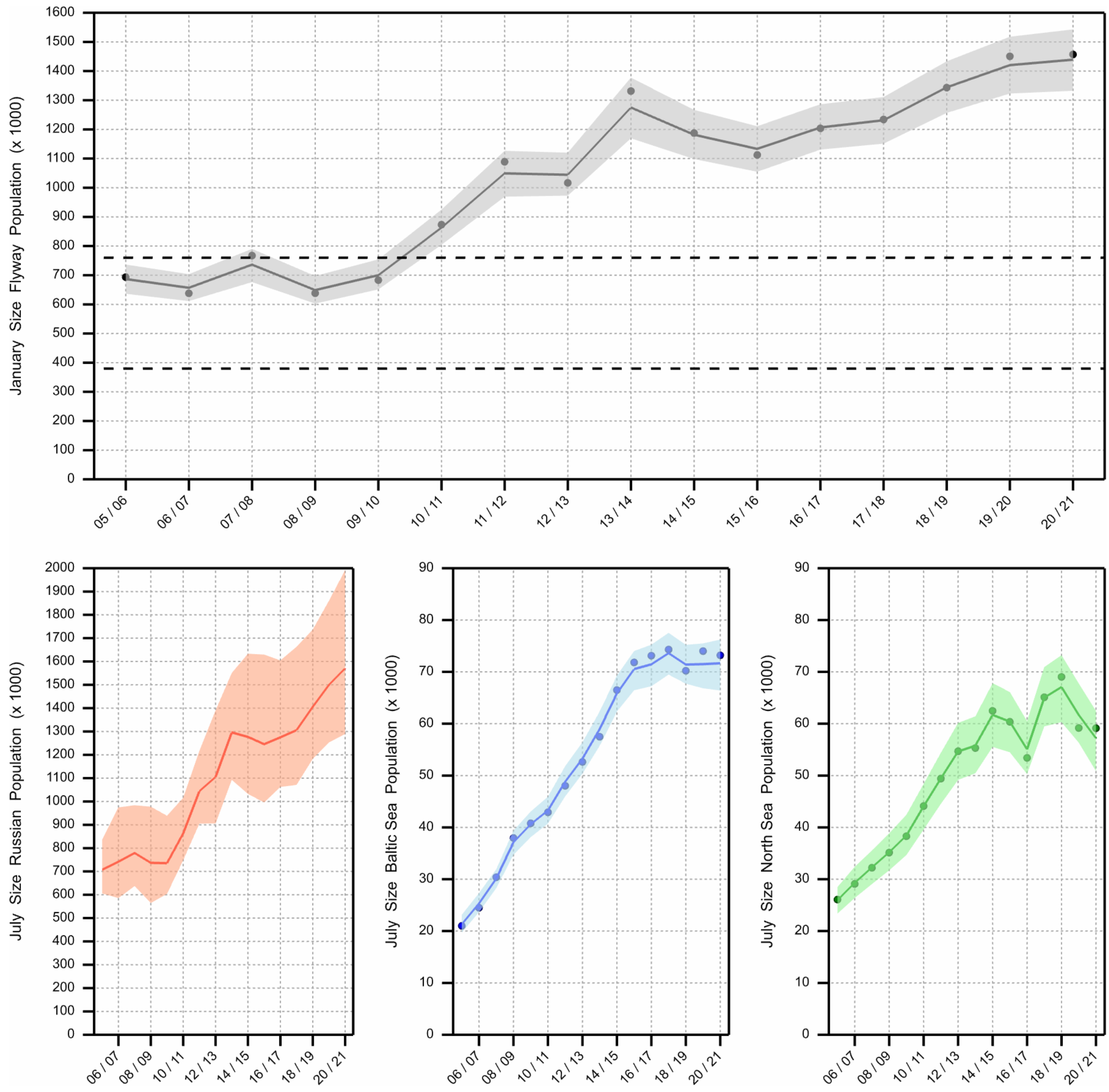

Figure 3.4-3. Top panel: January total flyway population counts (dots), posterior means (solid line), 95% intervals (shaded area) and FRP as well as the 200% of the FRP (dashed line). Bottom panels: July population sizes of the three MU-populations along with posterior means and 95% intervals. Left in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

Based on posterior abundance estimates in July, the Russian population is by far the largest of all MUs, comprised of 1.6 million individuals, whereas the Baltic populations in MU2 and North Sea populations in MU3 are much smaller: 70,000 and 60,000 individuals respectively (all rounded figures, Figure 3.4-3). Note that these figures are not directly comparable to those from January (and especially the estimate for MU1 also comes with large credibility intervals as they represent only estimates, due to natural and additive (by offtake) mortality occurring between July and January. The Russian MU1-population seems to be still increasing. To the contrary, the Baltic MU2-population seems to have levelled off over the past four years, and the North Sea MU3-population recently shows some signs of a decrease. For both MUs, posterior estimates from the IPM and census data correspond well. The saturation of the Baltic population is also well reflected by complete counts from Finland (levelling off from 2017 onwards), but whether the leveling off in the entire MU2 is realistic is not entirely clear as counts from Sweden (and from Norway) are largely missing, and a constant size was assumed for the Swedish population in recent years. However, e.g. at the former stronghold of the island of Gotland in Sweden, numbers are known to have declined (K. Larsson), although it is not known whether Gotland-geese have established elsewhere in Sweden or in neighboring countries.

Converted into breeding pairs, the size of the (still increasing) Russian breeding population in MU1 (posterior estimate 480,000 breeding pairs in 2020) is much larger than the FRP set for this MU, also exceeding the 200% threshold level multiple times (Figure 3.4-4). The Baltic MU2-population is also well above the FRP (30,000 breeding pairs in 2020), but much closer to the 200% threshold than the Russian population. The recent decline in the North Sea MU3-population (2020: 17,000 breeding pairs) has brought it close to its FRP now and clearly below the 200% threshold of the FRP.

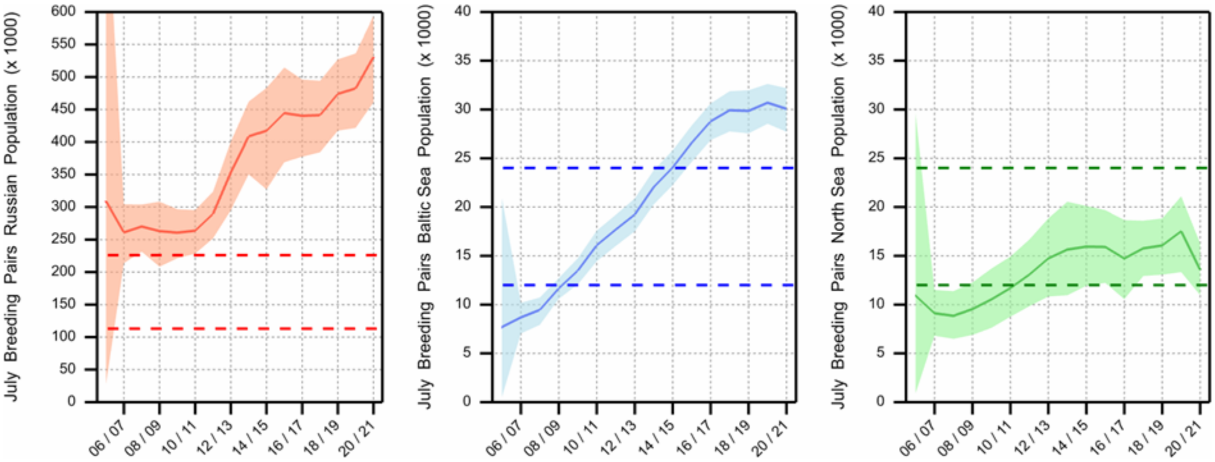

Figure 3.4-4. Posterior means (solid line) and 95% posterior intervals (shaded areas) for the number of breeding pairs in July for the three MU-populations. Dashed lines are the FRP as well as the 200% of the FRP. Left in red MU1, centre in blue MU2, right in green MU3. In the IPM framework, the number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

b) Mortality and offtake

Survival rates from the IPM, combined for summer and winter, show that adults have much higher survival rates (on average ranging from 0.904 to 0.969) than juveniles (range 0.451 to 0.758) (Figure 3.4-5). 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 (0.451). This is expected, as natural survival for this MU-population includes unknown offtake in Russia, but in addition this MU-population is also fully migratory and losses among juveniles are likely to occur during autumn migration. For the North Sea population natural survival for juveniles is estimated to be lower than in the Baltic Sea population, at least in the years before 2013. For recent years this is less so, as juvenile survival in the Baltic Sea population appears to decrease.

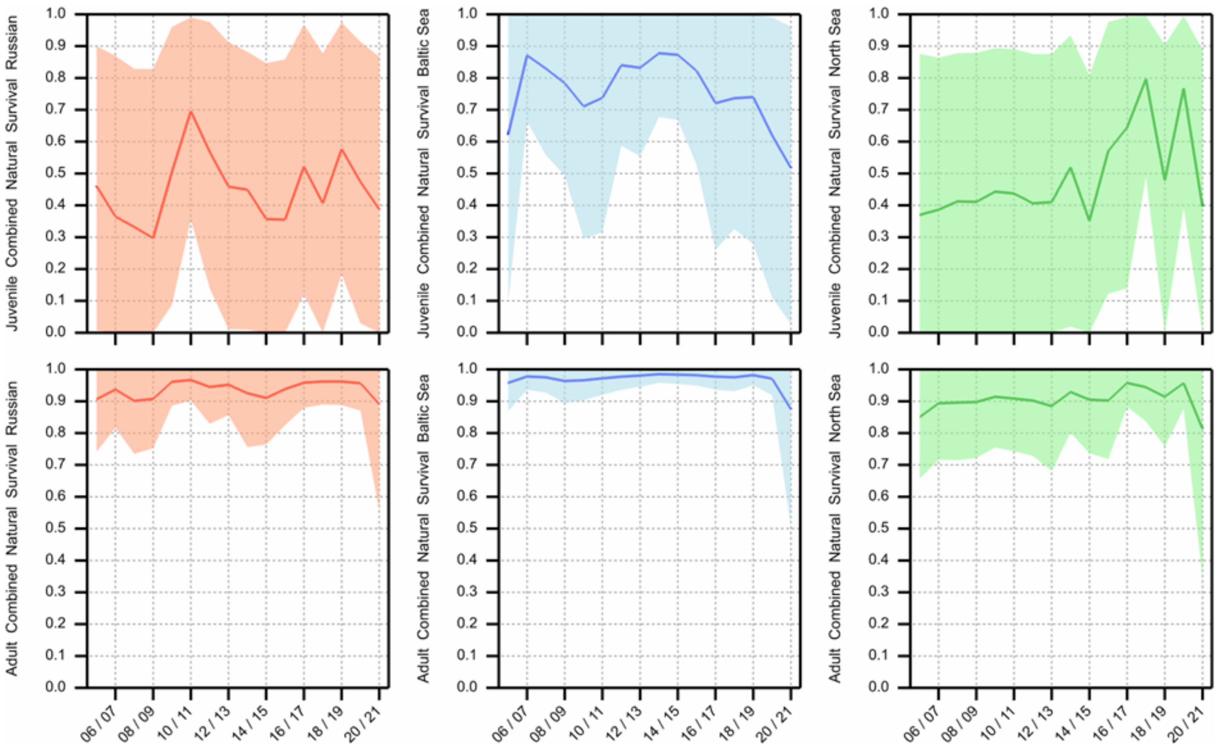

Figure 3.4-5. Posterior means and posterior 95% interval for combined, i.e. summer and winter, juvenile (upper panel) and adult (lower panel) natural survival for the three MU-populations. Left in red MU1, centre in blue MU2, right in green MU3. Note that his includes unknown offtake for the Russian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

Over recent years, combined offtake rates for the Russian MU1- and Baltic MU2-populations amount to around 4 and 5% for adults and 6 and 8% for juveniles (Figure 3.4-6). The difference between Russian and Baltic Sea population values stems from the Russian population's offtake around the breeding period being implicitly included in the natural survival estimate. Baltic Sea offtake rates from the local breeding MU-population are estimated to sum up to approximately 2% in recent years. Combined derogation offtake rates for the North Sea population appear to have increased steeply after 2013, up to approximately 35% for juveniles and 30% for adults in the last year with complete offtake data (2020). The high combined offtake values are caused by high offtake rates on the local breeding MU-population (partly by rounding up flocks during wing moult in June-July), as compared to the offtake rates during the period that the other MU-populations are also present in the North Sea region. Cleary, this outcome depends critically on the way reported offtake is divided over the period that only the local breeding MU-population is present and the period in which also the migrant MU-populations are present in the region. For the country with by far the most derogation offtake in the North Sea region, The Netherlands, this division is however, relatively robust and reliable, as monthly offtake data are available and offtake from June to September can be entirely assigned to MU3. In recent years, offtake in MU3 in summer (so only affecting MU3) has been 8,000 to 10,000 individuals while in winter (when other MUs are present) it amounted up to 15,000-20,000 individuals.

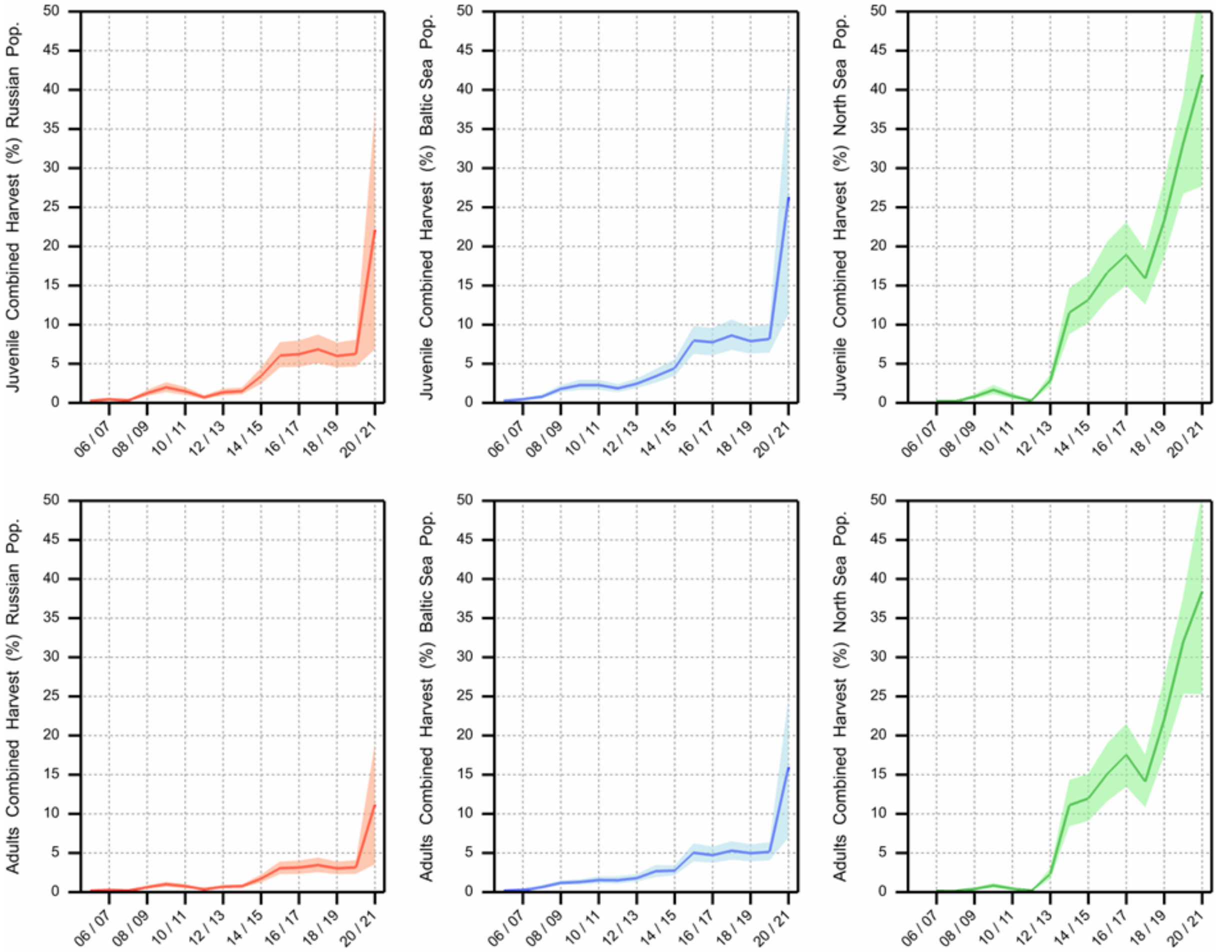

Figure 3.4-6. Posterior means (solid lines) and 95% posterior intervals (shaded area) for the combined derogation offtake rates of juveniles (top panels) and adults (bottom panels) for the three MU-populations. Left in red MU1, centre in blue MU2, right in green MU3. Note that data for 2020/21 season were incomplete and IPM output comes with large credibility intervals (2020 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 The Netherlands and northern Germany shows a high degree of variation, much larger than observed when considering only the counts in the field (Figure 3.4-7). Moreover, results from the IPM tend to show a higher level of productivity than the data collected in the field, although in 13 out of 16 years they are within the 95% posterior credible intervals of the IPM estimates. There is some evidence that counts in the field, predominantly made in November and December may be biased low, as moult in juvenile birds may have progressed such that proper identification of age can be problematic, but this aspect will be elaborated in more detail (and eventually monitoring protocols will be adjusted). As shown in the previous status report covering a much longer time series (Heldbjerg et al. 2021), productivity has undergone an overall decline in the past decades.

At the MU level, there are no field data from the Russian population in MU1 (in summer) but IPM results predict juvenile percentages as high as 30% in some years, but without a clear trend (Figure 3.4-7, lower panel). In the Baltic MU2-population productivity has declined since 2005. The trend in field data and IPM results are similar, but as for the situation at the flyway level in autumn, field data usually shows lower juvenile percentages than the IPM estimates (albeit mostly within the 95% posterior credible intervals). This is not an identification issue as hypothesized for the situation in autumn, but is likely associated with the monitoring data used. This is entirely based on assessments made in the Helsinki region in Finland, which according to the local experts may be not fully representative as this population has been established for a long time and shows some saturation because of local density-dependent effects. Hence, it may not reflect a representative sample, even more so as data from the large Swedish population are completely lacking.

IPM results point to a reproduction rate of 0.751 offspring per pair (surviving up to 15 July) for the Russian population. For the North Sea population, it is estimated to be much higher, on average 1.269, but fluctuating in recent years. For the Baltic Sea population reproduction appears to have gradually decreased over the years, from a value comparable to the Russian population, to around 0.2 to 0.3 in 2020 (on average only 0.424). These results are comparable to the monitoring data (July census of juveniles), showing the same low and decreasing pattern (Figure 3.4-7, lower panel).

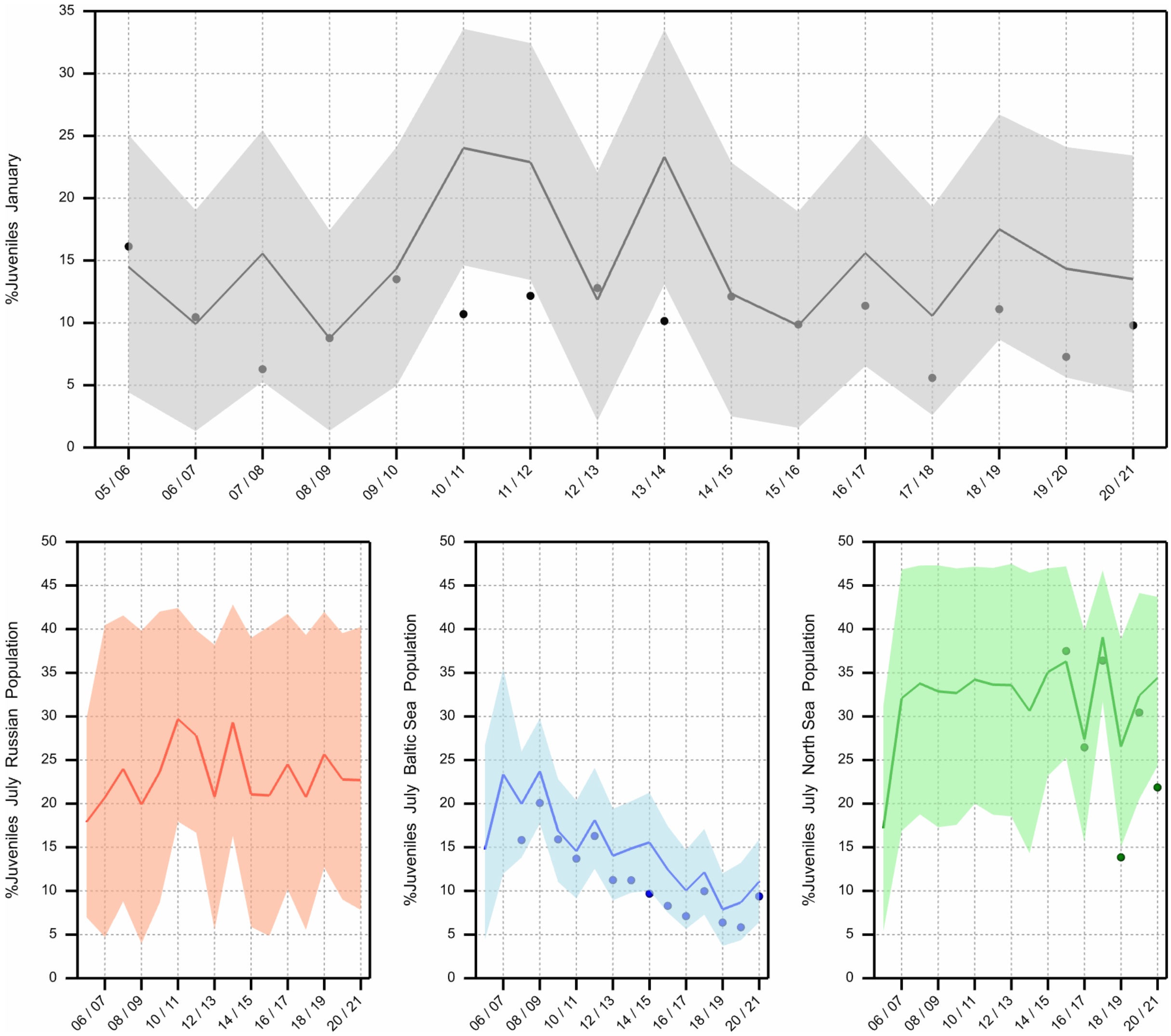

Figure 3.4-7. Top panel: Observed January percentage of Juveniles (dots), posterior means (solid line) and 95% posterior intervals (shaded area). Bottom panels: Observed July percentage of Juveniles in the three MU-populations, along with posterior means and 95% posterior intervals. Left in red MU1,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

Management guidance

The current level of derogations has been used to predict the population trajectories until the next full assessment in 2024. This "business as usual" scenario predicts a further increase of the Russian population, a decrease followed by an increase of the Baltic Sea population, and a continuous decline of the North Sea population. The total flyway population at the January census, as the sum of the three MU-populations, is predicted to further increase. The declining North Sea population is expected to drop within a short period to below the FRP (Figure 3.4-8). This may have already occurred in 2021 and 2022. The 2021 summer census data for MU3 have not yet been included in the IPM, but results from the count in The Netherlands suggest about similar numbers as in 2020.

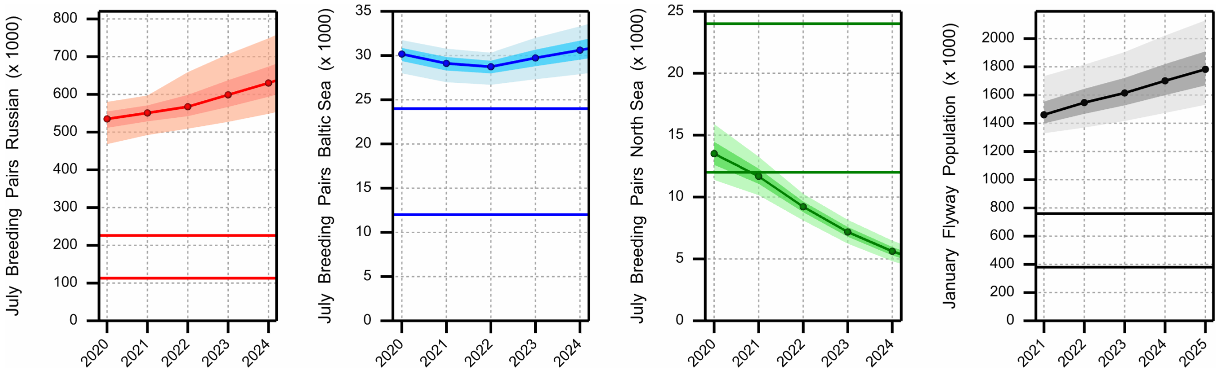

Figure 3.4-8. Simulated population trajectory of the number of July breeding pairs in the three MU-populations and the size of January flyway (individuals) under the "*business as usual*" scenario. The dark shading represents the 25% and 75% percentiles of the simulated values, while the light shading represents the 5% and 95% percentiles. Horizontal lines are given at the FRP as well as the 200% of the FRP. Left in red MU1, centre in blue MU2, right in green MU3 and most right in black flyway in January. Note the different scale on the y-axes.

A second scenario assumes that the declining North Sea MU-3 population leads to an adjustment of management and decreasing derogation offtake rates (Figure 3.4-9). For the Russian MU1- and Baltic Sea MU2-populations, a ban on derogation offtake in the North Sea region in the period all MU-populations are present (i.e. autumn, winter and early spring) leads to a somewhat larger rate of increase. For the North Sea MU-3 population, halving the derogation rates of the business as usual scenario from Figure 3.4-8 is almost sufficient to stop the decline, but it needs to be more than halved for a recovery to a size well above the FRP.

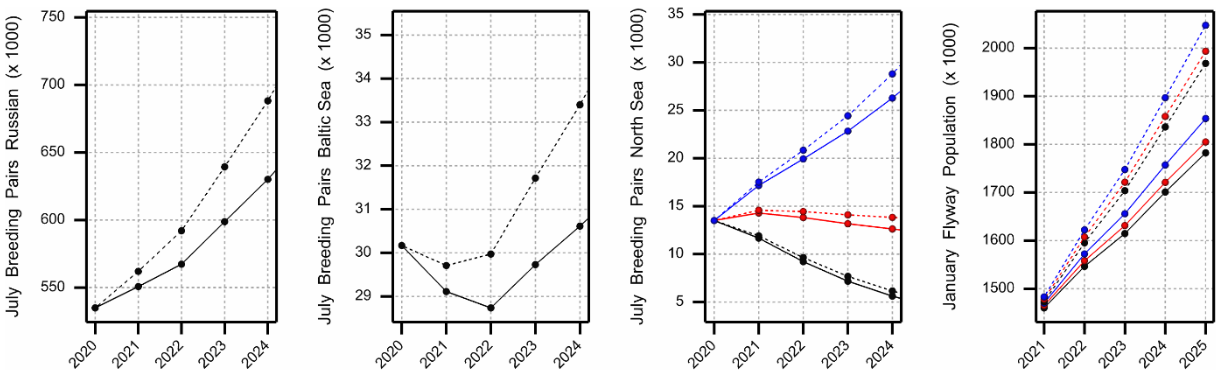

Figure 3.4-9. Simulated population trajectory of the number of July breeding pairs in the three MU-populations and the size of January flyway population under different scenarios. The line type represents the offtake rate "NS" in the North Sea region; solid for "business as usual" and dashed for no offtake. Colors represent different values for the offtake rates "N" in the North Sea population; Black for "business as usual", red for "business as usual"/2 and blue when there is no offtake on the local North Sea population. See Figure 3.4-2 for overview of offtake in the respective management units and definitions of "NS" and "N". Note the different scale on the y-axes.

In a third scenario, the impact of Avian Influenza (AI) in the first winter has been modelled (Figure 3.4-10). AI has been observed to have had a profound impact on the size of the Svalbard population at wintering sites in Scotland (suggesting perhaps a c. 30% loss, estimates will be updated in the autumn/winter 2022). Also, in e.g. Germany and The Netherlands during winter and spring 2020/21, observations suggest well above 10,000 individuals to have died from AI (but no precise estimates are possible; several reports mention that first-winter birds are especially hard hit). In the scenarios, it was assumed that AI affects the birds of all the MU-populations in the same way. The three AI-mortality percentages 10%, 20% and 30% were combined with the "business as usual" offtake scenario and also with a scenario in which the "N" and "NS" offtake rates were set to zero. The North Sea population will recover only when offtake rates on the local MU-population "N" are more than halved (as observed in the second scenario). For no offtake "N" at all, recovery takes place within two years, even for the highest AI mortality scenario. The Russian and Baltic Sea populations take much longer time to recover. For a "business as usual" scenario and 10% AI mortality, the Russian population can recover within 4 years, while for the Baltic Sea population recovery will take much longer than 4 years. For higher AI mortality values, the Russian population will also take longer. With no offtake in the North Sea region ("NS" offtake rates equal to zero), the Russian population may recover within 4 years from a 20% mortality per year, while the Baltic Sea population may do so only for a 10% mortality per year.

These outcomes are based on hypothetic scenarios, to give some indication what the impact from AI could be. Based on preliminary census data from The Netherlands, there is no sign of a comparable loss as observed at wintering sites in Scotland, as numbers in the midwinter period were about the average of previous seasons (Koffijberg & van Winden, 2022). But for sure, the impact of AI is an aspect that should be carefully monitored in future years.

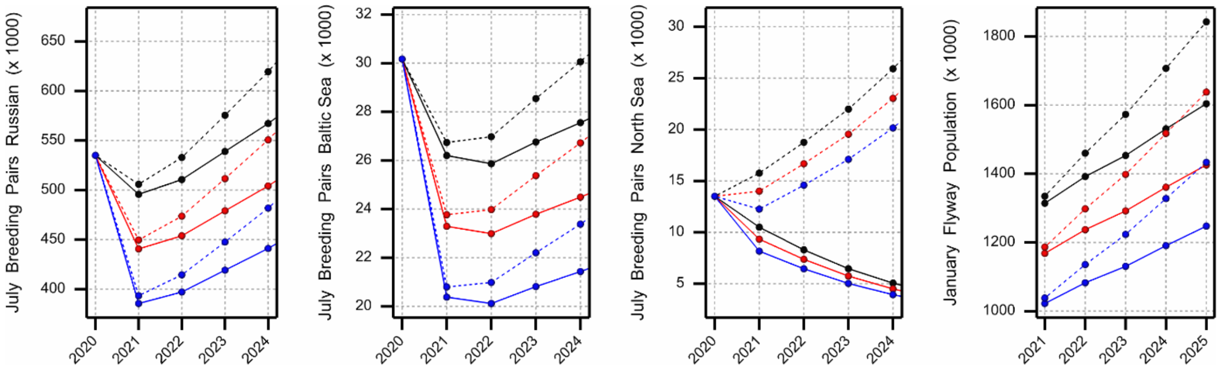

Figure 3.4-10. Simulated population trajectory of the number of July breeding pairs in the three MU-populations and the size of January flyway under different scenarios. The line type represents the offtake rate "NS" in the North Sea region and the offtake rate "N" on the local North Sea population; solid for "business as usual" and dashed for no offtake. Colors represent different values for AI mortality percentage; black for 10%, red for 20% and blue for 30% mortality. Note the different scale on the y-axes.

When it comes to actual management decisions, special care is needed for derogations within the MU-3 North Sea population, which is currently very close to FRP (Figure 3.4-4) and will decline to a level well below FRP, under the current management regime (Figure 3.4-8). The Russian MU-1 and Baltic MU2-populations are still above the 200% threshold set in the AFMP and their future developments give no reasoning for similar management adaptations as suggested for the MU3-North Sea population.

In terms of monitoring data for the IPM, the lack of summer counts in Sweden (and Norway) is still an important gap, suggesting the estimates for MU2 should be treated with caution (see appendix A.4). Moreover, timely delivery of recent data from Denmark has been an issue, both regarding January counts (2020-2021 still provisional data) and derogation data (2021 not available yet). The former gap in census data from Germany has been closed by making use of published information from the two most important federal states, Schleswig-Holstein and Lower-Saxony, which usually have well above 90% of the German wintering population in January. Furthermore, assignment of offtake within a year and assignment to the respective MUs still involves some assumptions and expert judgement, as most data are only available as a total figure for the entire calendar year. Data with a higher resolution (e.g per month) would allow more precise input to the IPM. In 2022, protocols for productivity assessments in autumn will be analysed, as the IPM suggest that autumn age counts may be biased low. In the Baltic MU2-population it is recommended to have age counts in place to achieve a more representative sample from the entire MU2-population (now data based mainly on Helsinki region in Finland). These counts should preferably assess productivity in the large Swedish population

3.5. Greenland/Scotland and Ireland population of Barnacle Goose

3.5.1 Range states and management units

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

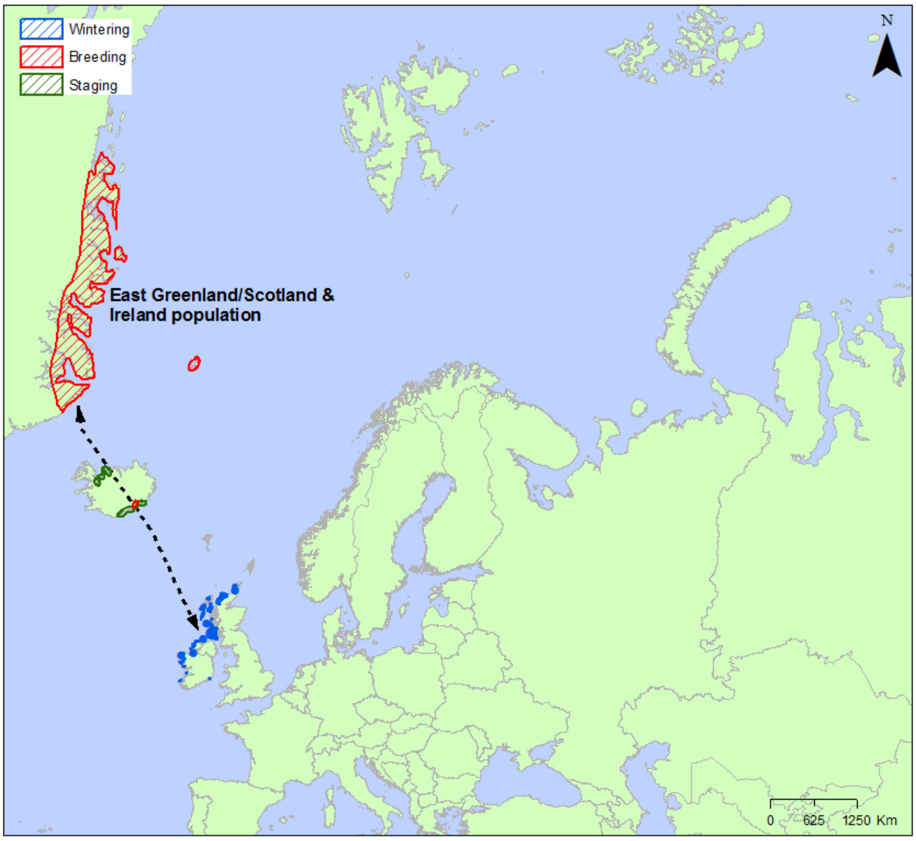

Figure 3.5-1. Annual distribution and migration routes for the E. Greenland/Scotland & Ireland population of Barnacle Geese, including breeding (red), staging (green) and wintering (blue) areas.

3.5.2 Population FRP's and target's

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

3.5.3 Management strategies

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

Within this framework, it has also been agreed to coordinate monitoring of the population and offtake under derogations or hunting when the actual size of the populations is below 200% of the defined FRP. This includes prediction of population development, coordination of offtake and taking coordinated conservation measures, where necessary. A protocol for this coordination has been subject to discussions in the Task Force and has not been finalized yet.

3.5.4 Assessment protocol

In 2020, Nature Scot 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 shall take place in 2023 and will be conducted using the Integrated Population Model (see chapter 2.4 for details). Input for the model will be derived from monitoring data on demographic variables like abundance, productivity and offtake; see Appendix A.5 for coverage in each country and the EGMP Database for overview of data used (see also chapter 2 for general details).

3.5.5 Status

a) Abundance

No census of the total population was conducted in 2021/22 (next in 2023), but there are annual winter counts from Islay, the most important wintering site in the UK from both 2021 and 2022 (Figure 3.5-2). In March 2021, 29,798 birds was counted and in March 2022, 28,759 bird was counted, which is the lowest since 1994/1995.

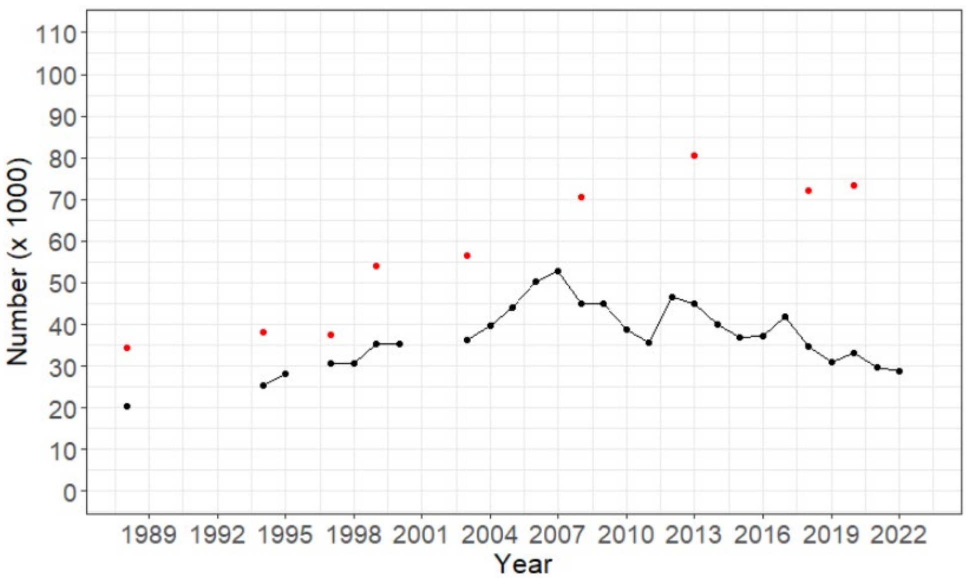

Figure 3.5-2. Development of the population size of the E. Greenland/Scotland & Ireland Barnacle Goose, Winter (filled red) with additional annual winter counts from Islay from, the most important wintering site in the UK (black line) (WWT).

b) Mortality and offtake

Updates on hunting bags and derogation shooting are available from the season 2020/2021, where 1,121 were shot in Scotland under derogation and 3,429 were harvested in Iceland. No birds was taken in Ireland (Figure 3.5-3). However, shooting was suspended on 1/2/22 on Islay as a result of an avian influenza outbreak.

There are no updates on survival or crippling rate.

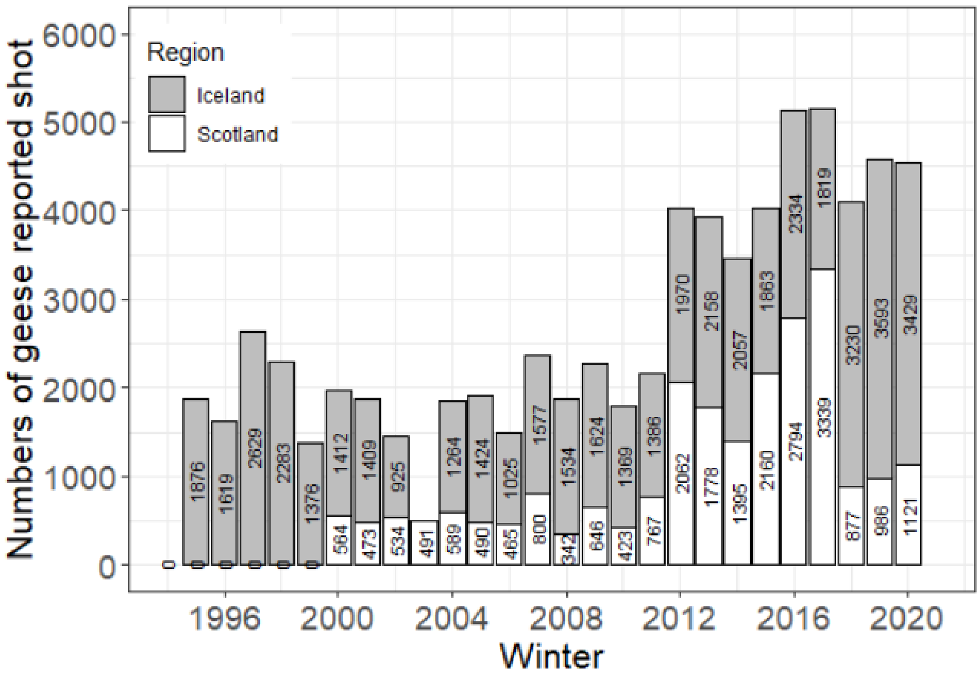

Figure 3.5-3. Development in the harvest of the E. Greenland/Scotland & Ireland Barnacle Goose population in Iceland (hunting) and Scotland (derogation). Numbers on the bars show the numbers killed. In Iceland 2003 data was unusable due to „protest−reports" delivered by hunters while Ptarmigan hunting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

c) *Reproduction*

The proportion of juveniles on Islay was 16.7% in November 2020 (data from 2021 is not available yet), and was the second highest recorded, only surpassed by the proportion in 1990 of 24% (Figure 3.5-4).

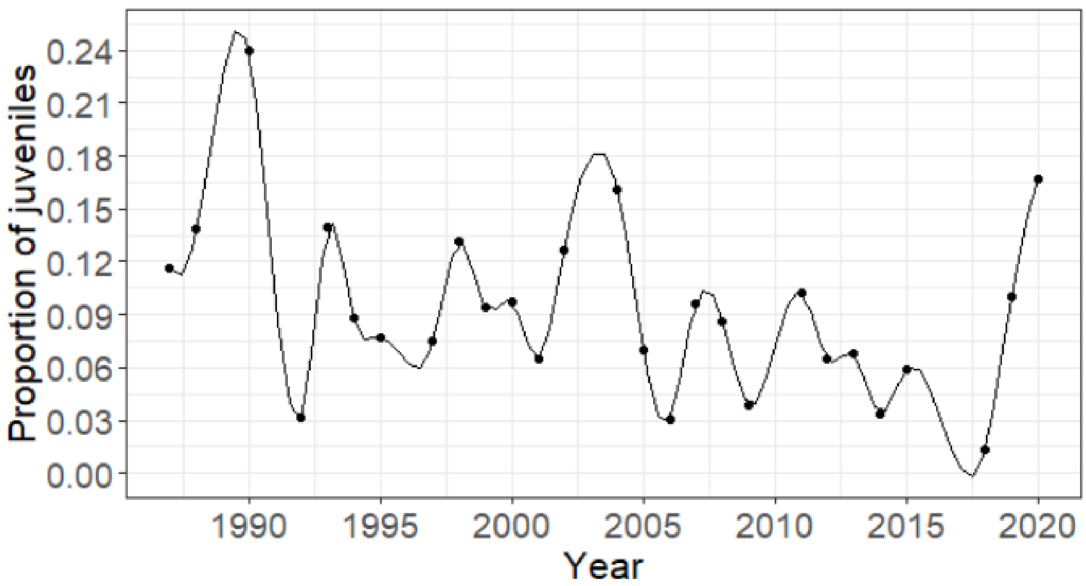

Figure 3.5-4. Annual productivity estimates from Islay based on age counts from November 1st - 17th November. Spline interpolation has been added for better visualization of the trend.

3.5.6 Management guidance

The first assessment of offtake will take place in 2023.

Appendix A – Data overview

A.1. Pink-footed Goose – Svalbard population

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

	NO	SE	FI	DK	NL	BE
Population count in Autumn	X	X	X	X	X	X
Population count in Spring	X	X	X	X		
Productivity	X	X		X	X	X
Hunting bag	X			X		
Wings				X		
Crippling	x			x		
Temperature on Svalbard	X					

A.2. Taiga Bean Goose

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

	NO	SE	FI	DK	DE	NL	LV	PL	UA	RU
Population count in Autumn		X	X	X	-	X				
Population count in mid-winter		X		X	-	X				
Population count 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 count in mid-winter	X	X
Productivity	X	

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

Table A.3. Overview of available monitoring data in the NW/SW European Greylag Goose population.
Grey cells makes data for MU1 and blue cells for MU2.
X data collected (nearly) annually and reported to EGMP, x data collected (nearly) annually, (x) data collected in part of the country and/or not annually, - no data collected or reported to the EGMP, * 0 or not relevant range state in this respect.

	NO	SE	FI	DK	DE	NL	BE	FR	ES

Population count in January	X	X	*	X	-	X	X	X	(x)
Breeding Bird Index	X	X	X	X	-	X	*	*	*
Summer count	(x)	(x)	(x)	(x)	(x)	X	X	(x)	(x)
Productivity	(x)	-	(x)	-	-	X	-	-	-
Hunting bag	X	X	X	X	(x)	*	X	(x)	(x)
Split hunting data into April-July and August-March	no	(yes)	yes	yes	-	*	(yes)	yes	?
Derogation	(x)	X	X	X	X	X	X	*	*
Split derogation data into April-July and August-March	no	no	no	(yes)	-	yes	yes		
Crippling rate		(x)				(x)			

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

	RU	FI	EE	SE	NO	DK	DE	NL	BE	Remark
January census	*	*	*	X	*	X	X[1]	X	X	
Summer census	-	X	-	-	(x)	(x)	(x)	X	(x)	
Productivity, MU1 and MU2	*	*	*	-	*	-	X	X	-	Autumn, Nov-Dec
Productivity, MU2	*	(x)	-	-	(x)	-	*	*	*	Summer, Jul-Aug
Productivity, MU3	*	*	*	*	*	*	(x)	X	-	Summer, Jul
Offtake, hunting	-	*	*	*	*	*	*	*	*	In EU-countries only derogations
Offtake, derogations	*	X	X	X	X[2]	X	X	X	X	Mostly annual totals

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

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

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

References

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