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European Goose Management Platform — an immediate and wide use of citizen science data in goose research and management

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Abstract. The AEWA European Goose Management Platform provides a mechanism for sustainable use and management of goose populations in Europe, based on various monitoring schemes. Most European countries are involved, especially in the northern and western parts. Updated population status reports are published annually and are used for immediate decision-making. The different monitoring activities provide important data for population modelling of the species/populations and thus reliable and updated information on population status, trends, and demographic parameters. A large number of volunteers are involved in different aspects of the monitoring.

Introduction

The European Goose Management Platform (EGMP) was established in 2016 and functions under the framework of the African-Eurasian Migratory Waterbird Agreement (AEWA). The goal of the EGMP is to provide a mechanism for a structured, coordinated and inclusive decision-making and implementation process for the sustainable use and management of goose populations in Europe (https://egmp.aewa.info/).

Most of the European goose populations are increasing. Foraging geese on cropland is a challenge for many farmers, in particular in north and west Europe (Fox et al. 2017, Fox & Madsen 2017). There is also a conflict between the increasing goose numbers and air traffic collision risks (Bradbeer et al. 2017). Some species are huntable, while others are protected, depending on national and international regulations. However, the large flocks of geese also attract attention from the public, witnessed by an increasing number of visitors at areas with high concentrations of staging or wintering goose. This has also resulted in an increase in the number of (colour)-ringed geese reported from various schemes on reporting portals such as www.geese.org. Hence, there is a lot of interest associated with this specific group of birds.

EGMP's main objective is to maintain goose populations at a favourable conservation status, taking into account concerns of relevant stakeholders as well as the pertinent legislative frameworks and regulations. To maintain a favourable conservation status it is crucial to have reliable information about the status and the trend for a given species. Thus, every available relevant dataset is included in the population monitoring of the species.

At present populations of four goose species, Pink-footed Goose *Anser brachyrhynchus*, Taiga Bean Goose *Anser fabalis fabalis*, Greylag Goose *Anser anser* and three populations of Barnacle Goose *Branta leucopsis* are included in the EGMP-work. To be able to manage the populations, some of these are further divided into Management Units (MUs) of reasonable sizes with coherent breeding areas, staging sites and wintering areas. The Taiga Bean Goose has been divided into four MUs, Greylag Goose two MUs and the Russian/Netherlands & Germany population of the Barnacle Goose three MUs, respectively. Altogether, 14 participating Range States and the European Commission are involved in the work, covering large parts of Europe (Fig. 1, Table 1).

These populations of Pink-footed Goose, Greylag Goose and Barnacle Goose have all increased significantly over the recent decades (Table 1), whereas a dramatic and range-wide decline in the population size of the Taiga Bean Goose has been recognized.

For all four species, species management plans or action plans have been produced (Madsen & Williams 2012, Marjakangas et al. 2015, Jensen et al.

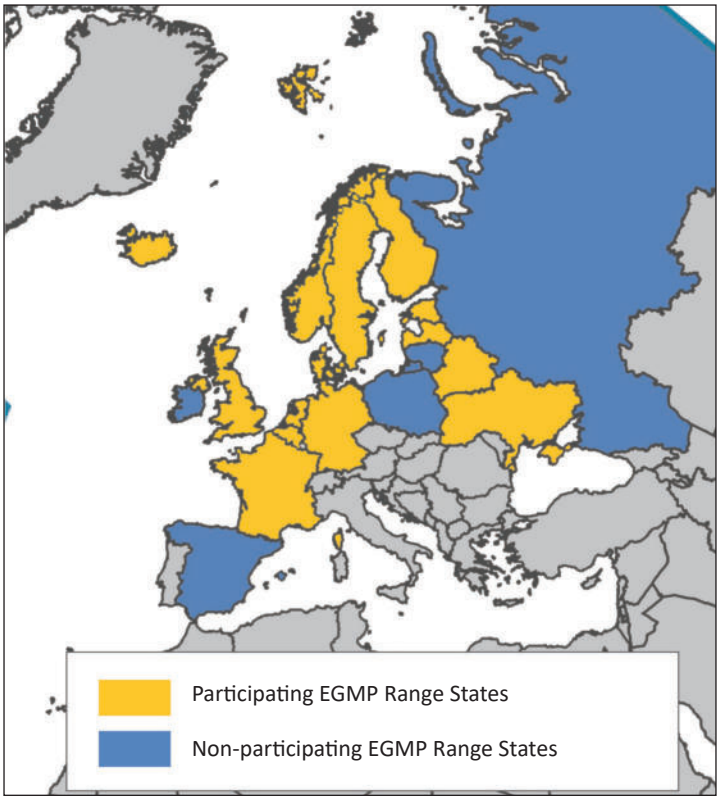

Figure 1. Map of the EGMP participating and non-participating Range States

Table 1. Overview of goose populations included in the work by the European Goose Monitoring Platform (EGMP).

Population	Breeding area	Staging/Wintering sites	Population size
Pink-footed Goose			
Svalbard population	Svalbard	Sweden, Norway, Finland, Denmark, The Netherlands, Belgium	1980s: 25,000–30,000 2019: 68,400–80,400
Taiga Bean Goose			
Western Management Unit	Norway, Sweden	NW-Denmark, Scotland, England	(2015): 1,500
Central Management Unit	N-Sweden, N- Norway, N-C Finland and NW Russia	Mostly in S-Sweden, SE Denmark and NE-Germany	Mid-1990s: 100,000 2019/2020: 75,200–80,700
Eastern 1 Management Unit	Russia	Mostly NE-Germany, and NW-Poland	(2015): 15,000
Eastern 2 Management Unit	Russia	SE-Kazakhstan, E-Kyrgyzstan and NW-China	(2015): 2,000–5000?
Greylag Goose			
NW/SW European population	Fenno-scandia, NW- Germany, The Netherlands, Belgium and N-France (2 MUs)	North and West Europe from S-Sweden to Belgium and Spain	1980s: 120,000–130,000 2018: 751,000
Barnacle Goose			
Russia/Germany & Netherlands population	Russian Arctic, in the Baltic Sea and North Sea areas (3 MUs)	Mostly Sweden, Denmark, Germany, The Netherlands and Germany	1980s: 50,000–200,000 2018: 1,4 million
East Greenland/Scotland & Ireland population	E-Greenland and Iceland	Iceland, Scotland and Ireland	1980s: c. 25,000–35,000 (winter) 2018: 72,200
Svalbard/South-west Scotland population	Svalbard	Norway, SW-Scotland	1980s: 10,000–12,000 2017: 41,700

Pink-footed Goose: Heldbjerg et al. (2020a).
Taiga Bean Goose: Marjekangas et al. (2015), Heldbjerg et al. (2020b).
Greylag Goose: Heldbjerg et al. (2020c).
Barnacle Goose: Russia/Germany & Netherlands population: Koffijberg (2020); Svalbard/South-west Scotland population: WWT Waterbird Monitoring (2020); Svalbard/South-west Scotland population: Jensen et al. (2018).

2018, Powolny et al. 2018). This has led to the development of Adaptive Flyway Management Programmes (AFMPs) for each species, however with a varying degree of implementation. The population status and harvest assessments for the huntable species are updated annually and published on EGMP's website (https://egmp.aewa.info/).
The European Goose Management International Working Group (IWG) serves as the main coordinating and decision-making body. It is composed of representatives of national governments, national experts, the European Union, observer organizations and other relevant stakeholders. The IWG meets annually to decide, at the multispecies level, on adjustments to the management frameworks, prioritization of plan processes as well as population specific harvest quotas and to exchange experiences.

A combination of wide use of citizen science and other specific studies

To understand the changes in population numbers, we need to know the current population size, the numbers added to this in the annual cycle (productivity of young) and the numbers removed from the population (natural mortality and 'offtake', which is the term used to describe the number of individuals removed from the environment through hunting or harvesting by humans). Since these species are exposed to harvest or derogation killing, the size and variation in the offtake plays a crucial role.
To describe the status, trends and demography for every species and MU, the EGMP uses several citizen science datasets. They rely on existing organised counts and use additional counts and specific data when needed (Table 2).
The long-term mid-winter counts run by Wetlands International provide the most valuable information about population size of a large number of species from many countries (Nagy & Langendoen 2020) and involve many keen ornithologists. However, for some of the goose populations, it became clear that there is an urgent need for more specific counts at other parts of the annual cycle. An example is the monitoring of the Central MU of Taiga Bean Goose that is counted in October, and again in early March when the majority of the birds are located in relatively limited areas of Sweden (see Table 1).
During autumn counts, ageing of individuals in flocks is possible from the distance, however preferably carried out by experienced ornithologists. The variation in annual productivity is often large; hence, it is an important parameter to include in the population modelling.
For Greylag Goose, evidence of breeding collected from Common Bird Monitoring schemes in several countries are included (Heldbjerg et al. 2020c). Although such data rarely provide much information on breeding numbers they have been proven to be useful to describe the trends for the national breeding populations. Traditionally, most goose populations are counted outside the breeding season when they occur in large flocks. However, this may be problematic when the origin of these birds is not known. If non-breeding staging areas include birds from several countries and MUs, it is preferable to include information from the breeding period to understand population changes in the different countries.
In some cases, there are no existing systematic counts, for instance foraging geese in agricultural areas and in such cases, casual records of geese from different bird record portals are included. Despite the lack of systematic counts, such portals are often useful since they include large numbers of records from a huge number of sites all year round.
In general, the four goose species discussed here are well studied and their migratory movements well known. The offtake from the populations represents a very important part of the total mortality. Hence, it is crucial to have reliable data on the offtake. Legal harvest seasons vary between species and countries and the countries involved manage reporting and maintain databases on the annual harvest in different ways. The format, reporting details, and quality varies between countries and regions. Derogation refers to the culling of geese in the non-hunting season in cases where there is no other satisfactory solution for the prevention of serious damage to crops or prevention of bird strikes. Data are reported annually to the EU in accordance with Article 9 of the European Birds Directive.
In most goose studies, ringing programs based on neck-rings or darvic tarsus rings are included. They show that for several species, the migratory behaviour and wintering ranges have changed considerably during recent decades. For example, Swedish Greylag Geese used to winter in Spain but have now shortened their mean migration distance and the major part of the population now stays in the Netherlands and Sweden (Nils-

Table 2. Overview of the existing and planned monitoring activities for the four goose species included in the work by the European Goose Monitoring Platform (EGMP). The four species are Pink-footed Goose (PfG), Taiga Bean Goose (TBG), Greylag Goose (GG) and Barnacle Goose (BG). (X) indicates that the activity is planned.

Species	PfG	TBG	GG	BG
Number of included populations	1	1	1	3
Number of MUs	1	4	2	3
Dedicated autumn counts	X	X		
Mid-winter counts		X	X	X
Dedicated spring counts	X	X		
Dedicated post-breeding counts			(X)	(X)
Common Bird Monitoring			X	
Casual records, Bird portals		X	X	X
Productivity — age counts	X	X	(X)	X
Survival — resightings	X	X	X	X
Harvest data	X	X	X	X
Derogation data	X	X	X	X
Weather information	X	X		
Crippling rate (from shotgun shooting)	X		(X)	(X)

son & Kampe-Persson 2018; Bacon et al. 2019). The Svalbard Pink-footed Geese used to migrate to wintering grounds in the Netherlands and Belgium; however, due to land use changes and milder winters, the majority of geese nowadays stay in Denmark throughout the winter (Clausen et al. 2018). These examples illustrate that monitoring activities need to be adapted according to the whereabouts of geese and that management decisions must be dynamic and drawn on recent information. Ring-readings by a huge network of volunteers as well as professionals provide highly valuable information, and online submission systems can provide immediate feedback of the life history of marked individuals, which is an important incentive for the observers to report.

In addition to this, tracking the movements of individual birds by using GPS-loggers enables us to use up-to-date knowledge on the movements and length of staging in different areas, information which is necessary to effectively protect or manage a population.

Survival of adult birds, i.e. the proportion of birds that survive from one year to the next, is estimated by resightings of neckbands and by recoveries of standard metal rings. Along with the capture of flocking geese, x-raying provides a measure of the number of geese crippled by carrying shot-gun pellets in their body tissue. By repeating x-raying and performing it at different sites, it is possible to study if there is a change in the crippling rate over time, between sites and between species.

Management and population modelling

In contrast to most other monitoring projects, where ideas, plans and use of the data develop over time, there is a planned and agreed use to all aspects of the EGMP goose monitoring and an immediate use in the conservation and management of the species. Here, ideas and plans may lead to additional monitoring activities. The availability and use of reliable data in combination with population modelling create the opportunity to understand and validate the importance of each parameter and thereby the expected impact at the population level when one or more parameters are changed. For huntable species, the most manageable parameter is obviously to change in offtake.

By using the data within the same annual cycle of the counts, it is possible to use data in an adaptive way where harvest management is based on the most recent data on population size, productivity and offtake. This is known as Adaptive Harvest Management, which is useful for several huntable species where there is a high degree of uncertainty in the understanding of the system, such as the drivers of population change.

In the EGMP, we have started to make use of Integrated Population Models (IPM) to predict the impacts of changes in the environment or management decisions on population sizes. It represents an advanced approach to modelling, in which all available demographic data, e.g. popu-

lation counts, age ratios, survival estimates, are incorporated into a single analysis. IPMs have many advantages over traditional approaches to modelling, including the proper propagation of demographic uncertainty, better precision in the estimation of demographic rates and population size, the ability to handle missing data and to estimate latent (i.e., unobserved) variables and, the capacity to guide the development of effective monitoring programs (Johnson et al. 2020).

Ideally, the combination of precise data on the important demographic parameters and predictive models lead to management, which can be adapted on an annual basis. In the EGMP, emphasis is put on a transparent and open discussion, where all relevant stakeholders are involved in the decision-making and hopefully, over time it will involve an increasing number of participating EGMP Range States. Reliable data is a crucial backbone in the process. This illustrates the idiom that 'A chain is no stronger than its weakest link'. We are grateful for the joint effort from a large number of involved volunteers to make this chain as strong as possible.

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