

species	data	document	Last updated
Pink-footed goose	Lincoln index and survival	Methodology	16032022

Lincoln index

To obtain an alternative estimate of total population size of Pink-footed Geese, we used a capture-mark-recapture approach (Lincoln index) on sightings of geese marked with neckbands in Denmark, Norway, Svalbard and Finland. The estimation is based on the ratio of total geese per marked goose and the total number of marked geese in the population (Clausen et al., 2019; Sheaffer and Jarvis, 2013). Recordings of marked versus unmarked individuals in flocks started in 1991 (Ganter and Madsen, 2001). In the first 20 years, recordings were made on relatively few flocks (average number of flocks scanned annually was 28; range 1-153); since 2012, the recordings have been intensified to increase the sample size (range 227-383). For each year we estimated a mean ratio of marked to unmarked geese for all flocks >100 individuals recorded in autumn and spring in Denmark and the Netherlands (Clausen et al., 2019). In 2020/21, only data from Denmark (October-November 2019 and March-April 2020) was available. The number of neck-banded geese alive was estimated based on the number of marked geese seen at least twice in an observation window covering mid-February to mid-May (corresponding to a period with coordinated observation efforts), corrected for the detection rate of marked birds alive. Ringing and re-sighting data was extracted from <http://www.geese.org>, where observers add their registrations. Detection rate was estimated using the program MARK (White and Burnham, 1999). As the detection rate of the last year in a time series is not estimable, we assumed the detection rate and the variance for the most recent year to be identical to the previous year since the variation between subsequent years has been moderate in recent years. In the springs of 2018 and 2019 as well as in the summer of 2018, a total of 44 Pink-footed Geese have been marked with GPS neckband transmitters by the Netherlands Institute of Ecology and Aarhus University. In the spring of 2021, 22 of these transmitters were still alive. Since we know for sure that these geese were alive, but not part of the CMR analysis on geese wearing traditional collars, this number has been added to the estimate of marked birds alive based on the resighted neckbanded geese. The total population size was estimated as the number of marked geese alive divided by the corrected estimate of the ratio. The confidence limits were estimated based on the variance estimate for the population. A full description of the methods is given in Clausen et al. (2019).

Survival

Annual survival was estimated using the program MARK (White and Burnham, 1999) based on recoveries of dead birds and encounter histories (Joint Live and Dead Encounters) of all Pink-footed Geese ringed with neck collars during 1990-2018 (including observations up until 2021). Ringing and re-sighting data were extracted from <https://www.geese.org/> and recoveries of dead birds were supplied by the ringing offices in Denmark and Norway. Encounter histories were based on an observation window from 23 February – 22 May and, because neckbanded individuals are generally seen several times during this period, only birds with at least two sightings within the observation window were included as positive observations. This ensured that the influence of re-sighting errors was kept to an absolute minimum. Using MARK, a number of models were fitted with various constraints on survival, re-sighting probability and recovery probability. These models were evaluated using AIC (Burnham and Anderson, 2002) and estimates of annual survival from the best performing model used. The survival estimates are updated each year and subject to minor changes due to continuous reporting of resightings. Therefore, the most recent estimate is preliminary.