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AEWA EUROPEAN GOOSE MANAGEMENT PLATFORM

WORKSHOP FOR THE REVISION OF THE INTERNATIONAL SINGLE SPECIES MANAGEMENT PLAN FOR THE SVALBARD POPULATION OF THE PINK-FOOTED GOOSE

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MODELING HARVEST CAPACITY AND POPULATION SIZE FOR MANAGING THE SVALBARD POPULATION OF THE PINK-FOOTED GOOSE

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Cover note:

This document provides an overview of the projection of population sizes under varying harvest rates for two population targets. This analysis is intended to inform discussions on target setting and harvest management. Following the agreement of population targets, similar projections of population sizes will be modeled to assess the harvest levels required to stabilise the population at the target level and forecast potential population growth over the next 12 years under a scenario where no further management measures are implemented for population control. These models will be incorporated into Annex 3 – Projection of Population Sizes and Harvest Rate in the revised plan.

Modelling harvest capacity and population size for managing the Svalbard Pink-footed Geese

This document is intended to inform discussions regarding the revision of the International Single Species Management Plan for Pink-footed Geese (PfG_ISSMP). Specifically, we address the question of how the capacity to achieve harvest quotas may affect managers ability to successfully reach a population target over the next 12 years, the expected lifespan of the revised management plan. We address in this document two potential targets:

(a) the existing target of 60,000 individuals in spring; and

(b) a potential target of 80,000, which is similar to the current spring population size of about 78,000.

We examined four scenarios for harvest capacity:

(1) unconstrained, in which managers can achieve any harvest necessary to control population size;

(2) a maximum harvest of 17,000, which is the maximum harvest achieved during the period of record (1992 – 2023);

(3) a maximum harvest of 15,000, which was the mean harvest during 2016 – 2020; and

(4) a maximum 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. 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. We used the most recent update of the integrated population model (IPM, EGMP_Population_Status_and_Assessment_Report 2024) 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. We used the optimization algorithm called stochastic dynamic programming (SDP), 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. We conducted 1,000 simulations 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 Zemlyla). Because we know that population size must ultimately be limited by the environment, we capped potential population size in the simulations at 150,000, or about twice 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.

Modelling results

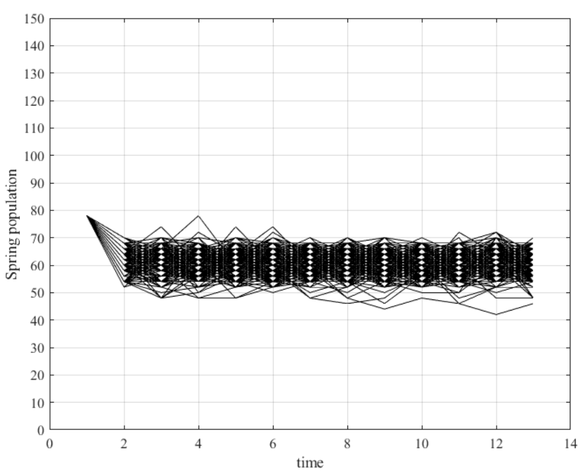
Scenario (a) - target of 60,000 individuals

Table 1. 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*. 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)

Figs. 1 – 4. One thousand simulated time paths of Pink-footed Goose population size and harvests (in thousands) under optimal harvest strategies with the specified limit on maximum attainable harvest, and *assuming a spring population target of 60,000*.

Maximum harvest = 50k (unconstrained)



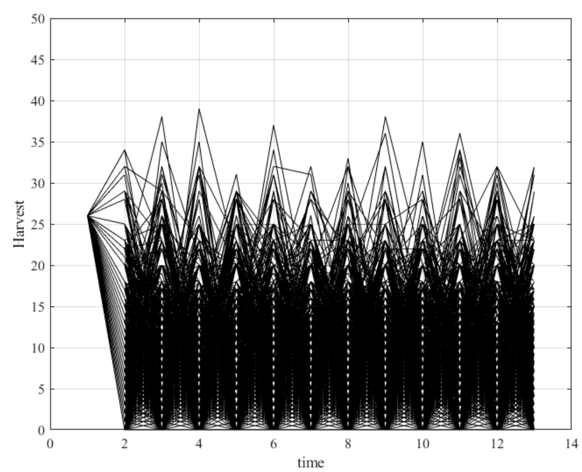


Figure 1. Modelling of variation of spring population of Pink-footed Goose in thousands of individuals per year from the start of the revised plan (right) and correspondent variability of harvest in thousands of individuals per year used by the model (right). Each line represents an individual model run.

Maximum harvest = 17k (maximum 1992-2023)

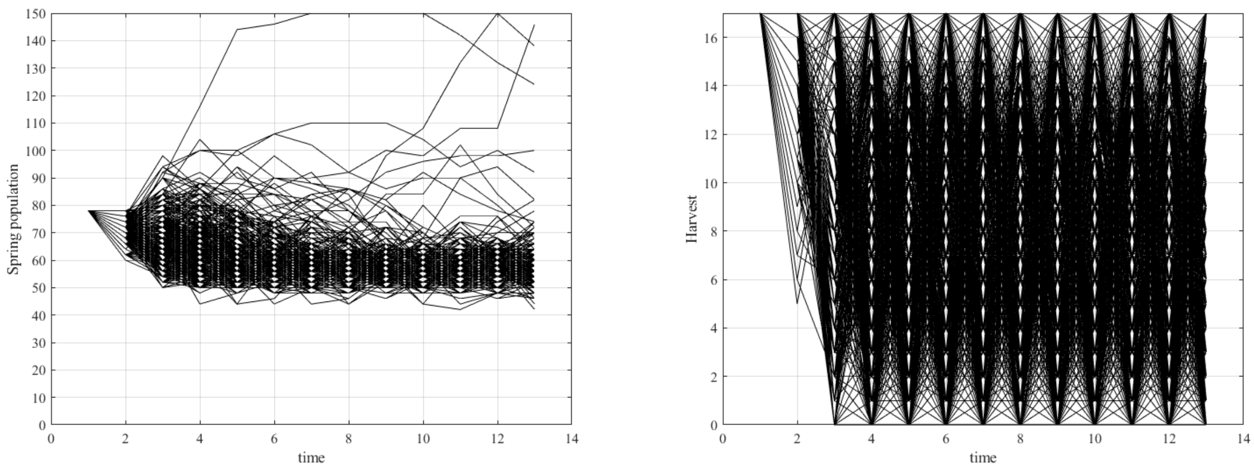


Figure 2. Modelling of variation of spring population of Pink-footed Goose in thousands of individuals per year from the start of the revised plan (right) and correspondent variability of harvest in thousands of individuals per year used by the model (right). Each line represents an individual model run.

Maximum harvest = 15k (mean 2016-2020)

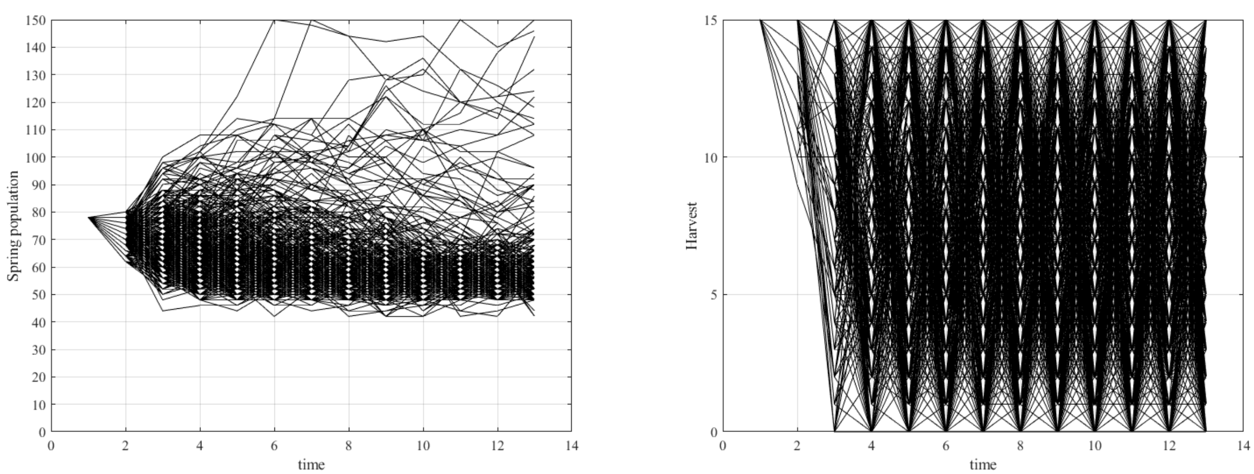


Figure 3. Modelling of variation of spring population of Pink-footed Goose in thousands of individuals per year from the start of the revised plan (right) and correspondent variability of harvest in thousands of individuals per year used by the model (right). Each line represents an individual model run.

Maximum harvest = 10k (mean 2021-2023)

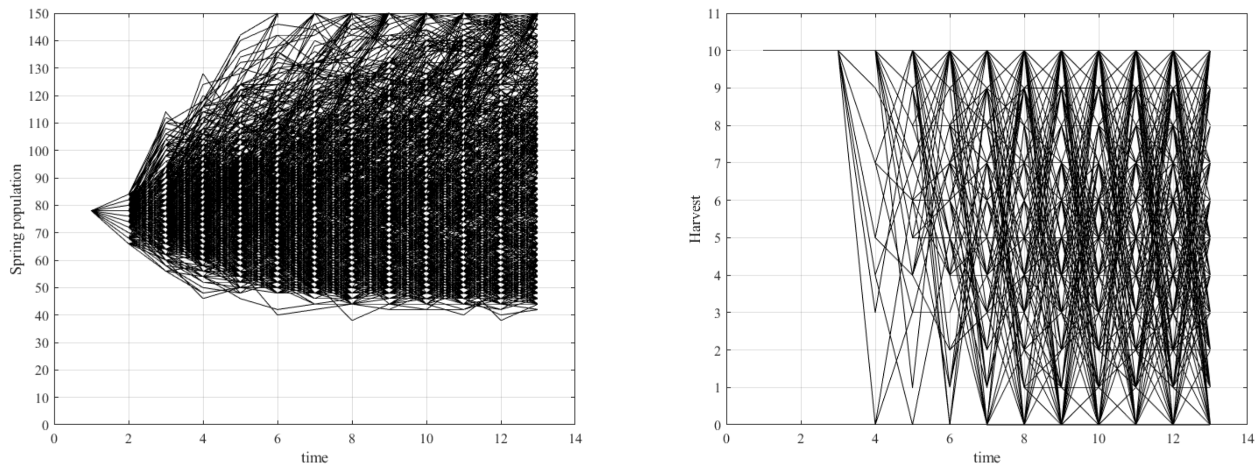


Figure 4. Modelling of variation of spring population of Pink-footed Goose in thousands of individuals per year from the start of the revised plan (right) and correspondent variability of harvest in thousands of individuals per year used by the model (right). Each line represents an individual model run.

Scenario (b) – target of 80,000 individuals

Table 2. 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 80,000*. 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	81.8k (4.5)	10.5k (8.5)	82.0k (4.6)	11.1k (8.9)
17k	maximum 1992-2023	76.0k (6.8)	10.1k (5.8)	76.6k (8.6)	10.2k (6.1)
15k	mean 2016-2020	76.4k (9.4)	10.2k (5.2)	78.0k (12.8)	10.1k (5.3)
10k	mean 2021-2023	87.2k (21.0)	9.1k (2.3)	100.0k (28.7)	9.2k (2.1)

Figs. 5 – 8. One thousand simulated time paths of Pink-footed Goose population size and harvests (in thousands) under optimal harvest strategies with the specified limit on maximum attainable harvest, and *assuming a spring population target of 80,000*.

Maximum harvest = 50k (unconstrained)

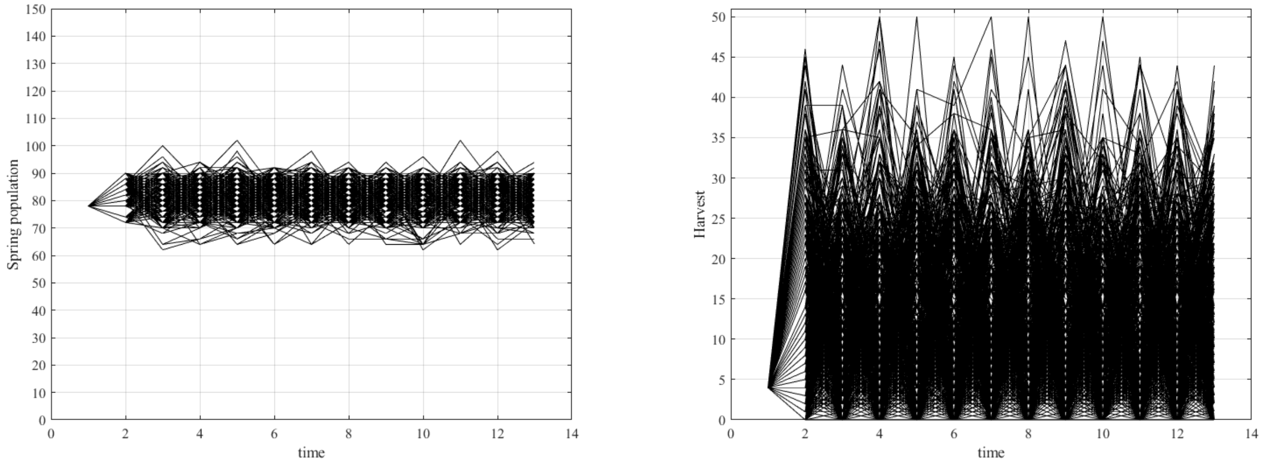


Figure 5. Modeling of variation of spring population of Pink-footed Goose in thousands of individuals per year from the start of the revised plan (right) and correspondent variability of harvest in thousands of individuals per year used by the model (right). Each line represents an individual model run.

Maximum harvest = 17k (maximum 1992-2023)

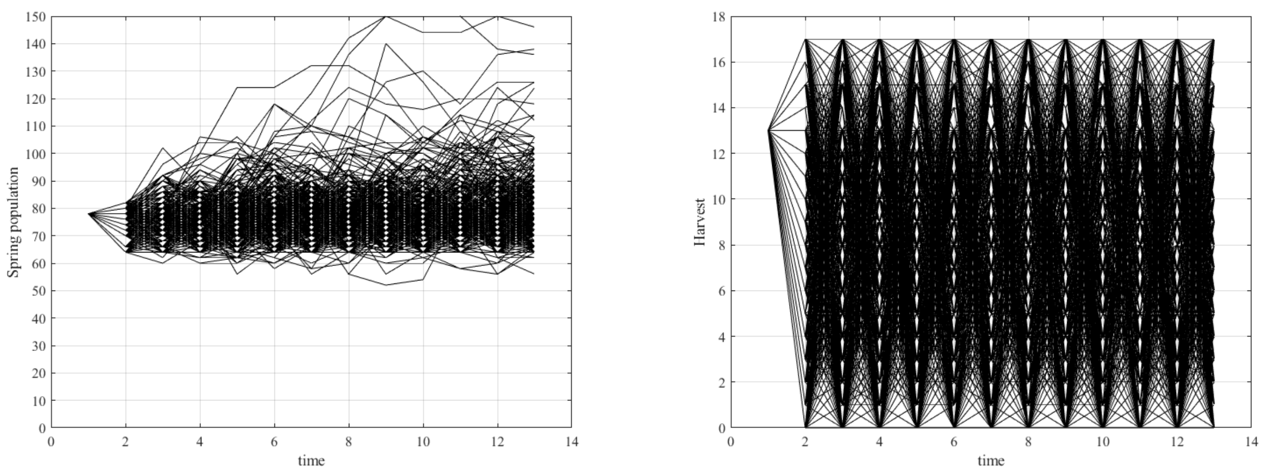


Figure 6. Modeling of variation of spring population of Pink-footed Goose in thousands of individuals per year from the start of the revised plan (right) and correspondent variability of harvest in thousands of individuals per year used by the model (right). Each line represents an individual model run.

Maximum harvest = 15k (mean 2016-2020)

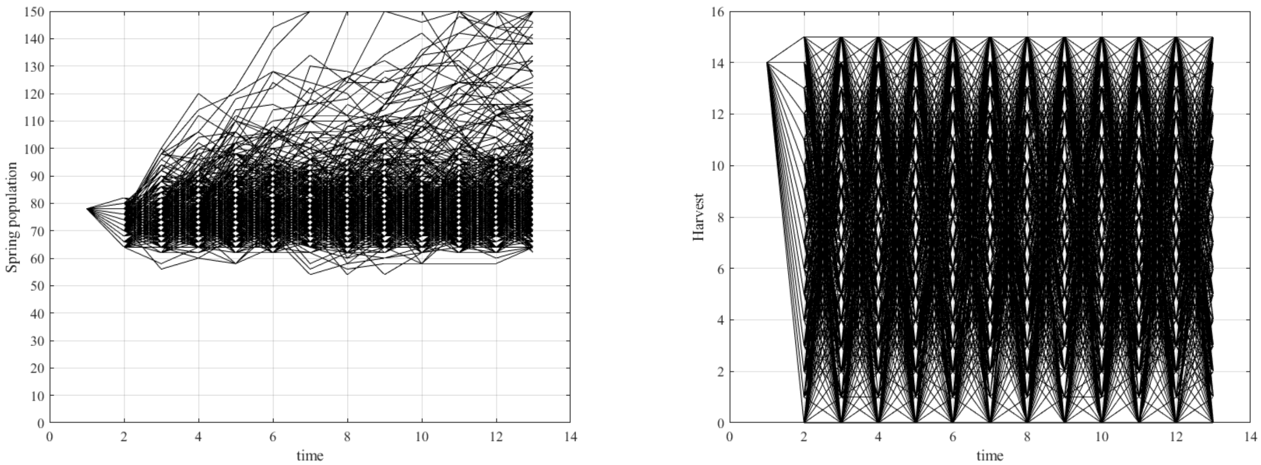


Figure 7. Modeling of variation of spring population of Pink-footed Goose in thousands of individuals per year from the start of the revised plan (right) and correspondent variability of harvest in thousands of individuals per year used by the model (right). Each line represents an individual model run.

Maximum harvest = 10k (mean 2021-2023)

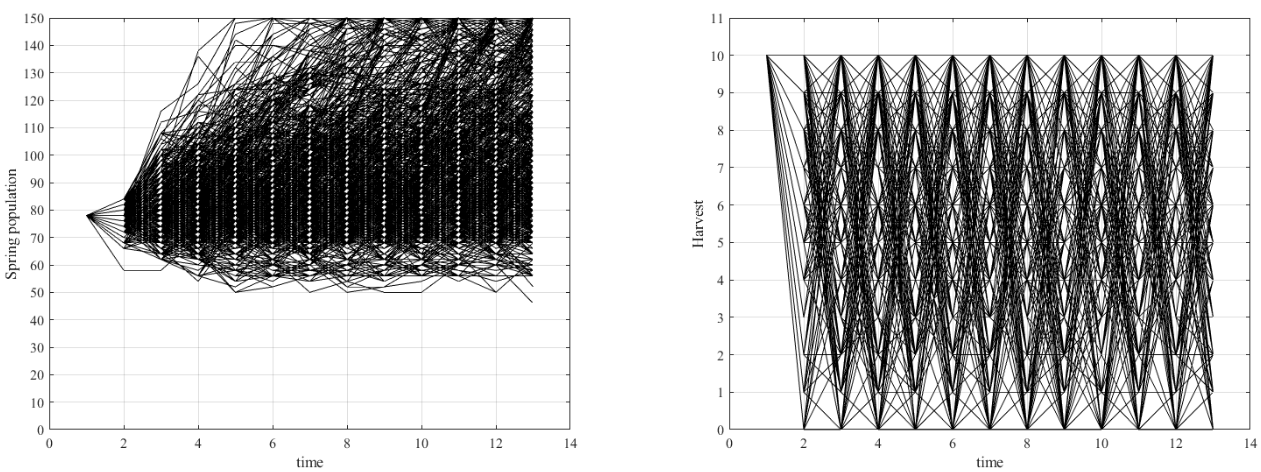


Figure 8. Modeling of variation of spring population of Pink-footed Goose in thousands of individuals per year from the start of the revised plan (right) and correspondent variability of harvest in thousands of individuals per year used by the model (right). Each line represents an individual model run.

Conclusions from the modeled scenarios:

i. In the case on unconstrained maximum harvest, optimal harvests are apparently able to successfully achieve a mean population size close to the desired target after 12 years.

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

iii. In the case of maximum attainable harvests of 17,000 and 15,000, the mean simulated population sizes are slightly below targets. This may be due to the abiity of optimal strategies to anticipate pulses in population growth that would be difficult to control with constrained maximum harvests.

iv. If the maximum attainable harvest was constrained to the mean of the last three years (10,000), managers could loose control over population growth, regardless of the population target.

v. Finally, a target of 80,000, 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.

Literature cited

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