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AEWA INTERNATIONAL SINGLE SPECIES MANAGEMENT PLAN FOR THE PINK-FOOTED GOOSE

(Svalbard (br) Population)
(Anser brachyrhynchus)

AEWA TECHNICAL SERIES No. XX

International Single Species Management Plan for the Pink-footed Goose

Svalbard breeding population

Anser brachyrhynchus

Revision 1

Ministry of Green Transition
Agency for Green Transition and Aquatic Environment

NORWEGIAN ENVIRONMENT AGENCY

AARHUS UNIVERSITY

Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA)

International Single Species Management Plan for the Pink-footed Goose

Svalbard breeding population

Anser brachyrhynchus

Revision 1

AEWA Technical Series No. XX

[November 2025]

Prepared by

Aarhus University/AEWA European Goose Management Platform Data Centre and UNEP/AEWA Secretariat

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This Management Plan represents a revision of the first AEWA International Species Management Plan for the Svalbard Population of the Pink-footed Goose, which was compiled by Jesper Madsen and James H Williams, and was adopted in 2012 at the 5th Session of the Meeting of the Parties to AEWA.

Date of adoption (Revision 1): [November 2025]

Lifespan and Evaluation of the Plan: The lifespan of this International Single Species Management Plan (ISSMP) is 12 years (2026-2037). Before the end of the ISSMP's lifespan, an evaluation should be undertaken to inform the decision regarding whether this Plan is to be retired, extended, updated or revised. The development of the Svalbard population of Pink-footed Goose should be closely monitored and, in the case of developments that deviate from the objectives of the ISSMP, the Plan should be subject to an emergency evaluation.

Milestones in the revision of the Plan:

Evaluation Report:	Approved by the AEWA Technical Committee and the AEWA Standing Committee in *September 2024*
Revision workshop:	Held in Levanger, Norway, on *8-9 October 2024*
Target-setting exercise:	Direct elicitation through polling of Range State governments and permanent observer organisations to the European Goose Management Platform conducted from *15-29 November 2024*
First draft:	Circulated to workshop participants on *6 June 2025*
Second draft:	Circulated to workshop participants on *27 June 2025* and submitted to the AEWA Technical Committee on *4 July 2025*
Third draft:	Circulated for formal consultation with the governments of the Range States on *23 July 2025*
Fourth draft:	Circulated to governments of the Range States on *23 October 2025*
Final draft:	[Submitted to the 9th Session of the Meeting of the Parties to AEWA, *11-14 November 2025*]

Please send any additional information or comments regarding this Management Plan to Professor Jesper Madsen, email: jm@ecos.au.dk

Photo cover: Pink-footed Goose (*Anser brachyrhynchus*) © Jari Peltomaki

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This International Single Species Management Plan represents a full revision of, and supersedes, the 2012 version (AEWA Technical Series No. 48).

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List of Acronyms and Abbreviations

AEWA	Agreement on the Conservation of African-Eurasian Migratory Waterbirds
EGMP DC	European Goose Management Platform Data Centre
AFMP	Adaptive Flyway Management Programme
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on the Conservation of Migratory Species of Wild Animals
EGM IWG	European Goose Management International Working Group
EGMP	AEWA European Goose Management Platform
FCS	Favourable Conservation Status
FRH	Favourable Reference Habitat
FRP	Favourable Reference Population
FRR	Favourable Reference Range
FRV	Favourable Reference Value
GBF	Kunming-Montreal Global Biodiversity Framework
ISSMP	International Single Species Management Plan
SPA	Special Protection Area (EU Birds Directive)

Key Terms

Adaptive Management	Adaptive management is an approach to natural resource management that emphasizes learning through management where knowledge is incomplete and when, despite inherent uncertainty, managers and policymakers must act. Unlike a traditional trial and error approach, adaptive management has explicit structure, including a careful elucidation of goals, identification of alternative management objectives and hypotheses of causation, and procedures for the collection of data followed by evaluation and reiteration. The process is iterative, and serves to reduce uncertainty, build knowledge and improve management over time in a goal-oriented and structured process (Craig R. Allen and Ahjond S. Garmestani 2015).
Accommodation or refuge area	Specifically designated goose foraging and resting areas to accommodate geese. These can be either natural habitats left without disturbance or agricultural areas where farmers receive incentives to tolerate the presence of geese in large numbers, in order to alleviate human-wildlife conflicts and to allow the maintenance of the population at desired levels. Sometimes also called "go" areas.
Favourable Conservation Status of a population	As defined in Article I.1(c) of the Convention on Migratory Species (CMS), which provides that conservation status will be taken as "favourable" when: *(1) Population dynamics data indicate that the migratory species is maintaining itself on a long-term basis as a viable component of its ecosystems;* *(2) The range of the migratory species is neither currently being reduced, nor is likely to be reduced, on a long-term basis;* *(3) There is, and will be in the foreseeable future sufficient habitat to maintain the population of the migratory species on a long-term basis; and* *(4) The distribution and abundance of the migratory species approach historic coverage and levels to the extent that potentially suitable ecosystems exist and to the extent consistent with wise wildlife management.* This definition is applied taking into account operative paragraph 10 of CMS Resolution 12.21 (Rev. COP14).
Favourable Reference Values	The minimum necessary values of population size, habitat and range to ensure the long-term viability of the population.
Fundamental objectives	Objectives that express what matters to stakeholders, representing a direction of change.
Means objectives	Represent means to achieve one or more fundamental objectives.
Population	When the term population is used with a name of a country, the term refers to the national population of a species. The AEWA title of the population, i.e. *Svalbard (br)* population, is used when the text refers to the entire flyway population.
Serious/ Significant damage	In those instances in which birds can only be legally killed by way of derogation/exception from the ordinary provisions of AEWA, the Birds Directive or Bern Convention, it is for each Range State to decide whether it wishes to grant

	derogations for damage-prevention purposes and, if it does so, to demonstrate that there is a risk of 'serious damage' to crops/forests/fisheries/livestock/water, and that there is no other satisfactory solution. The use of derogations can be applied in terms of preventing serious damage to crops, i.e. relating to an economic interest. However, it should also be noted that the Birds Directive does not specify whether damage should be assessed in financial or production terms. Nor does it define what constitutes 'serious damage', and this concept needs to be understood in relative terms.

Introduction

The International Single Species Management Plan (ISSMP) for the Svalbard Population of the Pink-footed Goose (*Anser brachyrhynchus*) was developed in response to paragraph 4.3.4 of the Action Plan in Annex 3 to African-Eurasian Migratory Waterbird Agreement (AEWA), which provides for the development of ISSMPs for populations that cause significant damage, in particular to crops and fisheries. The ISSMP was initially adopted by the fifth session of the AEWA Meeting of the Parties (MOP5) in 2012 with a 10-year lifespan. MOP8 extended the Plan's validity until 2025 to enable its revision (Resolution 8.4). This revised ISSMP responds to Resolution 8.4 and to a subsequent evaluation of the Plan's results and implementation performance, which concluded that implementation of management actions is still necessary, but that the ISSMP should undergo a full revision, including to its goal, objectives and framework for action.

1. Basic Data

Two populations of the Pink-footed Goose are recognised across its global range and listed in Table 1 of Annex 3 to AEWA: the Greenland & Iceland (br) population and the Svalbard (br) population. This International Single Species Management Plan covers the Svalbard (br) population.

Principal Range States[1] (regularly hosting 1% or more of a population) for the Svalbard population of the Pink-footed Goose covered by this Plan are:

- Breeding: Norway (Svalbard and mainland Norway), Russia
- Staging: Norway, Denmark, Sweden, Finland
- Wintering: Denmark, the Netherlands, Belgium

Other Range States with regular occurrence in low numbers are Germany and Poland.

Russia (which is not a Contracting Party to AEWA), Finland and Sweden have recently become Principal Range States after the fast development of new breeding grounds in Novaya Zemlya in Russia and a migratory route through Finland and Sweden (Fig. 1).

[1] The identification of Principal Range States in AEWA ISSMPs is an approach used to prioritise coordinated international management efforts in those countries considered to be crucial for ensuring the Favourable Conservation Status of the species/population in question or those countries that experience considerable human-wildlife conflict with the population. It should be noted that under no circumstances does the identification of Principal Range States in an AEWA ISSMP diminish the legal obligations of potential remaining Range States which are Contracting Parties to AEWA to equally ensure the Favourable Conservation Status of the species/population in question.

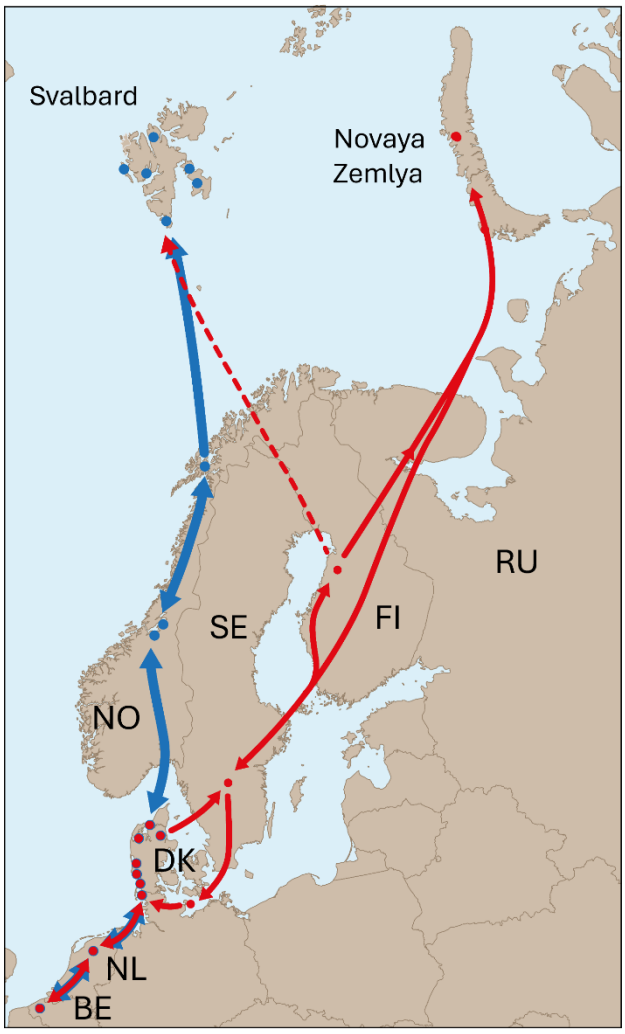


Figure 1. *Range and migratory routes including key staging and wintering areas used by the Svalbard population of the Pink-footed Goose. In blue is shown the traditional flyway and in red, the new expansion to the east. The route from Oulu in Finland to Svalbard appears not to be used consistently across years by marked individuals and has therefore been shown with a punctuated line.*

Table 1. *Summary of international conservation and legal status of the Pink-footed Goose.*[2] *Only Svalbard population.*

IUCN Red List status	
IUCN Global assessment	Least concern
IUCN European regional assessment	Least concern
IUCN EU27 regional assessment	Least concern
International legal status	
African-Eurasian Migratory Waterbird Agreement (AEWA)	Column B, category 1 of Table 1
Convention on Migratory Species (Bonn Convention)	Annex II
Convention on International Trade in Endangered Species (CITES)	Not listed
Bern Convention	Appendix III

[2] Annex 5 describes the implications of the international legal status of this population for its management.

EU Birds Directive	Annex II part B

2. Framework for Action

2.1 Introduction

The ISSMP for the Svalbard population of the Pink-footed Goose was developed in response to paragraph 4.3.4 of the Action Plan in Annex 3 to AEWA, which provides for the development of ISSMPs for populations which cause significant damage, in particular to crops and fisheries. Driven by factors such as protection measures, climate change and increasing food availability on farmland in staging and wintering areas, the Svalbard population of Pink-footed Goose has increased markedly in recent decades. In 2012, when the first ISSMP for the Pink-footed Goose (Madsen & Williams 2012) was adopted by AEWA MOP5, increasing agricultural damage and associated conflicts had been reported by most Range States, and increasing impacts on tundra vegetation caused by goose foraging (grubbing) was observed on their breeding grounds on Svalbard. Through implementation of the management actions that were agreed in the 2012 ISSMP, the population has stabilized over the past decade, which has alleviated or reduced many problems and thus dealt with the main objectives of the ISSMP (see Madsen *et al.* 2024). However, the population has stabilized above the population target that was set out in that ISSMP and its range has expanded, suggesting that several conflicts are likely to persist or resurface in the absence of continued efforts. An evaluation of the 2012 ISSMP's results and implementation performance therefore concluded that, although most of its planned results have been achieved, it is nevertheless important to maintain and adjust the adaptive management of this population. The evaluation recommended that implementation of the ISSMP continue but that it be revised; and these recommendations were approved intersessionally by the AEWA Standing Committee.

An overview of the various conflicts and risks associated with the Svalbard population of Pink-footed Goose, as well as potential threats to this population, is provided in the Problem Analysis in Annex 2.

2.2 Goal

To maintain the favourable conservation status of the Svalbard Pink-footed Goose population at flyway level while taking into account ecological, socio-economic and recreational interests.

2.3. Favourable Reference Values

Favourable Reference Values (FRVs) provide a reference for assessing whether the Svalbard population of Pink-footed Goose is in a favourable conservation status, and thus whether the goal of this Plan, and the obligation in Article II.1 of AEWA,[3] is met.

Using the reference-based approach to define the Favourable Reference Population (FRP) for this population, the **FRP is set at a spring population size of 49,000 individuals**, i.e., the closest available value after the date that AEWA entered into force on 1 November 1999. By that time, the population was flourishing in exponential growth and was expanding its range on the breeding and non-breeding

[3] Article II.1 of AEWA's Agreement text provides that "Parties shall take co-ordinated measures to maintain migratory waterbird species in a favourable conservation status or to restore them to such a status".

grounds. Habitat was not limiting the population, as new habitat became available on the breeding grounds due to global warming as well as on the non-breeding grounds due to beneficial changes in agricultural land use practices. At the Agreement Value the population plays a key role in the Arctic ecosystems. The increasing abundances exert an increasing grazing pressure on the Svalbard tundra, of concern to its ecosystem functions. In the non-breeding range, the population is heavily reliant on artificial agricultural habitat, which has caused socio-economic conflicts.

The range used in 2000 was sufficient to maintain the population and its ecosystem services throughout the annual cycle. The population's range at that time is therefore used to set the **Favourable Reference Range (FRR) at a total of 41,400 km^2 for the breeding range (Svalbard) and 374,600 km^2 for the non-breeding land range and 835,100 km^2 including seas crossed on migration.**

According to the EU and CMS definitions, the Favourable Reference Habitat (FRH) means that there is sufficient extent and quality of habitat to sustain the FRP. The current population size exceeds the FRP and there is no sign of density dependence. It can therefore be logically deduced that there is sufficient habitat to sustain an even larger population than the FRP.

(*A full discussion of the approach through which these FRVs were defined is available in Madsen et al. 2025*)

2.4 Fundamental Objectives

This ISSMP recognises six fundamental objectives[4] based on the stakeholders' perspectives expressed at the management plan revision workshop (Levanger, October 2024). Fundamental objectives do not need to be shared by all stakeholders, they express what is important for certain interest groups. Following the standards of structured decision-making they are presented with a direction of change, although it is recognised that these directions may conflict with one another. The Plan and its associated Adaptive Flyway Management Programme aim to resolve trade-offs between them.

I. Maintain a stable Pink-footed Goose population and its range and habitat at a satisfactory level[5] above the FRVs.

II. Keep agricultural conflicts[6] at an acceptable level.

III. Minimise the long-term degradation of tundra vegetation in the breeding range.

IV. Minimise the risk to human health and safety.

V. Minimise the risk to animal health and the risk of other ecological impacts.

VI. Maintain the socio-cultural value[7] of Pink-footed Geese in a manner that does not jeopardize the population status or aggravate conflicts and risks.

[4] The order of objectives does not imply any prioritisation.

[5] A satisfactory level means a level that satisfies the requirements of Article II.1 of AEWA, Article 2 of the Bern Convention, and Article 2 of the EU Birds Directive.

[6] Agricultural damage is a composite element of the broader human-goose agriculture conflict. Thus, by addressing the conflict, rather than the damage alone, this ISSMP takes a more holistic approach to dealing with all elements of the issue at stake, which include (1) actual or predictable future damage, (2) perception of damage, and (3) tolerance to damage. This also provides the opportunity for a more flexible approach to mitigating the conflict with a gradient of possible balance between the interdependent elements described above.

[7] In this context, 'socio-cultural value' refers to the significance that geese hold for human communities beyond their ecological role – including the cultural, spiritual, recreational, educational and aesthetic importance of geese

2.5 Means Objectives

Means objectives represent ways to achieve the fundamental objectives. This revised ISSMP has twelve means objectives, which are complemented by a set of process objectives (expressing ways to run the process to realistically achieve the objectives).

1. A spring population size of around 72,000 individuals[8] is maintained to prevent the population from collapsing or erupting.
2. The network of internationally and nationally important sites is maintained and managed throughout the population's range.
3. Preparedness for possible outbreaks of highly pathogenic avian influenza (HPAI) is enhanced and maintained.
4. The optimisation of compensation/subsidy schemes, or accommodation policies and alternative non-lethal methods to reduce agricultural conflicts is continued.
5. Restoration of grassland complexes in wintering and staging areas is continued (including to reduce the feeding on crops).
6. Tolerance towards geese is enhanced through economic and social incentives and nature education.
7. Contingency measures are in place to minimise the risk of long-term degradation of tundra vegetation caused by grubbing in the breeding range.
8. The risks of bird strikes with aircraft are minimised.
9. Risks to human and animal health from consumption of contaminated goose meat are minimised.
10. Hunting, where practised, is sustainable and follows wise-use principles.
11. Crippling rates from shooting are kept at a minimum level.
12. The socio-cultural values associated with and opportunities for observing Pink-footed Geese are promoted.

2.6 Process Objectives

A. An adaptive management framework for the flyway population is maintained.

B. Knowledge is available to support the implementation of the management plan.

C. Engagement with relevant stakeholder groups is enhanced and maintained.

D. Sufficient resources are secured on a long-term basis.

2.7 Emergency Evaluation

It is noted that certain Range States are cautious of the population target specified in this ISSMP. The development of the Svalbard population of Pink-footed Goose should be closely monitored and, in the

and their migrations. It therefore includes, but is not limited to, the value of Pink-footed Geese for recreational use (both consumptive and non-consumptive).

[8] This means objective replaces the population target specified in the first version of the ISSMP.

case of developments that deviate from the objectives of the ISSMP, the Plan should be subject to an emergency evaluation.

Table 2. *Framework for Action. Time scale: Immediate – launched within the next year; Short – launched within the next 3 years; Medium – launched within the next 5 years; Long – launched within the next > 5 years; Ongoing – currently being implemented and should continue; Rolling– to be implemented perpetually (any action above from immediate to ongoing can also qualify as rolling).*

Fundamental objectives	***Means/Process objectives***	***Actions***	***Priority***	***Time scale***	***Organisations responsible***
I, II, III, VI	1. A spring population size of around 72,000 individuals is maintained to prevent the population from collapsing or erupting	1.1 Maintain the internationally coordinated population management programme encompassing monitoring, assessment and decision-making protocols	Essential	Rolling	EGM IWG AEWA Secretariat Data Centre
		1.2 Adjust harvest levels nationally in response to annual decisions of the EGM IWG	Essential	Rolling	National authorities
		1.3 Increase the engagement of hunters to achieve hunting quotas defined by the EGM IWG	High	Rolling	National authorities Hunters' associations
I, II, IV, VI	2. The network of internationally and nationally important sites is maintained and managed throughout the population's range	2.1 Provide adequate protection and management to internationally and nationally important sites under Article 4(2) of the Birds Directive in the EU and other relevant instruments in other Range States throughout the range of the population and maintain them in good ecological status	Essential	Short/Rolling	National authorities
		2.2 Take key sites for geese into account in strategic land use planning and decisions regarding infrastructure development	High	Immediate/ Rolling	National authorities

		2.3 Improve planning instruments to avoid disturbance on breeding and moulting areas	High	Short	National authorities
I, IV, V	3. Preparedness for possible outbreaks of HPAI is enhanced and maintained	3.1 Establish a long-term monitoring system, including active and passive surveillance, to track baseline indicator levels and detect the early stages of HPAI outbreaks	Medium	Medium	National authorities
		3.2 Develop national response plans with clearly defined roles and responsibilities to enable rapid response to HPAI outbreaks	High	Medium	National authorities
		3.3 Enhance the collaboration with veterinary services, encouraging their expansion of monitoring to geese, and engage volunteers to report observations of dead birds	Medium	Medium	National authorities NGOs
II	4. The optimisation of compensation/ subsidy schemes, or accommodation policies and alternative non-lethal methods to reduce agricultural conflicts is continued	4.1 Share knowledge about best practices regarding compensation/subsidy schemes, accommodation and alternative scaring methods to reduce agricultural conflicts.	High	Medium/Rolling	National authorities
		4.2 Devise and experiment with new farming practices to reduce agricultural conflicts	Medium	Medium	National authorities Research institutes

I, II	5. Restoration of grassland complexes in wintering and staging areas is continued (including to reduce the feeding on crops)	5.1 Incorporate key sites and habitat requirements of geese into national nature restoration plans, where appropriate	High	Short/Rolling	National authorities
		5.2 Implement national nature restoration plans	High	Short/Rolling	National authorities NGOs
II, VI	6. Tolerance towards geese is enhanced through economic and social incentives and nature education	6.1 Promote goose-related economy such as ecotourism, organised hunting and meat products	Medium	Rolling	National authorities Hunters' associations NGOs Other stakeholders
		6.2 Increase awareness about geese and their migration and annual cycle, management and socio-cultural values	Medium	Rolling	National authorities NGOs Other stakeholders
		6.3 Promote the engagement of farmers with the management of Pink-footed Goose in order to enhance tolerance	Medium	Rolling	National authorities Farmer's associations
III, V	7. Contingency measures are in place to minimise the	7.1 Determine and agree on acceptable levels of tundra degradation and specify these in the Adaptive	High	Immediate	EGM IWG

	long-term degradation of tundra vegetation caused by grubbing in the breeding range	Flyway Management Programme for this ISSMP			
		7.2 Develop a contingency plan to minimize degradation of tundra vegetation in the breeding range	High	Medium	EGM IWG in conjunction with Norwegian authorities
		7.3 If the extent of tundra degradation is outside acceptable levels, EGM IWG agrees to take the necessary action[9]	High	Medium	EGM IWG Data Centre Norwegian authorities
IV	8. The risks of bird strikes with aircraft are minimised	8.1 Share knowledge regarding operational measures to reduce the risk posed by geese to flight safety (such as radar surveillance and local habitat management) and promote the use of such measures	High	Short/Rolling	National authorities Aerodrome operators
		8.2 Develop early warning systems and new technologies to reduce flight safety risks using GPS-tracking of goose migration	High	Medium	Data Centre National authorities Aerodrome operators
		8.3 Analyse aircraft-goose strike risk and raise awareness about risks of goose strikes with aviation authorities and aerodrome operators	High	Medium	Data Centre National authorities Aerodrome operators
IV, V	9. Risks to human and animal health from consumption of contaminated goose meat are minimised	9.1 Phase-out the use of lead ammunition	High	Rolling	National authorities
I, VI	10. Hunting, where practiced, is	10.1 Develop, and promote the use of, guidance and	Medium	Medium	National authorities

[9] See also section 2.7 on emergency review.

	sustainable and follows wise-use principles	training on best-practices for goose hunting			International, national and local hunting associations
		10.2 Ensure that hunting is performed in a manner that minimises disturbance, to allow geese to utilise local food resources, where there is no agricultural conflict	High	Rolling	National authorities Hunting associations
I, IV, VI	11. Crippling rates are kept at a minimum level	11.1 Maintain awareness campaigns in support of hunting practices to reduce crippling	Medium	Short	Data Centre EGM IWG
VI	12. The socio-cultural values associated with and opportunities for observing Pink-footed Geese are promoted	12.1 Develop information materials that support sustainable eco-tourism development and describe knowledge about geese, their socio-cultural values and the EGMP	Medium	Medium	AEWA Secretariat Data Centre National Authorities Stakeholders
All	A. An adaptive management framework for the flyway population is maintained	A.1 Develop an Adaptive Flyway Management Programme (following the guidance provided the *Format and Guidelines for AEWA International Single and Multi-species Management Plans*)	Essential	Immediate	EGM IWG National authorities
		A.2 Periodically monitor implementation of the Management Plan and its Adaptive Flyway Management Programme	Essential	Rolling	EGM IWG National authorities
All	B. Knowledge is available to support the implementation of the	B.1 Maintain offtake statistics, including derogations	High	Short/Rolling	National authorities
		B.2 Collect data on indicators periodically	Essential	Rolling	National authorities

	management plan	B.3 Understand the positive and negative effects of the EU Nature Restoration Law for Pink-footed Goose management	Medium	Short	Research institutes National authorities
		B.4 Collect systematic data on the extent and intensity of goose grubbing on Arctic tundra vegetation	High	Medium	Norwegian authorities Data Centre
		B.5 Investigate the impact of goose grubbing of tundra moss layers on habitat quality for high-Arctic waders	Medium	Medium	Norwegian authorities Research institutes
		B.6 Assess the extent and risks of radioactive contamination of geese breeding and moulting in Novaya Zemlya	High	Short	National authorities Research institutes
		B.7 Maintain monitoring of the proportion of the population carrying shotgun pellets in tissue after hunting (crippling rate)	Medium	Short	Data Centre EGM IWG
		B.8 Enhance communication and collaboration with citizen scientists and scientific associations providing information to the EGMP	Medium	Medium	AEWA Secretariat Data Centre National Authorities Stakeholders
All	A. Engagement with relevant stakeholder groups is enhanced and maintained	C.2 Develop and implement a communication strategy and plan	Medium	Short/Rolling	AEWA Secretariat National authorities
All	D. Sufficient resources are secured on a	D.1 Range States contribute on a regular basis to the budget of the EGMP	Essential	Ongoing/Rolling	National authorities

	long-term basis	D.2 National and regional governments secure the necessary funds for the implementation of the actions at national and sub-national levels	Essential	Ongoing/Rolling	National authorities

Annex 1. Biological Assessment

1. Distribution throughout the annual cycle

The Svalbard population of the Pink-footed Goose[10] traditionally breeds in Svalbard, as well as on Bear Island in the Barents Sea south of Svalbard. The main breeding grounds in Svalbard are found along the west coast and in the western and northwestern fjords, and only smaller numbers are also found nesting on the east side of Svalbard (https://goosemap.nina.no/goosemap_eng/Startpage.aspx). A few scattered breeding records are reported from Finnmark and Lofoten in northern Norway (European Breeding Bird Atlas 2; https://ebba2.info/maps/species/Anser-brachyrhynchus/ebba2/breeding/). However, systematic surveys are lacking. Within the last one-to-two decades, the Pink-footed Goose started to breed on the western part of Severny Island, in Novaya Zemlya, north Russia (Madsen et al. 2023).

In Svalbard, immature and failed breeders of Pink-footed Geese undertake a moult migration to the eastern part of the archipelago, where flocks of flightless geese gather along coasts or on larger lakes (Glahder et al. 2007). Breeding Pink-footed Geese moult their flight feathers during the brood-rearing period and stay relatively close to the nesting grounds.

In autumn, the Pink-footed Geese from Svalbard migrate non-stop to staging areas in Trøndelag in mid-Norway and onwards to wintering grounds in western Denmark, the Netherlands and Flanders in Belgium. The vast majority of geese bypass Germany on migration; however, surveys and GPS-tagging have shown that in autumn flocks of Pink-footed Geese increasingly roost and forage in Schleswig-Holstein, Germany, night-time roosting in Rickelsbüller Koog just south of the border with Denmark, and foraging in southwest Jutland or in the north of Schleswig-Holstein (J. Madsen unpubl. data). Furthermore, small flocks of Pink-footed Geese are observed in Lower Saxony during autumn and winter. In Flanders, the first wintering birds arrive early October, reaching a peak from mid to end December; early spring migration already starts mid-January. Increasingly, birds no longer stop in the Netherlands. (Kuijken, and Verscheure 2023).

In early spring, the Pink-footed Geese concentrate in west and northwest Jutland, Denmark, and migrate to spring-staging areas in Trøndelag in mid-Norway. From there, some of the geese migrate to stopover sites in Vesterålen in north Norway, from where they migrate to Svalbard; however, some geese make a non-stop migration from Trøndelag to Svalbard (Fig. 2).

Within the last two decades, flocks of Pink-footed Geese started to appear in the Örebro area in south Sweden in autumn and spring as well as in the Oulu area in western Finland in spring, i.e. far away from the tradition migratory path. Resightings of neckbanded individuals confirmed that the geese came from the traditional flyway. Numbers have rapidly increased, going from less than 100 birds around the year 2000 to close to 10,000 in the spring of 2024 (EGMP Data Centre data portal). GPS-tagging of geese caught in the Oulu area in the springs of 2018 and 2019 showed that around half of the tagged individuals migrated to Svalbard while the other half migrated to Novaya Zemlya (Fig. 2). The geese migrating to Novaya Zemlya were shown to breed there (Schreven et al. 2021). In autumn the Novaya Zemlya geese migrate back to south Sweden, with some individuals making stopover in the Oulu area as well in recent years. As winter sets in, the geese migrate further to southeast Denmark or northwest Denmark; some individuals also go to Belgium and the Netherlands. In spring, the Novaya Zemlya

[10] Throughout this document the population is termed as the Svalbard population, regardless that the current population also breeds in Novaya Zemlya.

geese migrate from Denmark back to south Sweden and onwards to Oulu. However, some individuals also follow the Svalbard birds to Norway and cross over to Oulu from there.

2. Habitat requirements

On the breeding grounds in Svalbard, the Pink-footed Geese exploit lowland wet, mesic and dry tundra vegetation, foraging on a variety of plants (graminoids, herbs, Equisetum, mosses) and plant parts (roots, rhizomes, leaves, seeds) in a spatial and temporal pattern dependent on snow melt and timing of availability, growth season and peaks in quality of food plants (e.g., Fox et al. 2009). At the time of snowmelt, Pink-footed Geese exert so-called 'grubbing', pulling out roots and rhizomes from the thawing moss carpet or soil (Fox, Francis & Bergersen 2006). As the Pink-footed Geese are able to defend themselves and their goslings against Arctic Foxes, they can forage inland during brood rearing when the adults are flightless; however, when non-breeders gather to shed their flight feathers, they are confined to foraging close to open water (coasts, rivers, larger lakes) where they can seek refuge. Pink-footed Geese nest on south facing slopes, typically in *Dryas* vegetation, or on small hillocks in more flat terrain in lowland areas.

Outside the breeding areas, the Pink-footed Geese almost exclusively forage in agricultural habitats, ranging from extensively grazed grasslands (the traditional habitat) to cropland, utilizing green parts of pasture grass, clover or cereals, newly sown cereals, waste after harvest such as spilt grain, maize, potatoes, carrots or sugar beet (Fox et al. 2005; J. Madsen unpublished data). At night, the geese typically roost communally on sheltered coasts, lagoons, lakes or larger rivers. At day the geese fly inland to feed in wide open fields in the vicinity of the roosts; however, this is very dependent on the food resource. Within the last two decades, the increasing growth of maize in northwest Europe has provided Pink-footed Geese with a novel energy rich resource, and geese fly up to 45 km from the roosts to feed in maize stubble fields (Clausen et al. 2018a). This has increased the available range and habitat as well as the migratory behaviour of the population, the majority nowadays staying in Denmark throughout the winter (Clausen et al. 2018b).

3. Productivity and survival

The productivity of the Svalbard population of the Pink-footed Goose is strongly affected by the timing of the snow melt. The Pink-footed Goose is a 'capital breeder', building up body fat stores, mating and females starting the development of follicles in the spring staging areas in Norway as a prelude to breeding in Svalbard (Klaassen et al. 2017). In years with early snow melt, nest sites are readily available, and the females can start egg-laying shortly after arrival and their likelihood of hatching successfully is high because they have sufficient body reserves to stay on the nest thereby reducing the risk of predation by Glaucous Gulls and Arctic Skuas and, for males, to protect the nest and female against predation by Arctic foxes. In years with late snow melt, geese may have to wait for nest sites to become available for weeks. Many geese give up the breeding attempt, and the likelihood of hatching successfully is sharply reduced because females increasingly leave the nests to feed, exposing the nest to predation (Madsen et al. 2007).

The effect of the timing in snowmelt on the nesting propensity and success is reflected in the overall productivity of the population. Age-ratio counts performed in goose flocks in the autumn have been carried out since 1980 and show highly fluctuating breeding success (Ganter & Madsen 2001), however with some biases due to the timing and spatial distribution of the age counts (Jensen, Johnson & Madsen 2023). Using an integrated population model (Johnson et al. 2020), it has been possible to estimate the post-breeding productivity of the population (i.e., prior to the departure from Svalbard and harvest on

the autumn staging areas). During 1992-2024, the post-breeding proportion of young averaged 0.19 (se = 0.01). 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 as a proxy for the timing of snow melt (Fig. 2) (Johnson et al. 2024).

Between 1990 and 2021, a capture-mark-recapture program based on neckbanding and metal ringing has provided estimates of the adult survival in the Pink-footed Goose (see Kéry, Madsen & Lebreton 2006). The program was recently stopped due to financial constraints. However, the integrated population model set up as part of the implementation of the adaptive harvest management program in 2013 continues to provide annual posterior estimates of survival. The model suggests a strong effect of harvest rate. Posterior estimates of annual harvest and survival rates of the flyway population are provided in Fig. 4. Harvests and harvest rates were increasing prior to 2013 but have been somewhat stable since. In recent years, harvest has decreased substantially in Denmark (Johnson et al. 2024). Estimates of annual survival have generally decreased during the entire period of record (from above 90% in the early 1990s to around 80% in the 2010s), although there is a high degree of uncertainty associated with the estimates in the last few years (due to the cessation of the capture-mark-recapture program).

4. Population size and trends[11]

Population census data for the Svalbard population of the Pink-footed Goose go back to the 1930s, when the wintering population was estimated at 5,000-8,000 individuals (Madsen 1982). Numbers increased to 8,000-12,000 in the 1940s and 1950s, and this increase continued in the 1960s and 1970s. By 1980, the population size had reached 27,000 individuals. The growth continued until the 2010s. Since then, the population size is estimated to have fluctuated between 72,000 and 90,000 in spring based on an integrated population model; Johnson et al. 2020) (Fig. 5). See Johnson et al. (2024) for adaptations in survey methodology and model. The causes behind the continued increase since the 1940s are mainly attributed to better protection from hunting, such as ban of spring shooting in Denmark since 1965, a national hunting ban in the Netherlands since 1976 and in Belgium since 1981 (with local bans instigated from 1958 onwards). The impact of hunting was corroborated by an analysis of ring recoveries showing an increase in adult survival from 1955-1974 to 1975-1983 (Ebbinge et al. 1984). Climate change giving rise to milder winters and land use changes (growth of winter cereals and maize) may also have contributed to better winter survival (Kéry, Madsen & Lebreton 2006). There are no signs of density-dependent regulation of the current population size (based on integrated population simulations; F. Johnson per. comm.). Hence, the current stabilisation in population size is primarily an effect of the current adaptive harvest management program (which, under the first edition of the ISSMP, has had the objective of stabilising the population at a target of 60,000 (±10,000) individuals) and not a sign of density dependence regulation.

[11] Extracted from the [draft] FRVs report (Madsen *et al.* 2025).

Table 3. *Population sizes and trend by Range State.*

Range State	Breeding numbers (individuals)	Quality of data	Year of the estimate	Breeding population trend in the last 10 years	Quality of data	Maximum size of migrating or non-breeding populations in the last 10 years	Quality of data	Year of the estimate
Norway	83,598	High (IPM-based)	2024	Stable/ Increasing (long-term increase)	High	84,363	High	2017
Russia	4,000	Moderate	2023	Increasing	High	NA		
Sweden	0					4,979	High	2023
Finland	0					9,942	High	2024
Denmark	0					87,593	High	2020
Netherlands	0					11,337	High	2016
Belgium	0					29,594	High	2024
Overall	**87,598**		**2024**					

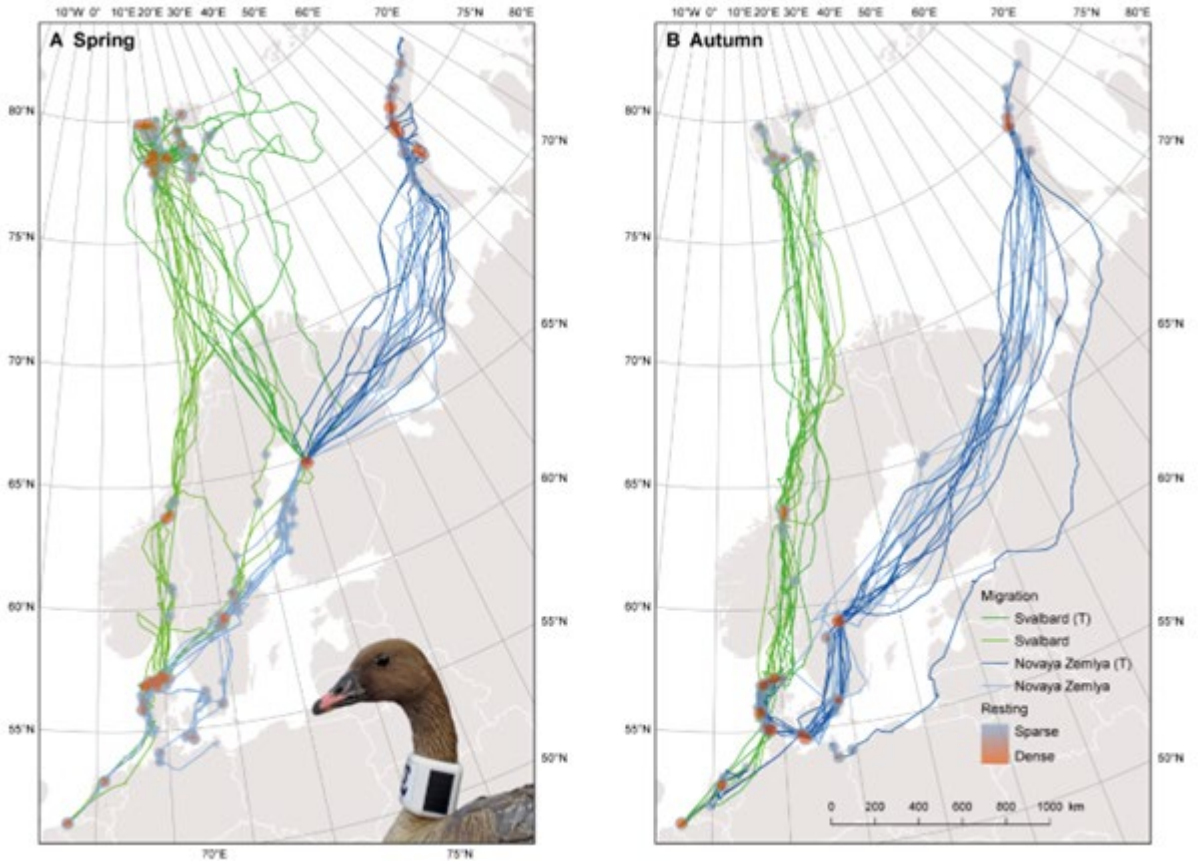


Figure 2. *Migration routes taken by Pink-footed Geese marked and tagged with GPS-transmitters in Oulu, Finland, spring 2018 and 2019 and breeding records in Novaya Zemlya. (A) Spring migration routes (towards Svalbard versus Novaya Zemlya) in the year of tagging (T) and in the subsequent two years (January-August). Insert photo shows individual marked with neckband GPS-tag with solar panel. (B) Autumn migration routes in*

the autumn after tagging (T) and in the subsequent two years (September-December). A heat map expressing the density of GPS positions is used to show areas where geese stopped (for resting, foraging, nesting). Source: Madsen et al. Current Biology (2023)

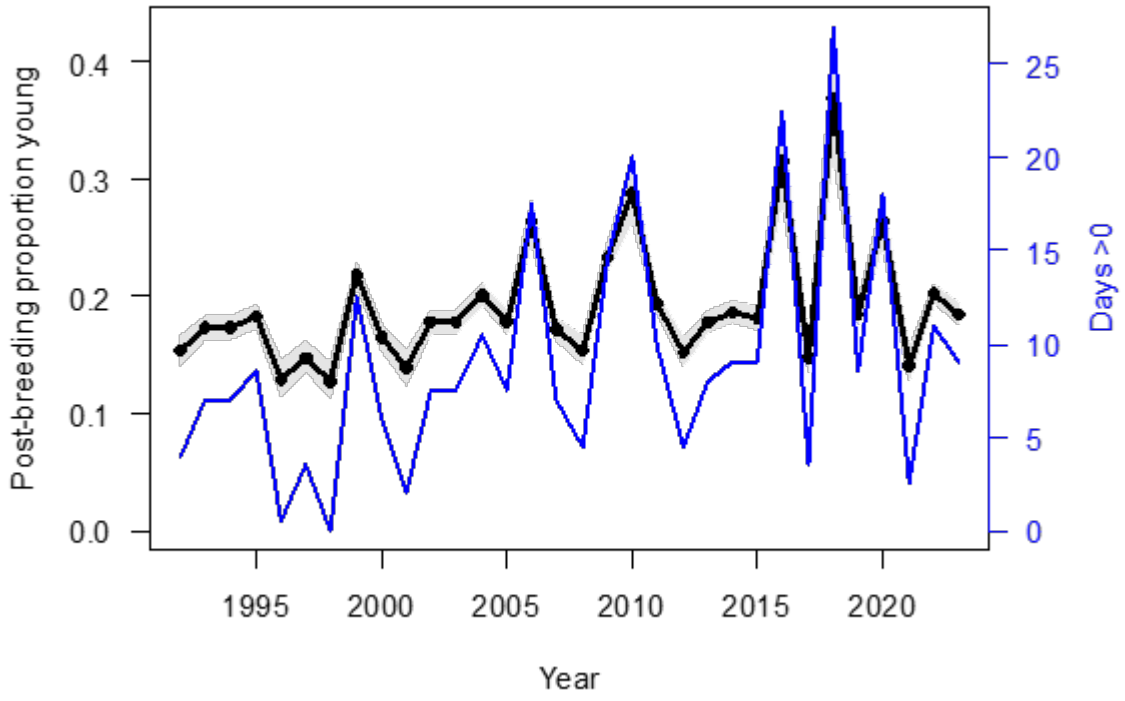


Figure 3. *IPM-based estimates of the post-breeding proportion of young for Svalbard Pink-footed Geese (95% credible intervals are indicated by shaded polygon). In blue are the number of days above freezing in May in Svalbard. Source: Johnson et al. (2024).*

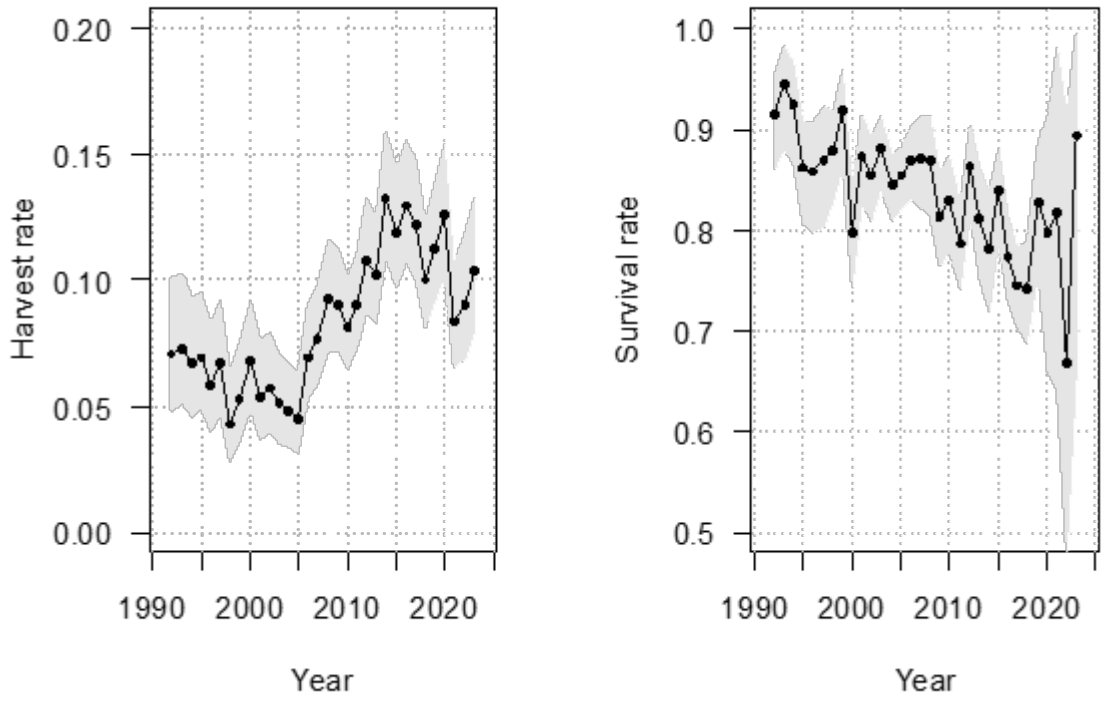


Figure 4. *IPM-based estimates of harvest and annual survival rates of adult Svalbard Pink-footed Geese (95% credible intervals are indicated by the shaded polygons). The apparently large increase in annual survival in 2023 should be viewed with some skepticism. Source: Johnson et al. (2024).*

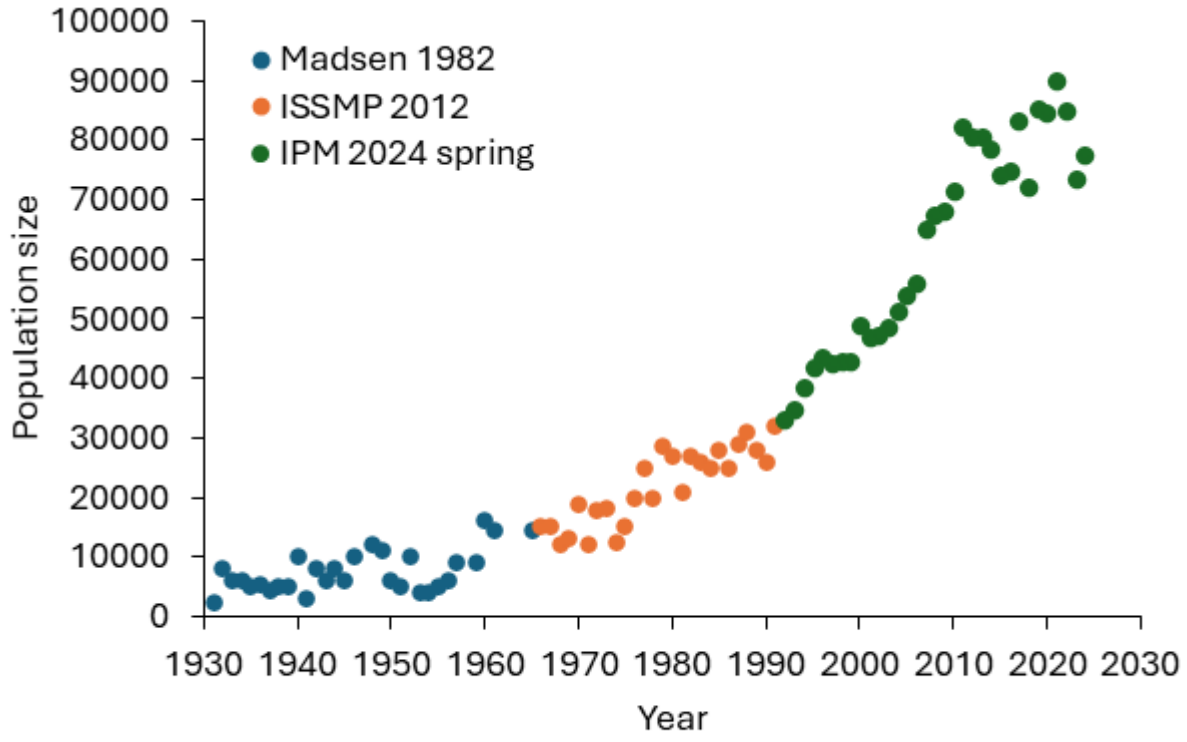


Figure 5. *Trajectory of the Svalbard population of the Pink-footed Goose, 1931-2024, based on censuses (Madsen 1982; ISSMP 2012, referring to Madsen and Williams 2012) and outputs from the integrated population model used to estimate the spring population size under the EGMP (IPM 2024 spring; only median values shown).*

Annex 2. Problem Analysis

1. Introduction

Driven by factors such as protection measures, climate change and increasing food availability on farmland in staging and wintering areas, the Svalbard population of Pink-footed Goose has increased markedly in recent decades. In 2012, when the first ISSMP for the Pink-footed Goose (Madsen & Williams 2012) was adopted, increasing agricultural damage and associated conflicts had been reported by most Range States, and increasing impacts on tundra vegetation caused by goose foraging (grubbing) was observed on their breeding grounds on Svalbard. Through implementation of the management actions that were agreed in the ISSMP, the population has stabilized over the past decade, which has alleviated or reduced many problems and thus dealt with the main objectives of the ISSMP (see Madsen *et al.* 2024). However, the population has stabilized above the population target set out in the ISSMP, and its range has expanded, suggesting that several conflicts are likely to persist or resurface in the absence of continued efforts.

This problem analysis was drafted on the basis of responses provided during the evaluation of the first ISSMP (see Madsen *et al.* 2024) by Pink-footed Goose Range States (Norway, Finland, Sweden, Denmark, the Netherlands, and Belgium), Permanent Observer Organizations to the EGMP, and the Pink-footed Goose Task Force. The draft analysis was discussed and elaborated during a workshop held in Levanger, Norway in October 2024. Additional information has been gathered by reviewing available literature.

2. Ecosystem services and ecological functions of geese

Expansions of breeding and/or wintering ranges have increased goose abundance in many areas, focusing attention on their adverse impacts such as damage to agricultural crops, risks to flight safety, and impacts on the tundra ecosystem. However, benefits for people (ecosystem services), and important ecological functions provided by geese, should also be considered. A review by Buij *et al.* (2017) provides an exhaustive list, and specific ecosystem services and functions of relevance to Pink-footed Goose management are briefly outlined below.

2.1. Human value

The presence of large flocks of geese generates a range of economic and non-economic (societal) benefits, ranging from the pleasure of watching the goose flocks to the consumptive use by hunters. The migratory habits of Pink-footed Goose (and other species) make their arrival to and departure from breeding, staging and wintering areas particularly valued, and often bird migration is culturally intertwined with the changing seasons and life in the countryside. The opportunity to experience Pink-footed Geese outside the breeding areas (by birdwatchers, hunters, and other outdoor enthusiasts) has led to annual celebrations and events in Norway, Denmark, the Netherlands, and Belgium. The fascination in geese has the potential to bring people together, although stakeholders may not always share interests.

The Pink-footed Goose harvest in Norway and Denmark (see further details below) locally represents opportunities for recreational hunting and a valued source of game meat. As an example, underlining the value of goose meat as a sustainably harvested delicacy, recipes based on wild goose meat were

recently presented in the Norwegian book "Goose and Gourmet" (https://www.orkana.no/produkt/gas-og-gourmet/).

Hunters, like other users of nature, often spend considerable amounts of time and money participating in their activities, which can bring direct and indirect economic benefits to rural areas of Europe during the winter months (Kenward & Sharp 2008). While hunters most often contribute financially directly to landowners to have the opportunity to shoot geese, societal benefits of passive use (eco-tourism, birdwatching) and non-use are more difficult to quantify. These contributions may however be estimated by counting visitors in nature reserves or goose hotspots and evaluating associated fees or local income. So far, this has not been quantified and analysed for the Pink-footed Goose.

Since the early 1990s, a legbanding and neckbanding project has been carried out by Aarhus University and collaborators in Norway, the Netherlands and Finland. More than half a million resightings have been gathered by professional as well as volunteer birdwatchers along the migratory route of the population, illustrating a big interest and curiosity in the whereabouts and movement patterns of the geese. Observers have entered their resightings into the online portal www.geese.org, (now https://submit.cr-birding.org/) where they have been able to follow the life history and movements of the observed geese. Likewise, hunters have reported rings and neckbands from shot geese to the national ringing centres, informing about the whereabouts and survival of geese. This has provided valuable information for scientific analyses of migration and demographics of the population and further incentivizes birdwatchers to observe and count these birds.

2.2. Dispersal of plants and invertebrates

Pink-footed Geese have been shown to act as long-distance dispersal vectors for plants previously assumed to lack such a mechanism, thus potentially allowing terrestrial and aquatic plants to cross oceans and to keep pace with climate change (Lovas-Kiss *et al.* 2023). Plant propagules dispersal by other goose species are commonly reported (Ayers *et al.* 2010, Buij *et al.* 2017), usually detected in droppings or carried on feet or feathers during migration, suggesting that geese could potentially assist selected species to extend their native range in response to habitat loss. On the other hand, geese may also facilitate the spread of invasive alien plant species such as the New Zealand Pygmyweed *Crassula helmsii* (Denys *et al.* 2014).

On the negative side, high goose densities resulting in intensive grazing has been shown to deplete local seed stocks, influencing the long-term potential for vegetation recovery after a disturbance (Kuijper *et al.* 2006) and potentially outcompete other goose species where formerly allopatric species now overlap on the breeding grounds (Rozenfeld & Sheremetiev 2014).

As well as plant propagules (Takacs *et al.* 2017), geese are likely important dispersers of invertebrates (Buij *et al.* 2017) such as bryozoans (Figuerola *et al.* 2004).

2.3. Other ecosystem functions

In Belgium, wintering geese traditionally occupy wet grassland areas where goose grazing, leaving the sward short and dense in February-March, creates an attractive habitat for migratory waders passing through in spring. At the start of the breeding season, the same short-grazed wet grasslands are very attractive for meadow-breeding waders such as Black-Tailed Godwit *Limosa limosa*, Lapwing *Vanellus vanellus*, and Eurasian Curlew *Numenius arquata*. As such, grazing by wintering geese conditions the area for use by numerous other bird species and reduces the amount of rough vegetation at the start of

the breeding season. Similar effects have been recorded in Denmark, where grazing by wintering, spring-staging and/or breeding Pink-footed, Barnacle *Branta leucopsis* and Greylag *Anser anser* Geese apparently benefit staging and breeding waders.

3. Conflicts and risks

3.1 Human-wildlife conflicts related to damage to agricultural crops

Leading up to the adoption of the first ISSMP for the Svalbard population of Pink-footed Goose, increasing agricultural conflict had been registered in most of the range states. Conflicts were still increasing in Norway during spring, whereas conflicts caused by Pink-footed Geese in the southern Range States were stabilizing. In Denmark, conflicts were partly alleviated due to the changing spring migration phenology of the geese (Madsen & Williams 2012). Nevertheless, agricultural conflicts remain a cause of concern with considerable economic costs. In four Range States (Norway, Sweden, the Netherlands, and Belgium) subsidy schemes or compensation payments have been instigated to alleviate conflicts and/or compensate farmers for losses. In two of these (Belgium and the Netherlands), there is a systematic recording of agricultural damage caused by geese. Subsidies and compensation payments in Norway, the Netherlands and Belgium amount to approximately half a million EUR per year (Madsen *et al*. 2024).

Establishing an adaptive harvest management (AHM) programme has been a key action under the ISSMP to ensure that a stable population has been maintained, thus avoiding a possible escalation of agricultural conflicts and increase in economic costs due to compensation and subsidy schemes as well as administrative management. However, the on-going move from traditional agricultural practices to a more intensified land use may in some cases result in new conflicts if crops become more sensitive to grazing and trampling. Furthermore, for several crops the growing season has advanced, potentially resulting in greater overlap between crop growth and Pink-footed Goose presence. Hence, the increase in damage is not only a result of a growing population. There is a trade-off between agricultural intensification/changes, population growth and agricultural damage.

Finally, it is important to note that conflicts and damage caused by other goose species may affect the level of tolerance with which damages caused by Pink-footed Goose are perceived, particularly since options for mitigation of such damage are often limited.

3.2 Effects on other flora and fauna

Potential long-term degradation of Arctic tundra vegetation

With the increasing population size and range expansion observed during recent decades, signs of a negative effect of foraging Pink-footed Geese on tundra vegetation in Svalbard were reported (Pedersen *et al.* 2013). As the geese are grubbing for roots and rhizomes in the wet moss carpets, moss and other food plants are pulled out which may create holes or craters which appear to regenerate at variable rates. Regeneration depends on wetness, patch size and the plant community (Speed *et al.* 2010, Ravolainen *et al.* in prep.) and is slowed down by geese returning to the same patches and grubbing on the edges of already open patches. The foraging activity may cause a shift in vegetation composition with a decrease in moss cover and an increase in graminoids (grasses and sedges) (van der Wal *et al.* 2007, Ravolainen *et al.* in prep.). During the ISSMP revision process, it was raised that there might be a cascading effect of goose grubbing of the tundra moss layers on the habitat quality for high-Arctic waders. Although not currently a documented pressure, this is a research gap that warrants attention. The adaptive harvest

management (AHM) programme has stabilised the population size which may reduce the negative effects on Arctic tundra ecosystems. However, the observed and anticipated rapid warming of the Arctic may alter the effects of goose grazing on tundra vegetation.

3.3 Flight safety risks due to goose strikes

At Copenhagen Airport in Denmark, the first bird strikes involving geese (primarily Greylag and Barnacle Geese) were recorded in the second half of the 1990s, and the frequency of bird strikes with geese has increased during the last decades (Powolny *et al.* 2018). This increase seems to be linked to an increase in numbers of geese migrating over the Copenhagen area between staging areas in the southern part of Sweden and wintering sites in Denmark and further south but may also be related to the increasing airport traffic (source: Eurostat Data; Bradbeer *et al.* 2017; Stroud *et al.* 2017). At Schiphol Airport in the Netherlands, bird strikes involving geese have been recorded since 2005 and the frequency appears to have increased during the last decades (Powolny *et al.* 2018), even though a comprehensive management scheme has been in place.

To the compilers' knowledge, no bird strikes involving Pink-footed Goose have been registered to date. However, bird strikes involving other goose species have been reported from at least five Range States (Norway, Sweden, Denmark, the Netherlands and Belgium), and specific concerns related to Pink-footed Geese are growing locally in at least two Range States (Norway and Denmark).
Pink-footed Geese are known to use areas close to airfields for foraging and resting, and they frequently pass over airports during migration. Construction of new airports or expansion of existing facilities do not always consider the most recent knowledge on migratory routes of geese and other bird species, which may increase collision risk.

3.4 Risks to human and animal health

Wild goose species may act as a reservoir for viral diseases (*e.g.* avian influenza, coronavirus) as well as carriers of pathogenic protozoans (such as *Toxoplasma gondii*) and bacteria (e.g. *Salmonella*, *E. coli* and *Campylobacter*). Geese have even been found to act as vectors for resistant strains of *E. coli* closely related to those commonly occurring in humans (Kallbekken & Mjelde 2020). Such pathogens potentially pose serious risks to human and animal health (Alexander 2000, Gorham and Lee 2016), although there is currently little evidence of transfer to livestock and humans (Elmberg *et al.* 2017).

Due to their migratory behaviour, geese may potentially transport infectious diseases over long distances, thus also potentially transmitting diseases to poultry farms. Studies show that migratory geese are often exposed to diseases such as avian influenza in the large flocks on the wintering grounds (Yin *et al.* 2017), indicating that migratory geese may be more likely to act as vectors during the spring, and less so during autumn migration. The first detection of highly pathogenic avian influenza (HPAI) virus in Norway included a wild Pink-footed Goose that had probably been exposed to the virus in its wintering area (Madslien *et al.* 2021). Outbreaks of HPAI in geese may also pose a risk to wild predators and scavengers such as White-tailed Eagle *Haliaetus albicilla*, Peregrine Falcon *Falco peregrinus*, and Red Fox *Vulpes vulpes*.

The use of lead shot for goose shooting may constitute a human health issue through people ingesting lead shot or fragmented lead shot when eating goose meat from shot birds (Kanstrup 2024), and lead poisoning of geese may also pose a general risk to avian and mammalian predators and scavengers (see Nadjafzadeh *et al.* (2013) and the chapter on diseases and contamination below).

If Pink-footed Geese breeding on Novaya Zemlya are indeed subject to high levels of radioactive exposure (see Piironen *et al.* (2021) and the chapter on diseases and contamination below), this may also pose a risk to human health through consumption of contaminated goose meat.

4. Potential threats to the population

4.1 General overview

This section is not intended as a full risk assessment but merely outlines the anticipated actual/potential threats to the population. The assessment is based on available knowledge through several decades of studies on this species, incorporating recent information from Range States and international stakeholder organisations.

Although the population has been growing for several decades and is currently stable above the target population size, the factors included here have the potential to negatively affect the survival and/or reproduction of the population, while others may decrease its range or reduce the quality of available habitat.

4.2 Habitat loss

Altered habitat use

Changes in habitat use may cause loss of foraging opportunities for Pink-footed Geese. Overgrowing of pastures, intensification of land use, abandoning traditional agricultural practices, afforestation, and establishment of human infrastructure (such as renewable energy plants) may force Pink-footed Geese to explore new foraging areas. Funding opportunities for reestablishing and maintaining natural meadows and marsh areas are currently limited, resulting in limited capacity for mitigation measures. If no high-quality natural habitat is available, this may locally increase agricultural conflicts.

In some cases, nature restoration may also have negative impacts on the Pink-footed Goose population. For example, an important autumn staging area in Denmark, consisting of farmland utilised by a large proportion of the Pink-footed Goose population, was transformed into a restored wetland area (lake) to benefit waterbirds and biodiversity in general, but caused the geese to avoid the area and seek new agricultural foraging sites, initially even leaving for the Netherlands earlier than seen in previous years (Clausen & Madsen 2016).

Climate change-driven habitat changes

Climate change is not anticipated as a major threat to Pink-footed Goose. However, roosting habitats such as bays, tidal mudflats and wet grasslands may become locally scarce or unavailable with the foreseen sea level rise combined with continued urban and industrial development. In addition, climate change-driven changes to land-use may cause foraging areas to become unsuitable for Pink-footed Geese.

4.3 Interspecific competition for resources

Competition for food with Barnacle Geese at spring staging sites in northern Norway may cause reduced opportunities for spring fattening prior to migration to the breeding grounds on Svalbard. This still needs to be analysed in more detail, and possible effects on reproductive output remains to be documented, but the inter-specific competition has already shifted important spring staging areas in Norway further south to Trøndelag (I. Tombre & J. Madsen unpublished). Likewise, in western Denmark, a strong growth in the wintering numbers of Barnacle Geese has led to increased inter-

specific competition with Pink-footed Geese. This has resulted in abandonment of important wintering sites by Pink-footed Geese and their redistribution further north and inland (J. Madsen unpublished), which may result in a poorer body condition for wintering geese.

4.4 Energy infrastructure

Large-scale development planning for renewable energy plants such as solar panels, offshore and land-based windfarms is on-going, and the green transition is currently gaining momentum. Pink-footed Geese exhibit strong changes in foraging behaviour by avoiding windfarms by several hundred metres (Larsen & Madsen 2000, Plonczkier & Simms 2012), although they also demonstrate habituation (Madsen & Boertmann 2008). The risk of collision is considered small, yet displacement effects may limit high-quality foraging areas available to the geese, demonstrating a need for strategic planning of energy clusters including careful consideration of potential effects on birds throughout the annual cycle.

High voltage power lines often cross open landscapes used for roosting and foraging by large flocks of geese, which may cause collisions (not least when geese are disturbed by predators or human activities). A project in Flanders, Belgium, to identify problematic trajectories for birds and mitigate collision risks on the high-risk trajectories, is currently on-going (led by NGO Natuurpunt). Further research and monitoring is recommended on the impact of power lines.

4.5 Human disturbance

A growing interest in visiting Svalbard has been registered in recent years, and tourist activity by both cruise ship passengers and hikers visiting the archipelago is increasing rapidly (Kaltenborn *et al.* 2024). Breeding Pink-footed Geese are highly sensitive to disturbances, both during nesting, brood rearing and moulting (Madsen *et al.* 2009), yet tourists may not realise the disturbance they cause as Pink-footed Geese exhibit strong avoidance behaviour and will likely leave at relatively long distances (often more than 1 km). The Governor of Svalbard has declared protection zones with limitations on tourist access; however, in Isfjorden, the central breeding area for Pink-footed Geese, tourist activities are less restricted. Depending on the timing, human disturbance in core breeding areas may cause a reduced number of pairs to initiate breeding attempts or increase gosling mortality; single hikers tenting in a core goose brood rearing area (the river plains in Sassendalen) were observed to displace hundreds of Pink-footed Goose families from a 4-5 km key stretch of the valley for several days (J. Madsen unpublished data).

During the migration and wintering periods, Pink-footed Geese may be displaced from core feeding areas by intensive scaring activities (to avoid crop damage) and hunting. As hunting intensity and practice varies along the flyway, disturbance from hunting is likely to be of mainly local importance, yet efforts to coordinate hunting in order to reduce disturbance will allow the geese to remain in suitable areas until food resources are utilized (Jensen *et al.* 2017). Intensive scaring was previously suggested to affect body condition, reproduction and summer survival (Madsen 1995; Klaassen *et al.* 2006), and even though conflicts in some areas have been solved by introducing subsidy schemes, future goose grazing in new areas (for example along the newly established migratory route) may invoke similar conflict.

4.6 Diseases and contamination

There have been no reports of die-offs of Pink-footed Geese which could be related to Highly Pathogenic Avian Influenza (HPAI), although an AI seroprevalence of around 50% has been recorded in the population (Lam *et al.* 2020). In view of recent outbreaks in other goose populations, and the possible emergence of new and more virulent strains, the potential threat from HPAI should not be underestimated (see Percival *et al.* 2024).
The use of lead shot for shotgun shooting has been banned in Denmark for more than three decades, and in Norway the use of lead shot has been banned in and close to wetlands since 2023 (as part of the EU REACH directive which is also legally binding for Norway). This is likely to reduce the contamination caused by ingestion of lead shot by geese and other waterbirds in the longer term, even though shotgun pellets may remain in the soil for decades (Kanstrup *et al.* 2020). However, the fact that most goose shooting takes place over farmland, often at a distance from wetlands, means that lead shot can still be used for goose hunting in Norway (and Russia). This may potentially have an ecotoxicological effect on birds being hit (and surviving as crippled), as well as causing a health exposure to people and animals ingesting lead when eating goose meat from shot or crippled birds (Kanstrup 2024).

The recent breeding colonisation of Pink-footed Geese in Novaya Zemlya (Madsen *et al.* 2023) is found in the vicinity of former Soviet nuclear weapon test sites, used from the 1950s to the 1990s. It is known that there is a widespread radioactive contamination of the environment from the fallout and leakage from nuclear weapon testing as well as radioactive dumping in the area (https://www.nuclear-risks.org/en/hibakusha-worldwide/novaya-zemlya.html). It is unknown to what extent this has contaminated geese breeding and moulting in the area, not only Pink-footed Geese but also large concentrations of other goose species undertaking flight feather moult in Novaya Zemlya, for example the majority of the Taiga Bean Geese (Piironen *et al.* 2021).

4.7 Natural predation

As recorded for other Arctic breeding bird species, geese are increasingly exposed to mammalian and avian predators. Polar Bears (*Ursus maritimus*) were first observed exploiting Pink-footed Goose colonies by emptying nests on Svalbard in 2011, which may locally cause a decrease in breeding success (Prop *et al.* 2013), particularly in coastal breeding colonies. Predation of eggs, young, and adult geese by Arctic Fox (*Vulpes lagopus)* and other natural predators currently seem to pose no elevated threat to the population. White-tailed Eagle (*Haliaeetus albicilla*) prey on Pink-footed Goose (mainly observed at staging grounds in Norway) but apparently this does not have an impact at population level. The disturbance and escape flights caused by approaching eagles may cause energetic stress to geese in several Range States, but this has not been systematically studied for Pink-footed Goose.

4.8 Maintenance of range

Pink-footed Geese have traditionally been extremely faithful to a limited number of sites and regions. Nevertheless, the population has undertaken several changes in migratory routes, timing of migration, and the use of staging grounds, probably partly explained by an increasing population size, inter-specific competition, land use changes and climate change. Particularly the increased use of maize in the agricultural sector in western Europe has provided geese with a lush new food supply. The geese visit the fields after harvest, feeding on spilt maize, which is energetically very attractive (Clausen *et al.* 2018a). As a result, a large proportion of the Pink-footed Geese stay in Denmark throughout the winter instead of migrating to the Netherlands, and in both Denmark, the Netherlands, and Belgium, the geese

have expanded their range, flying up to 45 km inland (in Denmark; 15-20 km in Flanders) in search for maize stubble fields.

Recently, the population has rapidly and unexpectedly expanded its breeding range to Novaya Zemlya in north Russia and its non-breeding range to include Finland and Sweden, partly based on emigration from the traditional flyway (Madsen *et al.* 2023). This is likely to continue in the coming decade, with yet unknown effects on the overall population size, biodiversity and human-related interests.

Hence, overall, the range of Pink-footed Geese has expanded on national as well as international scales. The geese have become increasingly explorative in their wintering strategies (Clausen *et al.* 2018b), reflecting the dynamic development of use of new food supplies and exploration of new range (Kuijken & Verscheure 2020, 2023, Madsen *et al.* 2023). However, climate change and policy-driven land-use changes may eventually result in a decreasing range, for example through afforestation and replacement of foraging grounds (see section on Habitat loss above), and it is important to maintain the range above the Favourable Reference Range defined in the Framework for Action (see section 2.3).

4.9 Hunting/Derogation shooting

Pink-footed Goose is only huntable in Norway, Denmark, and Russia. The species is listed on Annex II/B of the EU Birds Directive, which means that only certain Member States across the EU can allow hunting of this species. Within the current range, this only applies to Belgium and Denmark (Norway and Russia are non-EU countries). The hunting periods vary between Range States, but generally takes place from September to January, starting in Norway (including Svalbard) and continuing in Denmark as the birds move south. No information is available on the level of hunting in Russia.

***Table 4**. Hunting status in Range States*
H: species is huntable with declared open season, P: protected species (not huntable)

Range states	Hunting status	Open season	Remarks
Norway	H	10/8-23/12	With local restrictions
Russia	H		No information available
Finland	P		
Sweden	P		
Denmark	H	1/9 – 31/1	
Netherlands	P		
Belgium	P		

Derogations may be issued in accordance with country rules (for EU Member States, under Article 9 of the Birds Directive), for example in relation to problems associated with situations where agricultural damage, risks to human health and/or flight safety are reported to meet pre-agreed criteria. Only very few derogation permits are issued for Pink-footed Goose, and the most recent report to the European Commission included less than 200 Pink-footed Geese shot under derogation (see Table 4).

***Table 5**. Availability of bag statistics, derogation reports and recent bag sizes for the Pink-footed Goose*

Range state	Annual statutory bag statistics	Annual hunting bag size (latest estimate)	Hunting season	Annual derogation size (latest estimate)	Year
Norway	Yes	2,927	2023/24	NA	-
Russia	No	Not available	-	Not available	-

Finland	NA	0	-	0	2022
Sweden	NA	0	-	0	2022
Denmark	Yes	7,065	2023/24	164	2022
The Netherlands	NA	0	-	0	2022
Belgium	NA	0	-	0	2022
Overall		*9,992*		*164*	

4.10 Crippling

Crippling of Pink-footed Goose caused great concern in the mid-1990s, when more than one third of the population was reported to carry imbedded shotgun pellets from hunting (Noer & Madsen 1996), causing an apparent decrease in long-term survival (Madsen & Noer 1996). The crippling rate has been monitored closely since the adoption of the first ISSMP for Pink-footed Goose, and the actions taken to reduce crippling (raising awareness, improving hunters' skills, and changing hunting practises) have served to reduce crippling to the current level where this potential threat can be considered of negligible importance to the population (Madsen *et al.* 2024). With the introduction of a legal obligation to use a retrieving dog for goose hunting in Denmark, the 'severe wounding' leading to non-retrieved, killed geese (not reported in the hunting bag statistics), has probably decreased, but this has not been systematically investigated. Continued monitoring of the crippling rate is recommended, particularly considering the demand for maintaining a relatively high harvest rate to achieve the agreed population size target.

Annex 3. Population Target-setting

1. Introduction

As part of the revision of this ISSMP, the former population target of 60,000 Svalbard Pink-footed Geese in spring was reviewed.

In preparation for the review, Range States and observer organisations were provided background information, including: (1) empirical relationships between goose abundance and management objectives; (2) the proposed Favourable Reference Population Size of 49,000 for the Svalbard Pink-footed Goose population; and (3) the expected ability of managers to meet population targets while assuming various limits to maximum harvest capacity. All supporting information is available at this website: https://egmp.aewa.info/workshop-revision-pink-footed-goose-international-single-species-management-plan.

Although there are a number of approaches for setting population targets (e.g., Johnson et al. 2022), the approach that was ultimately chosen was to directly elicit a preferred population target from relevant stakeholders. The ISSMP compilers believed that this approach might reveal a consensus position quickly because there are only a small number of Range States, and the management of Pink-footed Geese has operated under a population target for over a decade.

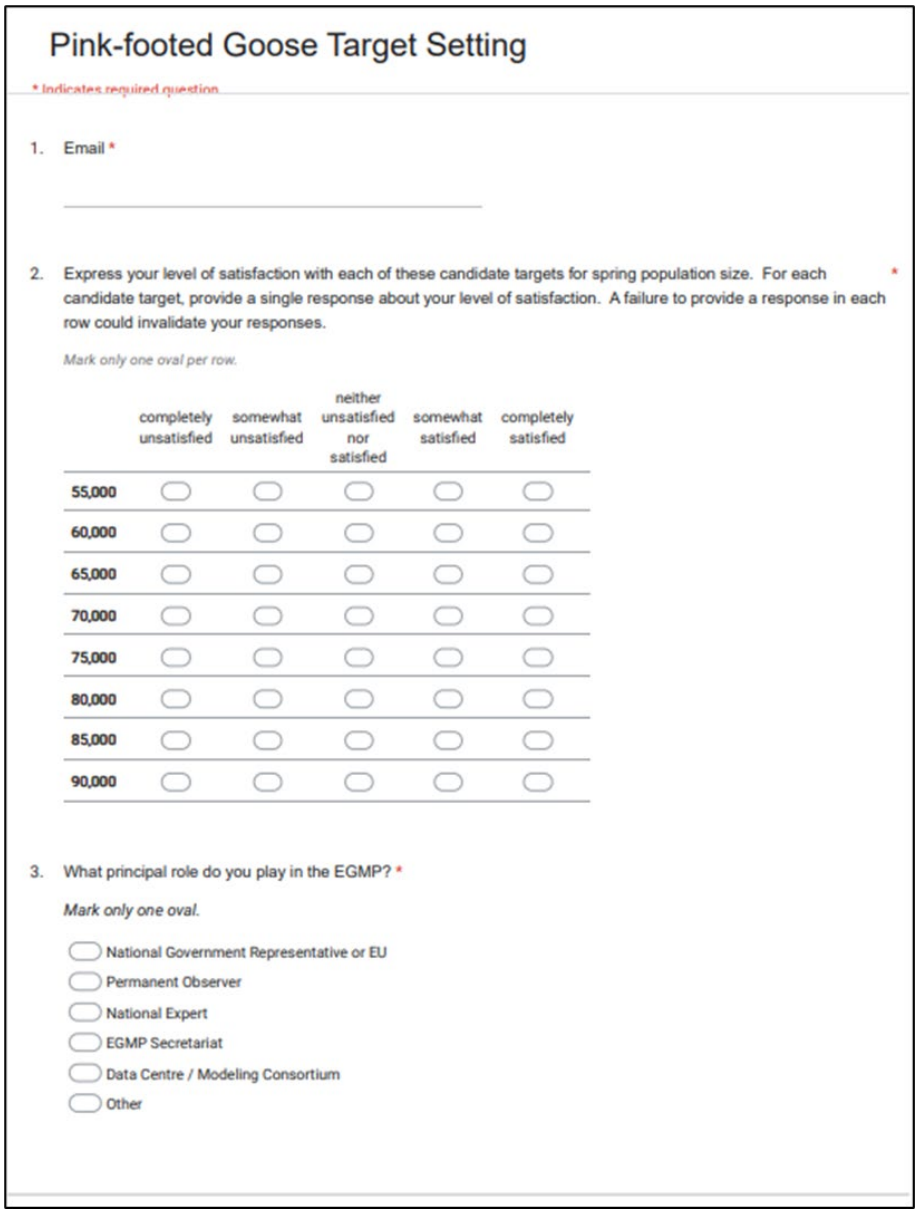
Critically, the direct-elicitation approach also identifies how satisfaction varies as population size diverges from a potential target. This is necessary for deriving an optimal harvest strategy. A caveat to the direct-elicitation approach, however, is that it requires each participant to mentally integrate the consequences of alternative population targets relative to various management objectives. Therefore, the participants implicitly rank the relative importance of various management objectives in a way they feel is appropriate (i.e., no explicit consensus on the "weighting" of management objectives was sought).

2. Methods

A trial elicitation was conducted by ballot (Fig. 6) to participants at the October 2024 workshop for the ISSMP revision (see website provided above). A formal poll was conducted in November 2024 to Range States (through National Government Representatives) and representatives of the Permanent Observer Organizations to the EGMP. The results of that poll are provided below.

Once ballots were tallied, the consensus-convergence model (Regan et al. 2006) was used to determine how collective satisfaction varies when population size varies from the most preferred target. This technique from negotiation analysis is inclusive and fair to all parties, blind to dominant personalities, immune to the influence of powerful special interests, and transparent and reproducible. Basically, the method relies on the correlations in responses among participants. Higher correlations result in more weight on those participants. In other words, participants with similar responses have more influence on the overall average, and extreme views have less influence on the overall average. By agreeing to the application of this method for creating consensus weights, all stakeholders must agree to compromise their values to some extent by explicitly recognizing the different values of others in the group (which, of course, is the basis of any negotiated settlement).

The product of this exercise is a "utility function," which can be used to derive an optimal harvest-management strategy using stochastic dynamic programming (Marescot et al. 2013). Using the consensus-convergence values from the formal balloting, we fit a quadratic curve reflecting how satisfaction with population size reaches a peak at a preferred target and declines as population size either falls below or above the preferred target. Satisfaction is measured on a scale of 0 to 1, reflecting completely unsatisfied and completely satisfied, respectively.



Pink-footed Goose Target Setting

* Indicates required question

1. Email *

2. Express your level of satisfaction with each of these candidate targets for spring population size. For each candidate target, provide a single response about your level of satisfaction. A failure to provide a response in each row could invalidate your responses. *

Mark only one oval per row.

	completely unsatisfied	somewhat unsatisfied	neither unsatisfied nor satisfied	somewhat satisfied	completely satisfied
55,000					
60,000					
65,000					
70,000					
75,000					
80,000					
85,000					
90,000					

3. What principal role do you play in the EGMP? *

Mark only one oval.

- National Government Representative or EU
- Permanent Observer
- National Expert
- EGMP Secretariat
- Data Centre / Modeling Consortium
- Other

Figure 6. *Ballot used for the trial exercise on eliciting the degree of satisfaction with varying targets for the Svalbard Pink-footed Goose population (conducted at the ISSMP revision workshop in October 2024). The subsequent formal poll was conducted in November 2024 and balloted only Range States (through National Government Representatives) and representatives of the Permanent Observer Organizations to the EGMP.*

3. Results and discussion

Completed ballots were received from five Range States and four Permanent Observer Organizations. Perhaps not surprisingly, there was a high degree of variability in responses (Fig. 7). Simple means of response and consensus-convergence values are provided in Fig. 8.

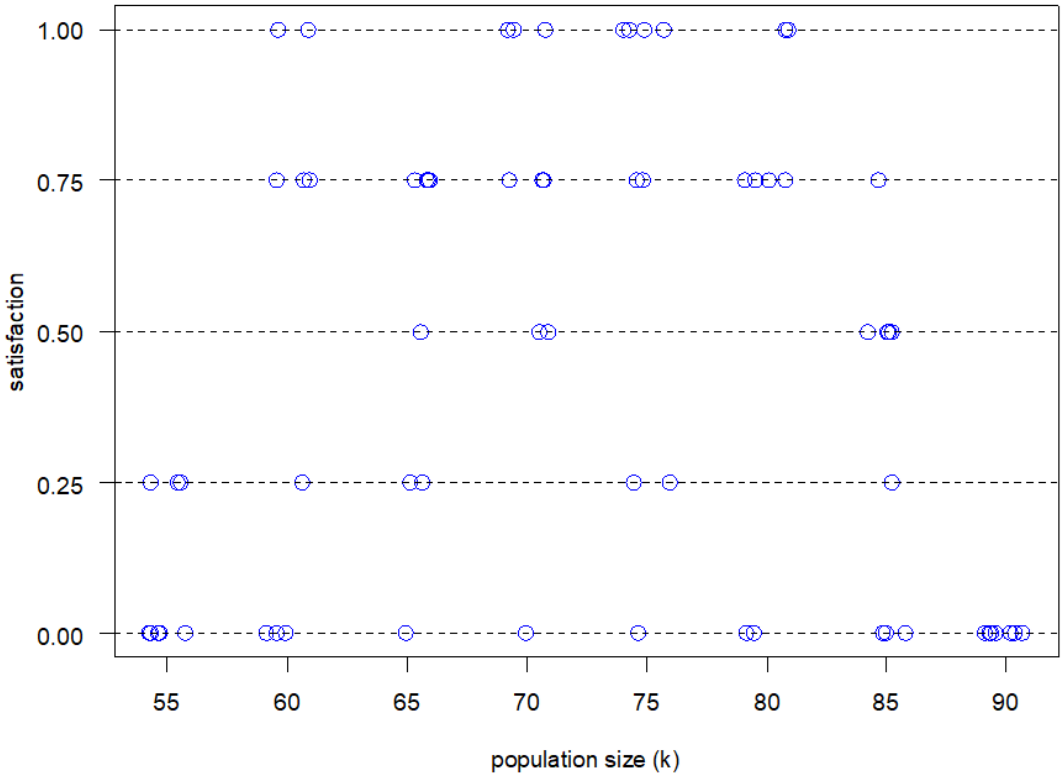


Figure 7. *Raw data from the formal poll to identify a preferred population target for the Svalbard Pink-footed Goose population and how satisfaction varies with departures from the target. In this graph, 0.00, 0.25, 0.50, 0.75, and 1.00 represent completely unsatisfied, somewhat unsatisfied, neither unsatisfied nor satisfied, somewhat satisfied, and completely satisfied, respectively.*

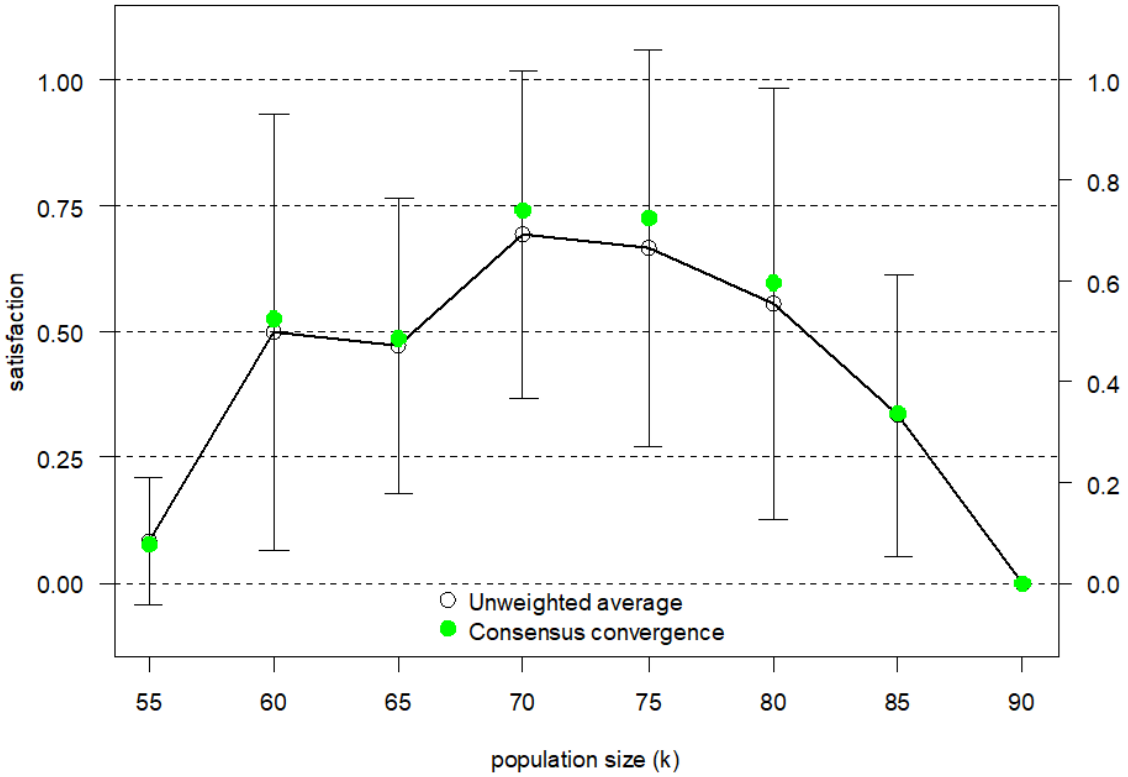


Figure 8. *Unweighted averages (and standard deviations) and consensus-convergence values from the formal poll to identify a preferred population target for Svalbard Pink-footed Geese and how satisfaction varies with departures from the target. In this graph, 0.00, 0.25, 0.50, 0.75, and 1.00 represent completely unsatisfied, somewhat unsatisfied, neither unsatisfied nor satisfied, somewhat satisfied, and completely satisfied, respectively.*

Using normalized consensus-convergence values, the fitted quadratic utility curve is provided in Fig. 9. Based on this utility curve, a target population size of 72,000 was proposed. Again, referring to the utility curve, there is complete dissatisfaction with population sizes below 54,000 and above 90,000. Respondents were somewhat to completely satisfied with population sizes in the range of 59,000 – 84,000. For comparison, the former population target was 60,000, with at least some degree of satisfaction for a range of 50,000 – 70,000 birds in spring. Part of the desire for a higher population target now may be due to the expansion of the range of the Svalbard Pink-footed Goose population that has occurred since the adoption of the original ISSMP (Madsen & Williams 2012, Madsen et al. 2023).

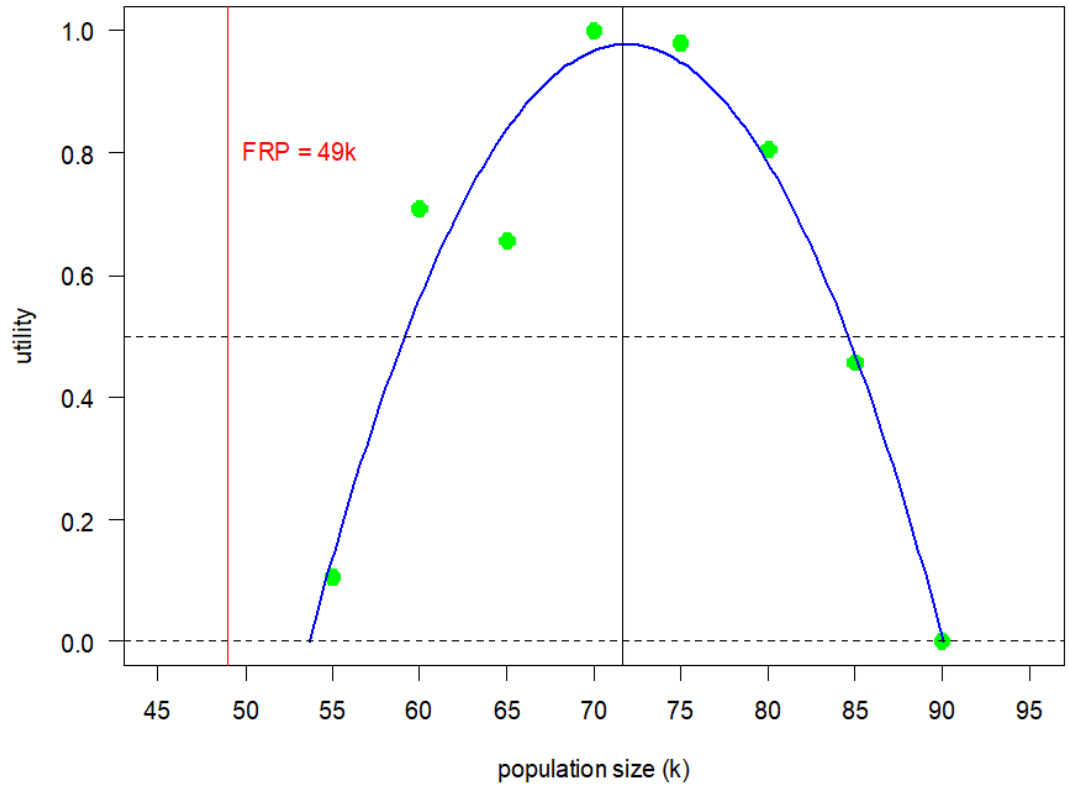


Figure 9. *A quadratic fit to consensus-convergence values to specify the "utility" (i.e., relative satisfaction) with varying population sizes of Svalbard Pink-footed Geese. The proposed Favourable Reference Population size (FRP) is 49,000. The highest utility is for a spring population size of 72,000. The quadratic curve does not peak at exactly 1.0 because the curve represents the best fit to the consensus-convergence values. This is irrelevant for the purpose of deriving optimal harvest strategies.*

Annex 4. Projection of Population Size and Harvest Rates

1. Introduction

To inform discussions regarding harvest capacity and target population size during the revision of the ISSMP for the Svalbard population of Pink-footed Geese, the EGMP Data Centre investigated how the capacity to achieve varying harvest quotas may affect managers' ability to successfully reach a given population target over the next 12 years (the expected lifespan of the revised management plan).

For illustrative purposes, two potential targets were addressed:

(b) the proposed target of 72,000 individuals in spring (using the revised utility function ("new") for optimizing harvests, see Fig. 10 and Annex 3), and
(b) the former target of 60,000 individuals in spring (using the original utility function ("old") for optimizing harvests, see Fig. 10)

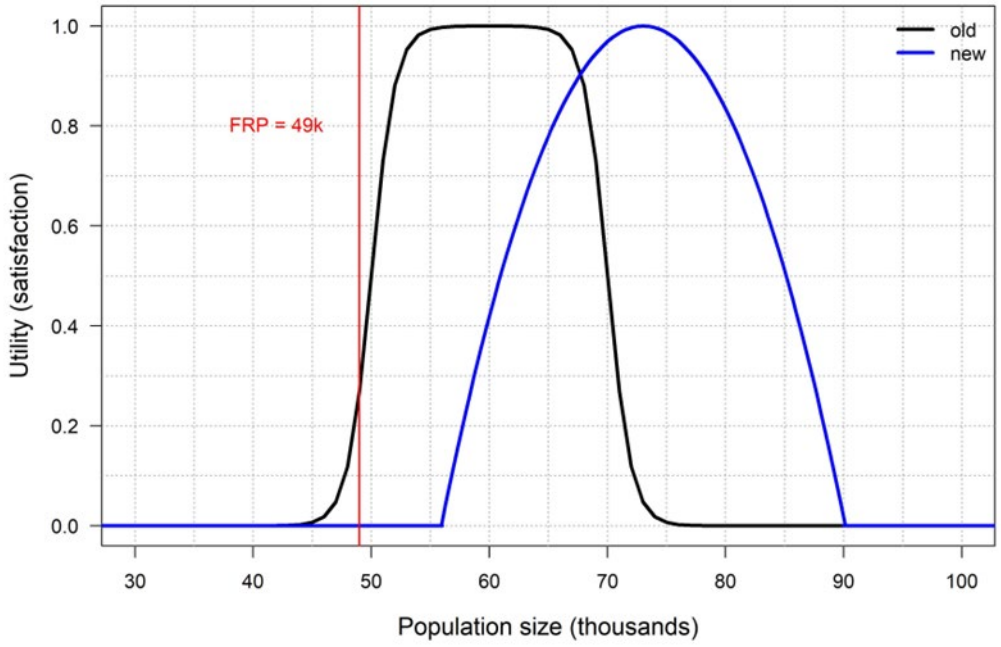


Figure 10. *Utility functions used to derive optimal harvest strategies for Pink-footed Goose, each expressing the relative satisfaction with varying population sizes and both normalized to values from 0 to 1. The "old" function relates to the former spring population target of 60,000 geese, whereas the "new" function relates to the proposed spring population target of 72,000 geese (see Annex 3). The vertical red line represents the proposed Favourable Reference Population (FRP) size which has been set at 49,000 individuals.*

Four scenarios for harvest capacity were examined:

(1) unconstrained harvest capacity, in which managers can achieve any harvest necessary to control population size;
(2) a maximum harvest capacity of 17,000, which is the maximum harvest achieved during the period of record (1992 – 2023);
(3) a maximum harvest capacity of 15,000, which was the mean harvest during 2016 – 2020; and
(4) a maximum harvest capacity of 10,000, which was the mean harvest during the last three years (2021 – 2023).

The harvests in the last three years were significantly below the prescribed quotas and may reflect a redistribution of birds during the winter in Denmark or emigration to a new flyway (Madsen et al. 2023), or both.

2. Methods

The analyses first involved deriving an optimal harvest strategy with an upper limit to potential harvest as described above and then simulating application of that strategy over the next 12 years. The most recent update of the integrated population model (IPM, EGMP_Population_Status_and_Assessment_Report_2024) was used to specify the demography of Pink-footed Geese and effects of harvest on population size. 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 and simulate optimal harvest strategies. The optimization algorithm called stochastic dynamic programming (SDP) was used, which can explicitly account for demographic and environmental uncertainty in population dynamics (Marescot et al. 2013). Optimal harvest strategies prescribe an allowable harvest for each possible population size and number of thaw days that might be observed in the future, up to the harvest limits described above. 1,000 simulations were conducted of the optimal harvest strategy for each possible population target and maximum attainable harvest.

An important consideration in projecting simulated population sizes is whether density dependence acts through survival or reproduction to limit population size. Based on the IPM, there currently is no empirical evidence that survival from natural causes or reproduction decline with increasing population size. This could be because population size has not yet reached a level in which it is limited by the environment, or that the population has escaped these limits by pioneering new breeding areas (i.e., in Novaya Zemlya). Because it is known that population size must ultimately be limited by the environment, the potential population size in the simulations was capped at 150,000, or about twice the current population size. In populations subject to harvests near the maximum sustainable, carrying capacity is approximately twice the observed population size (Runge et al. 2004). Fortunately, the specification of carrying capacity appears to make little difference in the simulations, assuming that carrying capacity is set well above current population size.

3. Modelling results

Scenario (a) – new target of 72,000 individuals

Table 6. Projection of Pink-footed Goose population size (N) and harvest (H) 12 years into the future, beginning with the 2024 system state (N ≈ 78k, thaw days ≈ 10), ***assuming a target population in spring of 72,000 and using the new utility function.*** Mean N and H are the means over the 13-year timeframe (and 1,000 simulations). Last N and H are the ending (year 13) population size and harvest averaged over the 1,000 simulations.

Maximum attainable harvest	Source	Mean N (sd)	Mean H (sd)	Last N (sd)	Last H (sd)
50k	unconstrained	74.2k (4.1)	10.2k (7.5)	74.1k (4.1)	10.3k (7.9)
17k	maximum 1992-2023	69.5k (6.3)	10.1k (6.0)	68.7k (6.8)	9.0k (6.0)
15k	mean 2016-2020	69.9k (8.3)	10.1k (5.2)	69.2k (10.0)	9.5k (5.2)

10k	mean 2021-2023	82.5k (21.4)	9.2k (2.1)	91.0k (31.0)	8.9k (2.5)

Scenario (b) – former target of 60,000 individuals

Table 7. Projection of Pink-footed Goose population size (N) and harvest (H) 12 years into the future, beginning with the 2024 system state (N ≈ 78k, thaw days ≈ 10), ***assuming a target population in spring of 60,000 and using the old utility function.*** Mean N and H are the means over the 13-year timeframe (and 1,000 simulations). Last N and H are the ending (year 13) population size and harvest averaged over the 1,000 simulations.

Maximum attainable harvest	Source	Mean N (sd)	Mean H (sd)	Last N (sd)	Last H (sd)
50k	unconstrained	62.8k (5.5)	9.7k (7.8)	61.7k (3.4)	8.5k (6.4)
17k	maximum 1992-2023	61.2k (8.3)	9.9k (6.0)	57.4k (4.9)	7.7k (5.7)
15k	mean 2016-2020	62.4k (10.2)	10.0k (5.3)	57.6k (7.8)	8.1k (5.1)
10k	mean 2021-2023	80.1k (23.3)	9.5 (1.8)	84.9k (35.0)	8.8k (2.7)

The optimal harvest strategies based on the new and old utility functions are provided in Figs. 11 and 12, respectively. In both cases, the maximum possible harvest has been constrained to 20,000, which is slightly higher than the maximum harvest of about 17,000 observed since a harvest strategy went into effect in 2013. Using the new utility function for a target of 72,000, the spring population size would be expected to have a long-term mean of 70,900 (sd = 8,700) if optimal harvest quotas were realized.

The mean harvest would be expected to be 9,600 (sd = 6,600). For comparison, the old utility function for a target of 60,000 would be expected to produce a mean population size of 57,700 (sd = 6,800) and a mean harvest of 7,800 (sd = 5,800). The harvest strategy based on the new utility function is somewhat more conservative than for the old utility function because of the desire to maintain the population at a higher level.

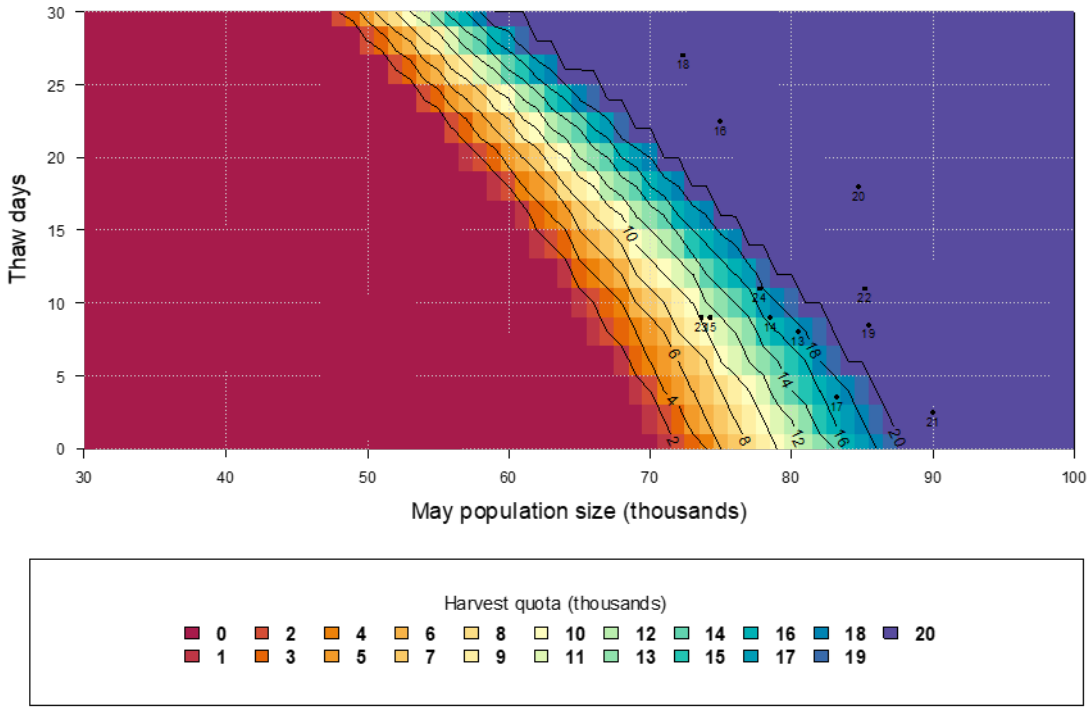


Figure 11. *Optimal harvest quotas for Pink-footed Geese based on an IPM and an* ***objective to maintain population size near 72,000****. Thaw days is the number of days above freezing in May in Svalbard. Also depicted are population sizes and days above freezing for the years in which AHM has been in place, with 13 = year 2013 and 24 = year 2024.*

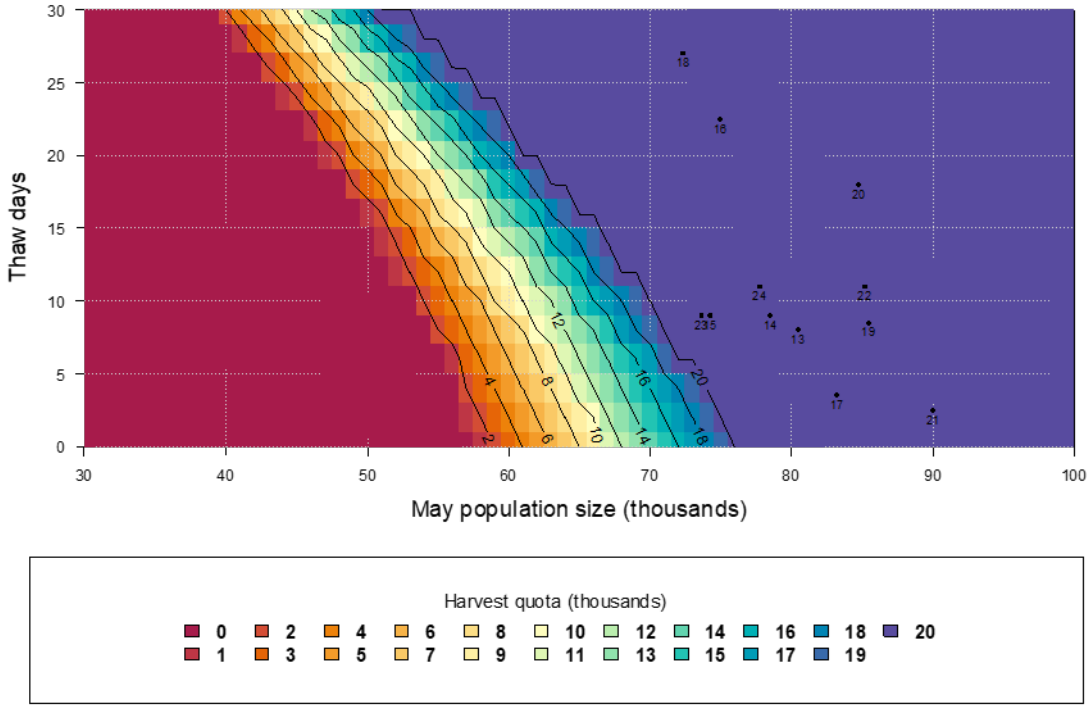


Figure 12. *Optimal harvest quotas for Pink-footed Geese based on an IPM and an* ***objective to maintain population size near 60,000****. Thaw days is the number of days above freezing in May in Svalbard. Also depicted are population sizes and days above freezing for the years in which AHM has been in place, with 13 = year 2013 and 24 = year 2024.*

4. Conclusions from the modelled scenarios:

- Variation in population size increases, and variation in annual harvests decreases, as the capacity to exert harvest pressure declines. Thus, with constrained maximum harvest capacity, the risk of failing to achieve the target increases.

- In the case of unconstrained maximum harvest, optimal harvests are apparently able to successfully achieve a mean population size close to the desired target after 12 years. Note however, that for practical and administrative reasons the resulting (potentially very large) variation in annual harvest quotas may not be desirable.

- If the maximum attainable harvest is constrained to the mean of the last three years (10,000), managers may lose control over population growth, regardless of the population target.

- Finally, a target of 72,000, once achieved, provides more hunting opportunity (larger harvests) than those available with a target of 60,000. However, higher harvests have to be maintained on a more regular basis with higher population targets than with lower targets and achieving a mean population size close to the desired target could be problematic if sufficient harvesting capacity is not maintained.

Annex 5. Legal Status of Pink-Footed Goose and Implications for Population Management

***Table 8**. Summary of the international legal status of the Svalbard population of Pink-footed Goose.*

	CMS	AEWA		Bern Convention	EU Birds Directive	CITES
Pink-footed Goose *Anser brachyrhynchus*	Appendix II	Svalbard (br)	Column B (category 1)	Appendix III	Annex II (Part B)	Not listed

***Table 9**. Applicability of relevant international legal instruments to Range States of the Svalbard population of Pink-footed Goose.*

Range State	CMS	AEWA	Bern Convention	EU Birds Directive	CBD
Belgium	X	X	X	X	X
Denmark	X	X	X	X	X
Finland	X	X	X	X	X
The Netherlands	X	X	X	X	X
Norway	X	X	X	-	X
Russia	-	-	-	-	X
Sweden	X	X	X	X	X

1. Convention on the Conservation of Migratory Species of Wild Animals (CMS)

The Pink-footed Goose is listed in Appendix II of the CMS. This appendix includes species which have an unfavourable conservation status and require international agreements for their conservation and management, as well as species which have a conservation status which would significantly benefit from the international cooperation that could be achieved by an international agreement.[12] The CMS envisages the conclusion of Agreements covering the conservation and management of Appendix II species[13], and provides that the object of each Agreement shall be to restore the species concerned to, or maintain it in, a Favourable Conservation Status[14].

Per Article I.1(c) of the CMS, conservation status will be taken as 'favourable' when:

1. population dynamics data indicate that the migratory species is maintaining itself on a long-term basis as a viable component of its ecosystems;
2. the range of the migratory species is neither currently being reduced, nor is likely to be reduced, on a long-term basis;
3. there is, and will be in the foreseeable future sufficient habitat to maintain the population of the migratory species on a long-term basis; and
4. the distribution and abundance of the migratory species approach historic coverage and levels to the extent that potentially suitable ecosystems exist and to the extent consistent with wise wildlife management.

[12] CMS Article IV.1.
[13] CMS Articles III.3(c) & IV.3.
[14] CMS Article V.1.

2. Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA)

AEWA is one of the ancillary Agreements developed under Article IV of the CMS and applies in respect of 255 species of migratory waterbirds, including the Pink-footed Goose. Except for Russia, all Range States of the Svalbard population of Pink-footed Goose are Parties to AEWA.

Parties to AEWA shall take coordinated measures to maintain migratory waterbird species in a Favourable Conservation Status or restore them to such a status. To this end, they shall apply – within the limits of their national jurisdiction – the measures prescribed in AEWA's Agreement text, together with the specific actions determined in the Action Plan found in Annex 3 to AEWA[15]. These include a wide variety of conservation measures, ranging from habitat conservation (including the conservation of site networks) to the management of hunting and other human activities, to research, monitoring, education and awareness-raising.

AEWA's legal text explicitly recognises the importance of addressing conflicts between the populations of species covered by the Agreement (as listed in Table 1 of Annex 3 to AEWA) and various human interests. To this end, Parties shall endeavour to gather information on the damage (particularly to crops and fisheries) caused by waterbird populations listed in AEWA's Table 1 and cooperate with a view to both identifying appropriate techniques to minimize such damage and developing single species management plans[16]. The 2012 ISSMP for the Svalbard population of the Pink-footed Goose was the first ISSMP to be developed under AEWA and adopted by the AEWA MOP. In the period since this ISSMP's adoption, additional management planning processes have occurred under the Agreement and, drawing from these experiences, the *Format and Guidelines for AEWA International Single and Multi-species Management Plans* were developed.

The Format and Guidelines were adopted by MOP8 in 2022 and envision, *inter alia*, the definition of FRVs for each population covered by an ISSMP, as well as for the management units thereof (if applicable). This is a crucial step, as it provides the reference for assessing whether a population is in a Favourable Conservation Status, in accordance with AEWA's legal requirements. AEWA applies the same definition of 'Favourable Conservation Status' as that found in the CMS[17]. The Format and Guidelines for ISSMPs consequently explain that FRVs will be established in accordance with this definition (which has four criteria: population dynamic, range, habitat and historic levels) and that the population will be considered to be in unfavourable status if it does not meet any of the criteria or its future prospects are negative. FRVs (including Favourable Reference Population, Range and Habitat) are to be included either in the ISSMP itself or, if this is not possible, in the ancillary Adaptive Flyway Management Programme(s).

The Svalbard population of Pink-footed Goose is listed in Column B, category 1 of AEWA's Table 1[18]. The deliberate killing of birds belonging to this population is therefore permissible (including for management purposes) but must be regulated in a manner that ensures the maintenance of the population's Favourable Conservation Status and that any taking is sustainable (based on the best available knowledge of population dynamics)[19]. The taking of birds from this population during their

[15] AEWA Article II.1.
[16] AEWA Annex 3 paragraphs 4.3.2 – 4.3.4.
[17] AEWA Article I.2.
[18] This category includes populations of AEWA species which number between around 25,000 and 100,000 individuals and do not fulfil the conditions in respect of Column A of Table 1.
[19] AEWA Article II.1 & Annex 3 paragraph 2.1.2.

stages of reproduction and rearing, or during their return to their breeding grounds, is only permissible if this does not have an unfavourable impact on the population's conservation status.[20]

Various modes of taking that are indiscriminate, or capable of causing mass destructions or local disappearance of or serious disturbance to, AEWA populations must be prohibited unless AEWA's provisions on exemptions are satisfied.[21] The available grounds of exemption include, *inter alia*, the prevention of serious damage to crops, interests of air safety, public health and public safety, and other imperative reasons of overriding public interest (including those of a social or economic nature and beneficial consequences of primary importance to the environment). Managing conflict by culling through means that are otherwise prohibited is therefore possible, provided it can be demonstrated that one of these grounds applies, that the threat/risk in question can be addressed by granting the exemption, that there are objective and verifiable grounds for concluding that there is no other satisfactory alternative, and that the exemption will not operate to the detriment of the population, is precise as to content, and is limited in space and time.[22] The grounds of exemption that are recognised by AEWA, and the conditions for their use, are discussed in detail in the *Guidance on Satisfying the Conditions of Paragraph 2.1.3 of the AEWA Action Plan*, which was adopted by AEWA MOP7.

Caution must be taken to ensure that management measures in respect of Pink-footed Geese do not breach Parties' commitments in respect of populations with a higher AEWA Table 1 categorization (e.g. by causing the significant disturbance, or accidental taking, of birds belonging to a Column A population). Any impacts on non-target species must similarly be considered under the other legal instruments discussed in this annex.

3. Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)

The Bern Convention aims to conserve wild flora and fauna and their natural habitats – especially those whose conservation requires the cooperation of several States.[23] Except for Russia, all Range States of the Svalbard population of Pink-footed Goose are Parties to this Convention.

Per Article 2 of the Bern Convention, Parties "shall take requisite measures to maintain the population of wild flora and fauna at, or adapt it to, a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements and the needs of sub-species, varieties or forms at risk locally". The Pink-footed Goose is included in Appendix III of the Convention, with the result that Parties shall take "appropriate and necessary legislative and administrative measures" to ensure its protection.[13] Parties undertake to coordinate their efforts for the protection of the migratory species specified in Appendix III whose range extends into their territories, and to give special attention to the protection of areas that are of importance to these species and are appropriately situated in relation to migration routes, as wintering, staging, feeding, breeding or moulting areas.[24]

[20] AEWA Annex 3 paragraph 2.1.2(a).
[21] AEWA Annex 3 paragraphs 2.1.2(a) & 2.1.3.
[22] AEWA Annex 3 paragraph 2.1.3.
[23] Bern Convention Article 1.1.
[24] Bern Convention Articles 10.1 and 4.3.

The exploitation of Appendix III species is permissible under the Bern Convention, provided that this is regulated in order to keep populations out of danger.[25] Such regulation must ensure that populations are not reduced below the level required by Article 2 of the Convention.

Animals belonging to Appendix III species may not be killed or captured through the means prohibited by Article 8 of the Bern Convention unless the conditions for exception set out in Article 9 are satisfied. Managing conflict by culling through means that are otherwise prohibited will therefore only be permissible if it is demonstrated that the birds being targeted present a threat to public health and safety, air safety or other overriding public interests, or the protection of flora and fauna, or a risk of serious damage to crops or other property; and that this threat/risk can be addressed by granting the exception, there are objective and verifiable grounds for concluding that there is no other satisfactory alternative, and the exception is not detrimental to the population's survival. Revised Resolution No.2 (1993) of the Bern Convention's Standing Committee provides further guidance on the exceptions allowed by Article 9.

4. EU Directive on the Conservation of Wild Birds (Birds Directive)

The Birds Directive relates to the conservation of all species of naturally occurring birds in the wild state in the European territory of Member States to which the Treaty establishing the European Community applies.[26] Per Article 2 of the Directive, EU Member States shall take the requisite measures to maintain the population of these species "at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements, or to adapt the population of these species to that level".

Article 5 of the Birds Directive requires EU Member States to prohibit, *inter alia*, the deliberate killing or capture of the species of birds covered by the Directive. However, certain deviations from this requirement are accommodated by Articles 7 and 9.

The Pink-footed Goose is listed in Annex II, Part B to the Birds Directive. It may therefore be hunted under national legislation in accordance with the provisions of Article 7 of the Directive. This provision only permits hunting within the Member States in respect of which the Pink-footed Goose is indicated in Annex II, Part B[27] (i.e., Belgium, Denmark and Ireland[28]). Per Article 7, these Member States must ensure that hunting does not jeopardize conservation efforts in this species' distribution area, that hunting complies with the principles of wise use and ecologically balanced control of the species, and that it does not occur during the period of reproduction or during birds' return to their rearing grounds. The European Commission has explained that 'ecologically balanced control' "implies that the measures taken should be ecologically sound and in proportion to the problem to be solved taking into account the conservation status of the species concerned".[29] This need for proportionality must be considered when formulating any new population target under the Pink-footed Goose ISSMP, as must the need to ensure that the objective of the Birds Directive (as identified in Article 2) is not jeopardised.

Per Article 8 of the Directive, Member States are required to prohibit the use of non-selective and large-scale methods of capture/killing.

[25] Bern Convention Article 7.2.
[26] Birds Directive Article 1.1.
[27] Birds Directive Article 7.3.
[28] While the United Kingdom is also indicated, this has only historic relevance given the United Kingdom's withdrawal from the European Union.
[29] European Commission (2008) at § 2.4.33.

Article 9 of the Birds Directive allows derogations from the requirements of Articles 5-8 for reasons including the interests of public health and safety, the interests of air safety, the prevention of serious damage to crops, and the protection of flora and fauna. In principle, it may therefore be permissible to apply lethal management measures outside the normal hunting period and/or in Range States that are not indicated in Annex II, Part B, or that use means of killing/capture that are otherwise prohibited, provided that it can be demonstrated that one of these grounds applies, that the conflict in question can be addressed by granting the exemption, and that there are objective and verifiable grounds for concluding that there is no other satisfactory solution for addressing the conflict. Further guidance on these conditions, and the Birds Directive's other provisions on hunting, is available in *Guide to Sustainable Hunting under the Birds Directive* (European Commission 2008).

The Birds Directive requires that special conservation measures be taken concerning the habitat of both Annex I species and regularly occurring migratory species not listed in Annex I (as regards their breeding, moulting and wintering areas and staging posts along their migration routes).[30] Regardless of whether management measures occur in the context of Article 7 or Article 9 of the Birds Directive, such measures must not result in the deterioration of Special Protection Areas (SPAs) or the disturbance of species for which these have been designated in so far as this would be significant having regard to the objectives of the Directive.[31] Hunting activities within SPAs do not necessarily contravene this provision, but must be compatible with a site's conservation objectives and be managed and monitored in a manner that avoids significant disturbance.[32]

5. Convention on Biological Diversity (CBD)

All Range States of the Svalbard population of Pink-footed Goose are Parties to the CBD, the objectives of which include both the conservation of biodiversity and the sustainable use of its components.[33] In December 2022, the CBD's Conference of the Parties (COP) adopted the Kunming-Montreal Global Biodiversity Framework (GBF), which identifies 23 action-oriented global targets for completion by 2030. The following GBF targets are especially noteworthy in the context of managing the Svalbard population of the Pink-footed Goose:

- One of the elements of Target 4 is that action needs to be taken to "effectively manage human-wildlife interactions to minimize human-wildlife conflict".
- Target 5 emphasises, *inter alia*, the need for measures to ensure that the use and harvesting of wild species is sustainable, preventing overexploitation and minimising impacts on non-target species and ecosystems.
- Target 9 focuses on ensuring that the management and use of wild species is sustainable for the benefit of people, and refers explicitly to the provision of social, economic, and environmental benefits.

The revised ISSMP for this species will support the delivery of these GBF targets, and also has the potential to contribute to others (such as those regarding habitat conservation and restoration).

Annex 6. References

[30] Birds Directive Article 4.
[31] Birds Directive Article 4.
[32] European Commission (2008) at §1.5.1.
[33] CBD Article 1.

Ayers, C.R., Depreno, C.S., Moorman, C.E., & Yelverton, F.H. (2010). Canada goose weed dispersal and nutrient loading in turfgrass systems. *Applied Turfgrass Science.* https://doi.org/10.1371/journal.pone.0071912

Bradbeer, D.R., Rosenquist, C., Christensen, T.K., et al. (2017). Crowded skies: conflicts between expanding goose populations and aviation safety. *Ambio.* https://doi.org/10.1007/s13280-017-0901-2

Buij, R., Melman, T.C.P., Loonen, M.J.J.E., & Fox, A.D. (2017). Balancing ecosystem function, services and disservices resulting from expanding goose populations. *Ambio, 46*, 301–318. https://doi.org/10.1007/s13280-017-0902-1

Clausen, K., & Madsen, J. (2016). Philopatry in a changing world: Response of Pink-footed Geese *Anser brachyrhynchus* to the loss of a key autumn staging area due to restoration of Filsø Lake, Denmark. *Journal of Ornithology, 157*(1), 229–237. https://doi.org/10.1007/s10336-015-1271-9

Clausen, K.K., Madsen, J., Cottaar, F., Kuijken, E., & Verscheure, C. (2018b). Highly dynamic wintering strategies in migratory geese: Coping with environmental change. *Global Change Biology, 24*(7), 3214–3225. https://doi.org/10.1111/gcb.14061

Clausen, K.K., Madsen, J., Nolet, B.A., & Haugaard, L. (2018a). Maize stubble as foraging habitat for wintering geese and swans in northern Europe. *Agriculture, Ecosystems & Environment, 259*, 72–76. https://doi.org/10.1016/j.agee.2018.03.002

Denys, L., Packet, J., Jambon, W., & Scheers, K. (2014). Dispersal of the non-native invasive species *Crassula helmsii* (Crassulaceae) may involve seeds and endozoochorous transport by birds. *New Journal of Botany, 4*(2), 104–106. https://doi.org/10.1179/2042349714Y.0000000046

Ebbinge, B.S., van der Meulen, H., & Smit, J.J. (1984). Changes in winter distribution and population size of the pink-footed goose in Svalbard. *Norsk Polarinstitutt Skrifter, 181*, 1–17.

Elmberg, J., Berg, C., Lerner, H., Waldenström, J., & Hessel, R. (2017). Potential disease transmission from wild geese and swans to livestock, poultry and humans: A review of the scientific literature from a One Health perspective.

Figuerola, J., Green, A.J., Black, K., & Okamura, B. (2004). Influence of gut morphology on passive transport of freshwater bryozoans by waterfowl in Doñana (southwestern Spain). *Canadian Journal of Zoology, 82*, 835–840. https://doi.org/10.1139/z04-055

Fox, A.D., Eide, N.E., Bergersen, E., & Madsen, J. (2009). Resource partitioning in sympatric Arctic-breeding geese: Summer habitat use, spatial and dietary overlap of barnacle and pink-footed geese in Svalbard. *Ibis, 151*, 122–133.

Fox, A.D., Francis, I.S., & Bergersen, E. (2006). Diet and habitat use of Svalbard pink-footed geese *Anser brachyrhynchus* during arrival and pre-breeding periods in Adventdalen. *Ardea, 94*, 691–699.

Fox, A.D., Madsen, J., Boyd, H., Kuijken, E., Norriss, D.W., Tombre, I.M., & Stroud, D.A. (2005). Effects of agricultural change on abundance, fitness components and distribution of two Arctic-nesting goose populations. *Global Change Biology, 11*(6), 881–893.

Ganter, B., & Madsen, J. (2001). An examination of methods to estimate population size in wintering geese. *Bird Study, 48*, 90–101. https://doi.org/10.1080/00063650109461206

Glahder, C.M., Fox, A.D., O'Connell, M., Jespersen, M., & Madsen, J. (2007). Eastward moult migration of non-breeding pink-footed geese (*Anser brachyrhynchus*) in Svalbard. *Polar Research, 26*, 31–36. http://www.blackwell-synergy.com/doi/abs/10.1111/j.1751-8369.2007.00006.x

Honka, J., Baini, S., Searle, J.B., Kvist, L., & Aspi, J. (2022). Genetic assessment reveals inbreeding, possible hybridization, and low levels of genetic structure in a declining goose population. *Ecology and Evolution, 12*(1), e8547. https://doi.org/10.1002/ece3.8547

Hoye, B., Munster, V., Nishiura, H., Fouchier, R., Madsen, J., & Klaassen, M. (2011). Reconstructing an annual cycle of interaction: Natural infection and antibody dynamics to avian influenza along a migratory flyway. *Oikos, 120*, 748–755.

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

Jensen, G.H., Pellissier, L., Tombre, I.M., & Madsen, J. (2017). Landscape selection by migratory geese: Implications for hunting organisation. *Wildlife Biology.* https://doi.org/10.2981/wlb.00192

Johnson, F.A., Heldbjerg, H., Nagy, S., & Madsen, J. (2022). Setting population-size targets for geese causing socio-economic conflicts. *Ambio, 51*, 209–225.

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

Johnson, F.A., Zimmerman, G.S., Jensen, G.H., Clausen, K.K., Frederiksen, M., & Madsen, J. (2020). Using integrated population models for insights into monitoring programs: An application using pink-footed geese. *Ecological Modelling, 415*, 108869. https://doi.org/10.1016/j.ecolmodel.2019.108869

Kallbekken, H.P., & Mjelde, H.K. (2020). Multi-resistant *E. coli* in long-distance migratory geese: How Greylag Geese (*Anser anser*) and Pink-Footed Geese (*Anser brachyrhynchus*) can act as vectors for antimicrobial resistance. *Norges miljø- og biovitenskapelige universitet.* https://nmbu.brage.unit.no/nmbu-xmlui/bitstream/handle/11250/2656553/KallbekkenOgMjelde2020.pdf?sequence=1&isAllowed=y

Kaltenborn, B., Lebel, J., & Slaymark, V. (2024). Shaping sustainable tourism: Local insights for Svalbard's future. *Polar Geography.* https://doi.org/10.1080/1088937X.2024.2402759

Kanstrup, N. (2024). The transition to non-lead ammunition: An essential and feasible prerequisite for sustainable hunting in modern society. *Aarhus University, Department of Ecoscience.* 164 pp.

Kanstrup, N., Fox, A.D., & Balsby, T.J.S. (2020). Toxic lead gunshot persists accessible to waterbirds after a 33-year ban on their use. *Science of The Total Environment, 714.* https://doi.org/10.1016/j.scitotenv.2020.136876

Kenward, R., & Sharp, R. (2008). Use nationally of wildlife resources across Europe. In Manos, P. & Papathanasiou, J. (Eds.), *GEM-CON-BIO: Governance & Ecosystems Management for the Conservation of Biodiversity* (pp. 117–132). Thessaloniki.

Kéry, M., Madsen, J., & Lebreton, J.-D. (2006). Survival of Svalbard pink-footed geese *Anser brachyrhynchus* in relation to winter climate, density and land use. *Journal of Animal Ecology, 75*, 1172–1181. http://www.blackwell-synergy.com/doi/abs/10.1111/j.1365-2656.2006.01140.x

Klaassen, M., Bauer, S., Madsen, J., & Tombre, I. (2006). Modelling behavioural and fitness consequences of disturbance for geese along their spring flyway. *Journal of Applied Ecology, 43*, 92–100. https://doi.org/10.1111/j.1365-2664.2005.01109.x

Klaassen, M., Hahn, S., Korthals, H., & Madsen, J. (2017). Eggs brought in from afar: Svalbard-breeding pink-footed geese can fly their eggs across the Barents Sea. *Journal of Avian Biology, 48*, 173–179. https://doi.org/10.1111/jav.01364

Kuijper, D.P.J., Bakker, J.P., Cooper, E.J., et al. (2006). Intensive grazing by Barnacle Geese depletes High Arctic seed bank. *Canadian Journal of Botany, 84*, 995–1004. https://doi.org/10.1139/B06-052

Kuijken E. & C. Verscheure (2020). Could changes in feeding behaviour affect longstanding site fidelity of Pink-footed Geese *(Anser brachyrhynchus)* wintering in Flanders (Belgium). Goose Bulletin 25: 19-28

Kuijken, E., & Verscheure, C. (2023). Long-term trends in occurrence and behaviour of wintering Arctic geese in the coastal region of Flanders. *Natuur.oriolus, 2023*(4), 141–154.

Lam, S.S., Tjornlov, R.S., Therkildsen, O.R., Christensen, T.K., Madsen, J., Daugaard-Petersen, T., Ortiz, J.M.C., Peng, W.X., Charbonneaux, M., Rivas, E.I., Garbus, S.E., Lyngs, P., Siebert, U., Dietz, R., Maier-Sam, K., Lierz, M., Tombre, I.M., Andersen-Ranberg, E.U., & Sonne, C. (2020). Seroprevalence of avian influenza in Baltic common eiders (*Somateria molissima*) and pink-footed geese (*Anser brachyrhynchus*). *Environment International, 142*, 105873. https://doi.org/10.1016/j.envint.2020.105873

Larsen, J.K., & Madsen, J. (2000). Effects of wind turbines and other physical elements on field utilization by pink-footed geese (*Anser brachyrhynchus*): A landscape perspective. *Landscape Ecology, 15*(8), 755–764. https://doi.org/10.1023/A:1008127702944

Lovas-Kiss, A., Martín-Vélez, V., Brides, K., Wilkinson, D.M., Griffin, L.R., & Green, A.J. (2023). Migratory geese allow plants to disperse to cooler latitudes across the ocean. *Journal of Biogeography, 50*(9), 1602–1614. https://doi.org/10.1111/jbi.14674

Madsen, J. (1982). Observations of the Svalbard population of *Anser brachyrhynchus* in Denmark: A: Numbers, distribution and breeding success 1980/81, and B: Population trends 1932–1981. *Aquila, 89*, 131–140.

Madsen, J. (1995). Impacts of disturbance on migratory waterfowl. *Ibis, 137*(1), 67–74.

Madsen, J., & Boertmann, D. (2008). Animal behavioral adaptation to changing landscapes: Spring-staging geese habituate to wind farms. *Landscape Ecology, 23*, 1007–1011. https://doi.org/10.1007/s10980-008-9269-9

Madsen, J., & Noer, H. (1996). Decreased survival of pink-footed geese *Anser brachyrhynchus* carrying shotgun pellets. *Wildlife Biology, 2*(2), 75–82.

Madsen, J., & Williams, J.H. (2012). International Species Management Plan for the Svalbard Population of the Pink-footed Goose *Anser brachyrhynchus*. *AEWA Technical Series No. 48*. Bonn, Germany.

Madsen, J., Pedersen, C.L., Tombre, I., Nienhuis, J., Koffijberg, K., & Schreven, K.H.T. (2025). Defining Favourable Reference Values for the Svalbard Population of Pink-footed Goose (*Anser brachyrhynchus*). *EGMP Technical Report No. XX (draft)*. Bonn, Germany.

Madsen, J., Schreven, K.H.T., Jensen, G.H., Johnson, F.A., Nilsson, L., Nolet, B.A., & Pessa, J. (2023). Rapid formation of new migration route and breeding area by Arctic geese. *Current Biology, 33*(6), 1162–1170.e4.

Madsen, J., Tamstorf, M.P., Klaassen, M., Eide, N., Glahder, C.M., Riget, F.F., Nyegaard, H., & Cottaar, F. (2007). Effects of snow cover on the timing and success of reproduction in high-Arctic pink-footed geese *Anser brachyrhynchus*. *Polar Biology, 30*, 1363–1372. http://www.springerlink.com/content/p5455560q38702x7/?p=b44622de75324f1ba5a4cfb062004cb6&pi=2

Madsen, J., Tombre, I.M., & Eide, N.E. (2009). Effects of disturbance on geese in Svalbard: Implications for regulating increasing tourism. *Polar Research, 28*, 376–389. https://doi.org/10.1111/j.1751-8369.2009.00120.x

Madsen, J., Tombre, I.M., Gundersen, O.M., Verhaeghe, F., Kuijken, E., Verscheure, C., Mensink, G., Koffijberg, K., & Lewis, M. (2024). Evaluation of the AEWA International Single Species Management Plan for the Svalbard Population of the Pink-footed Goose (*Anser brachyrhynchus*). Results achieved and implementation performance. *EGMP Technical Report No. XX (draft)*. Bonn, Germany.

Madslien, K., Moldal, T., Gjerset, B., Gudmundsson, S., Follestad, A., Whittard, E., Tronerud, O.H., Dean, K.R., Åkerstedt, J., Jorgensen, H.J., das Neves, C.G., & Romo, G. (2021). First detection of highly pathogenic avian influenza virus in Norway. *BMC Veterinary Research, 17*(1). https://doi.org/10.1186/s12917-021-02928-4

Marescot, L., Chapron, G., Chadès, I., Fackler, P.L., Duchamp, C., Marboutin, E., & Gimenez, O. (2013). Complex decisions made simple: A primer on stochastic dynamic programming. *Methods in Ecology and Evolution, 4*, 872–884.

Melville, D.S., & Shortridge, K.F. (2006). Migratory waterbirds and avian influenza in the East Asian-Australasian Flyway with particular reference to the 2003–2004 H5N1 outbreak. In Boere, G., Galbraith, C., & Stroud, D. (Eds.), *Waterbirds around the world* (pp. 432–438). The Stationery Office, Edinburgh, U.K.

Nadjafzadeh, M., Hofer, H., & Krone, O. (2013). The link between feeding ecology and lead poisoning in white-tailed eagles. *The Journal of Wildlife Management.* https://doi.org/10.1002/jwmg.440

Noer, H., & Madsen, J. (1996). Shotgun pellet loads and infliction rates in pink-footed goose *Anser brachyrhynchus*. *Wildlife Biology, 2*(2), 65–73.

Pedersen, Å.O., Speed, J.D.M., & Tombre, I.M. (2013). Prevalence of pink-footed goose grubbing in the Arctic tundra increases with population expansion. *Polar Biology, 36*(11), 1569–1575. https://doi.org/10.1007/s00300-013-1374-9

Piironen, A., Paasivaara, A., & Laaksonen, T. (2021). Birds of three worlds: Moult migration to high Arctic expands a boreal-temperate flyway to a third biome. *Movement Ecology, 9*, 47. https://doi.org/10.1186/s40462-021-00284-4

Plonczkier, P., & Simms, I.C. (2012). Radar monitoring of migrating pink-footed geese: Behavioural responses to offshore wind farm development. *Journal of Applied Ecology, 49*(5), 1187–1194. https://doi.org/10.1111/j.1365-2664.2012.02181.x

Prop, J., Oudman, T., van Spanje, T.M., & Wolters, E.H. (2013). Patterns of predation of pink-footed goose nests by polar bear. *Ornis Norvegica, 36*, 38–46. https://doi.org/10.15845/on.v36i0.439

Regan, H.M., Colyvan, M., & Markovchick-Nicholls, L. (2006). A formal model for consensus and negotiation in environmental management. *Journal of Environmental Management, 80*, 167–176.

Rozenfeld, S.B., & Sheremetiev, I.S. (2014). Barnacle Goose *Branta leucopsis* feeding ecology and trophic relationships on Kolguev Island: The usage patterns of nutritional resources in tundra and seashore habitats. *Biological Bulletin, 41*, 645–656. https://doi.org/10.1134/S106235901408007X

Runge, M.C., Kendall, W.L., & Nichols, J.D. (2004). Exploitation. In Sutherland, W.J., Netwon, I., & Green, R.E. (Eds.), *Bird Ecology and Conservation: A Handbook of Techniques* (pp. 303–328). Oxford University Press, Oxford, U.K.

Schreven, K.H.T., Stolz, C., Madsen, J., & Nolet, B.A. (2021). Nesting attempts and success of Arctic-breeding geese can be derived with high precision from accelerometry and GPS-tracking. *Animal Biotelemetry, 9*, Article 25. https://doi.org/10.1186/s40317-021-00249-9

Speed, J.D.M., Cooper, E.J., Jonsdottir, I.S., Van der Wal, R., & Woodin, S.J. (2010). Plant community properties predict vegetation resilience to herbivore disturbance in the Arctic. *Journal of Ecology, 98*, 1002–1013.

Stroud, D.A., Madsen, J., & Fox, A.D. (2017). Key actions towards the sustainable management of European geese. *Ambio, 46*, 328–338.

Takács, A., Molnár, A.V., Horváth, O., et al. (2017). The rare aquatic angiosperm *Elatine gussonei* (Elatinaceae) is more widely distributed than previously thought. *Aquatic Botany, 141*, 47–50.

Tombre, I.M., Eythórsson, E., & Madsen, J. (2013). Towards a solution to the goose-agriculture conflict in North Norway, 1988–2012: The interplay between policy, stakeholder influences and goose population dynamics. *PLOS ONE, 8*(8), e71912. https://doi.org/10.1371/journal.pone.0071912

Van der Wal, R., Sjögersten, S., Woodin, S.J., Cooper, E.J., Jonsdottir, I.S., Kuijper, D., Fox, A.D., & Huiskes, A.D. (2007). Spring feeding by pink-footed geese reduces carbon stocks and sink strength in tundra ecosystems. *Global Change Biology, 13*, 539–545.

Yin, S.L., Kleijn, D., Müskens, G.J.D.M., Fouchier, R.A.M., Verhagen, J.H., Glazov, P.M., Si, Y.L., Prins, H.H.T., & de Boer, W.F. (2017). No evidence that migratory geese disperse avian influenza viruses from breeding to wintering ground. *PLOS ONE, 12*(5), e0177790. https://doi.org/10.1371/journal.pone.0177790