

**Recommendations for survey design to estimate
the abundance of the Iceland Greylag Goose population
in the United Kingdom**

Richard Hearn
WWT
Slimbridge
Gloucestershire
GL2 7BT

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1. Issue

Recent modelling of the dynamics of the Iceland population of Greylag Goose *Anser anser* found that discrepancies exist between the data for the different population parameters used in the models. Surveys and research that clarify where this impreciseness lies, and determine improved methodologies for future data collection, are needed in order for population estimates to remain accurate.

2. Background

Estimates of abundance for geese breeding in the arctic and sub-arctic regions of the Western Palearctic are generally carried out during the non-breeding season when the birds are at wintering areas in Europe. This is primarily because of the remoteness and inaccessibility of their breeding areas and their highly dispersed nature at that time.

In the UK, the abundance and distribution of many non-breeding waterbird populations are estimated through the Wetland Bird Survey (WeBS), in which co-ordinated monthly counts are carried out at established wetlands by volunteer birdwatchers. The habits of geese, however, and particularly their use of farmland for foraging, dictate that a separate suite of surveys is required because WeBS counts are carried out during the daytime when many geese are foraging away from their wetland roost sites. The monitoring of most migratory geese is therefore carried out as part of The Wildfowl & Wetlands Trust's (WWT) Goose Monitoring Programme (GMP). This consists of a suite of surveys that not only aims to estimate abundance and distribution, but also reproductive success, movements of marked individuals and annual survival rates for each of the goose populations. Many of these surveys are reliant upon a network of volunteer fieldworkers to collect data and just over 500 observers currently contribute to the GMP.

The abundance of the Iceland population of Greylag Goose is estimated using data collected as part of the Icelandic-breeding Goose Census (IGC). This census is one of the longest running GMP surveys and also estimates the abundance and distribution of the other UK-wintering species of goose that breeds in Iceland - the Pink-footed Goose *A. brachyrhynchus*. The methods for this census were developed during the 1950s through a combination of ground and aerial surveys that established an inventory of roost sites (Boyd 1963). Comprehensive coverage was achieved in November 1960 and a full census has been carried out annually since then. Since the start of this survey, the abundance and distribution of Iceland Greylag Geese and Pink-footed Geese have changed significantly, yet the survey methods have not been reviewed in relation to these biological changes. It is possible, therefore, that they may have become less effective over time in describing abundance and population trends, since birds may now roost at sites not covered during the IGC.

In 2001, a workshop was held at Hvanneyri Agricultural University, Iceland, to discuss the status and monitoring of the Pink-footed Goose and Iceland Greylag Goose. Workshop participants reviewed recent work, in particular the analyses of monitoring data collected by the Icelandic Institute of Natural History (IINH) and WWT during 1996-2000 (see Frederiksen *et al.* in press), and produced a series of recommendations for future monitoring effort (Frederiksen 2001).

The population modelling carried out by Frederiksen *et al.* (in press) found that the current survey methods provide an accurate means of monitoring abundance in Pink-footed Geese. In contrast, the IGC and estimates of harvest rate in Iceland were

incompatible for the Iceland Greylag Goose: using each of these data sources in population models, with their associated age ratios, provided widely differing estimates of abundance. The study concluded that either the Icelandic hunting bag was dramatically over-estimated or that the IGC missed a significant proportion of the population, or both to a lesser degree. Frederiksen *et al.* (in press) also concluded that productivity estimates from the UK are likely to underestimate true reproductive success, but these are not closely related to the estimates of abundance (except through the survival rates), i.e. assuming a higher proportion of juveniles in autumn in itself does not resolve the problem about underestimation of abundance and/or overestimation of the hunting bag.

Over-estimation of the hunting bag in Iceland could occur, for example, because of misidentification of bagged geese by hunters (confusion with Pink-footed Geese) or double-reporting by hunting parties. However, inspection of recovery reports of ringed geese killed by hunters showed no evidence of widespread identification problems (M. Frederiksen, unpublished data), and a sample survey of licence holders indicated that double-reporting was not an important bias (A. Sigfússon, unpublished data). This suggests that the main source of error was the IGC. Underestimation of the autumn population size could come about by two mechanisms: undercounting in the UK or a large part of the population wintering outside the UK.

Given the apparent decline in abundance of Iceland Greylag Goose that has recently been suggested by IGC data, and the need for conservation action that this may require, it is imperative that greater confidence is obtained in our assessment of the status of this population. Therefore, in order to establish exactly where sources of error may lie within the current monitoring effort, a thorough assessment of all of these protocols and possible sources of error is needed. This report examines the possibility that large numbers of Iceland Greylag Geese wintering in the UK are not detected during the IGC and provides recommendations for survey design that would determine whether undercounting in the UK was indeed a principal source of error.

3. Current IGC methodologies

The IGC is a site-based survey: counters are asked to estimate the number of birds at known roost sites, or feeding areas. No attempt to locate birds elsewhere is made, although new sites are introduced to the census when they become known to local experts, and in many areas counters carry out preliminary checks of the sites being used by roosting geese prior to the census. Two counts are carried out each year, one in November and, since 1990, one in October, although the latter was designed to improve estimates of population size for the Pink-footed Goose. The counts are carried out at these times because they occur soon after the arrival of the geese from Iceland, when the birds are concentrated at relatively few sites. On average, 111 sites are counted during October and 127 in November (based on survey in 1997-2001).

Since 2000, counters have also been encouraged to carry out a count of their site in September, prior to the arrival of Iceland Greylag Geese, in order to determine the number of NW Scotland or re-established Greylag Geese also present (see below).

IGC counters use one of two methods: (i) a dawn or dusk count of a roost site, either as birds flight in or out, or (ii) a daytime count of feeding areas. This latter method is less preferable than roost counts, because of difficulties in locating all feeding areas which are less predictable than roosts, and problems with duplicated counts of birds moving between feeding sites during the count. Counts of feeding areas are, however, necessary

where it is not possible to carry out co-ordinated counts of all known roost sites, for example because of a lack of counters, or inaccessible roost sites. No formal training of counters is carried out and it is a general assumption of most bird monitoring in the UK that counters volunteering to assist are competent to do so.

In the past, IGC coverage has been largely confined to the range within the UK (northern England and Scotland), since this is where the vast majority of Iceland Greylag Geese are believed to occur. In recognition of the fact that Iceland Greylag Geese do occur outside the UK, WWT extended the scope of the IGC in 1998 to include Ireland and again in 2001 to include Iceland, the Faeroes and Norway. Currently, the number of birds in these areas is believed to be small.

4. Limitations of current IGC methodology

There are two main factors that may lead to inaccurate estimates of abundance of Iceland Greylag Goose using current IGC methodology: 1) an inability to locate all Iceland Greylag Geese; 2) an inability to identify correctly birds belonging to the Iceland population among Greylag Geese in Great Britain.

4.1 Detection of Greylag Geese

The site-based nature of the IGC means that Iceland Greylag Geese occurring away from known roost sites are unlikely to be detected. Furthermore, certain behavioural characteristics mean that they may be less likely to be detected compared to Pink-footed Geese, even in areas where they are known to occur. For example, they occur in smaller flocks than do Pink-footed Geese and more readily use temporary areas of floodwater for roosting.

4.2 Identification of Iceland Greylag Geese

Within the UK there are two other, sedentary, populations of Greylag Goose: (i) NW Scotland (or Native) Greylag Goose; and (ii) re-established Greylag Goose. NW Scotland Greylag Geese occur predominantly in western Scotland, on offshore islands, and in mainland northern Scotland (Caithness and Sutherland). Areas of high importance include the Uists, Coll, Tiree and Sutherland. This population is the remnant of that which was once widespread in Britain before becoming extinct in all but the current range as a result of habitat loss and over-harvesting. The re-established Greylag Geese were reintroduced into this former range, predominantly by wildfowlers between the 1930s and 1960s, and were in most cases derived directly from the NW Scotland population. Further information on the re-establishment of Greylag Geese can be found in Owen & Salmon (1986).

When IGC methods were tested and developed during the 1950s, these two populations were small, and occurred in areas discrete from those occupied by Iceland Greylag Geese. In recent decades, however, counts and observations of marked birds show that they have increased their range and abundance. As a consequence, these three populations now overlap during the winter in a number of areas, and some mixed flocks are known to occur.

Field characteristics that allow birds from each of these populations to be distinguished in the field do not exist. Therefore, current attempts to assign Greylag Geese to the correct population still rely largely on former differences in their distribution and birds are identified to population on the basis of their location. It is likely, therefore, that this method of assigning population status to individual flocks of Greylag Geese is

increasingly prone to error; error that could lead to either over-estimation or under-estimation of the number of Iceland Greylag Geese at a particular site. WWT is currently investigating the feasibility of using stable isotope analysis to identify the breeding location of Greylag Geese captured in Britain during the winter. If successful, this technique may allow the estimation of population status of Greylag Geese at specific sites, and assist with determining whether Iceland Greylag Geese occur in areas currently outwith that covered by the IGC.

5. Overview of alternative sampling methods

A more robust estimate of the number of Iceland Greylag Geese, either in the UK or in the flyway as a whole, requires a sound understanding of their distribution and an ability to separate them from other populations of Greylag Goose. These issues would require a range of research avenues to be pursued; however, recommendations to this end are not covered in this report. Therefore, the recommendations in this report make two key assumptions: (i) that the current IGC covers the range of Iceland Greylag Geese in the UK, and (ii) that all Greylag Geese within this area are from the Iceland population. These assumptions may, of course, be untrue (to a greater or lesser degree), but they allow for a more thorough examination of whether large numbers of Greylag Geese are currently undetected during the IGC. Thus, only recommendations that deal with the detection of Greylag Geese within the range thought to be currently occupied by Iceland Greylag Geese in the UK are made.

It should be noted, however, that improving the detection of Greylag Geese within the winter range of Iceland Greylag Geese alone will not answer the overriding question: how many Iceland Greylag Geese are there? Rather, it will simply provide a robust estimate of the number of Greylag Geese from all UK populations. In order to answer the overriding question it is vital, therefore, that the implementation of the recommendations in this report is carried out in conjunction with research that aims to provide a sound understanding of the winter distribution of Iceland Greylag Geese and the population status of all Greylag Geese at sites covered by the survey.

Even if, in future, it proves more feasible to estimate the abundance of Iceland Greylag Geese during the breeding season, when the birds are clearly separated from other populations, the following recommendations would remain relevant as the UK would still be obliged to identify important sites for Iceland Greylag Geese within its territory.

5.1 Recommendation 1

Design and implement a survey that: a) improves the detection rate of Greylag Geese, b) provides confidence in the population estimates derived, and c) is a feasible and cost-effective long-term monitoring tool for Iceland Greylag Geese in conjunction with the existing IGC.

Option 1: Ground-based stratified sample survey

Phase 1: Survey design

- 1) Define survey area using all available information on range of Iceland Greylag Goose within Britain and Ireland.
 - i) Examine re-encounter data for marked Iceland Greylag Geese.
 - Data from current colour-marking study are maintained by Bob Swann, on behalf of WWT, Icelandic Institute of Natural History (IINH) and Highland Ringing Group.

- Some metal ring recovery data may also be held by Icelandic Ringing Scheme (c/o IINH).
 - ii) Conduct preliminary surveys of areas where count data are currently lacking.
 - Priority areas include Galloway, Ayrshire, Argyll & Bute and the southern Highlands.
 - These surveys could be carried out by aerial survey and/or ground counts, and should be conducted at the same time as the main survey.
 - iii) Examine the distribution of Greylag Geese in the UK during September.
 - Collate and analyse existing data (e.g. Naturalised Goose Census (Delany 1992), NW Scotland Greylag Goose Census (Mitchell *et al.* 2000), and WeBS).
- 2) Compile inventory of all possible roost sites within survey area, including coastal bays, river sections and sites where floodwater regularly occurs.
 - i) Consult with organisations holding relevant inventories on the location and characteristics of waterbodies, e.g. County Wildlife Trusts, co-ordinators of regional Biodiversity Action Plans, Environment Agency, including areas of floodwater of sufficient depth and persistence to be used as a roost site.
 - An important consideration at this stage will be how to treat areas currently counted during the daytime, when birds are at their feeding sites. In a small number of areas (e.g. Orkney) this is a more effective method as roost site selection is fickle and hard to predict, with a large number of possible options for the geese to choose from.
- 3) Determine the primary factors that affect the distribution of Greylag Geese and collate data on these factors for each site.
 - Primary factors are likely to be area of open water, surrounding aspect or habitat, human use of site (i.e. level of disturbance), proportion of suitable foraging habitat within a certain distance of the site, altitude, latitude, and region.
 - Further detail on agricultural characteristics and their effect on goose distribution can be found in Bell & Rees (1994).
 - Coastal bays and, particularly, river sections are believed to be relatively poorly used, yet may hold important concentrations of birds at times. It may be necessary to use different criteria in order to stratify such sites.
 - Principal data sources that will need to be accessed include land use classifications, waterbody characteristics and site use information.
- 4) Compile all count data for sites within this range.
 - Primary source will be IGC dataset, but other sources should also be included, e.g. WeBS, County Bird Club records.
- 5) Use count data to assign all sites into strata that have a high likelihood of holding similar numbers of Greylag Geese.
 - i) For sites with no existing count data, an exercise to establish basic presence/absence of birds prior to stratification may be desirable.
 - This could be achieved by ground survey visits to sites, or by aerial survey (assuming Greylag Geese can be confidently separated from Pink-footed Geese from the air).

Phase 2: Logistics and implementation

- 1) Select the preferred survey design from the sampling scenarios. This will essentially be a trade-off between the following criteria.
 - i) The level of survey precision required.
 - ii) The amount of time required to complete this survey and the best time at which to carry out the survey (autumn, midwinter or spring; dependant on level of between site movement).
 - iii) The number of sites from each strata that would need to be surveyed.
 - iv) The number of volunteer fieldworkers that are available.¹
 - v) The number of additional professional fieldworkers required.
 - vi) Whether the cost of this proposed survey design is acceptable.

A flowchart displaying this cost-benefit decision-making process is shown in Appendix 1.

- 2) Once the preferred survey design has been selected, the following step-wise approach to implementation should be taken.
 - i) Contact all potential counters with sufficient lead-in time with details of the proposed survey dates and methodology.
 - ii) Based on the level of interest shown by IGC counters, contact other survey networks and known birdwatchers to augment the survey team.²
 - iii) Employ professional counters to top-up survey team.

Notes:

¹ The number of volunteer counters available is the least flexible component of the survey. Note that all counters currently volunteering for the IGC already count a site as part of the co-ordinated census. Therefore, any additional sites to be covered as part of a stratified sample survey may need to recruit counters from elsewhere. This may increase the likelihood of professional counters being required, which would increase the costs of the survey.

² A rough estimate should be determined prior to the selection of the preferred survey design.

Phase 3: Analysis and follow-up

- 1) Use results of the pilot survey to determine future approach to monitoring Iceland Greylag Geese
 - i) Is the stratified sample survey a useful monitoring tool?
 - ii) What frequency could or should it be carried out with?
 - iii) What role does the current IGC have in future monitoring of this population?
- 2) It is essential that if a population estimate is required as a part of this survey then all actions are co-ordinated with all other countries holding wintering Iceland Greylag Geese (Ireland, Norway, Iceland and The Faeroes).

Option 2: Aerial survey

If a ground-based survey design proves to be unfeasible (e.g. if the time taken to visit the required number of sites is so great that the movement of birds between sites is likely to cause a high degree of duplication), an alternative option would be to conduct an aerial survey.

An aerial survey of Greylag Geese with the aim of making a confident estimate of abundance would require the following criteria to be fulfilled:

- 1) Counts would need to be carried out during the daytime, when birds are at feeding sites.

- 2) Flights would therefore best be undertaken from late morning to mid-afternoon, when the birds are least likely to be moving from one feeding area to another.
- 3) To achieve the level of co-ordination necessary, a number of aerial survey teams would be required.
- 4) It would be vital that Greylag Geese could be confidently separated from Pink-footed Geese – some testing of this would be first required.

A number of factors associated with these criteria mean that aerial survey is unlikely to be preferable to Option 1: (i) the likelihood of weather causing flights to be interrupted and the required degree of co-ordination therefore becoming unachievable – leading to high likelihood of duplication as a result of the mobility of Greylag Geese; (ii) extensive area to be surveyed, as birds would be counted during the daytime when they are dispersed throughout their foraging range (although see below); and (iii) cost.

In order to determine the feasibility of this option it would be necessary first to design and cost the methodology. A number of options exist for the areas to be covered by the survey, e.g. areas (see Conant *et al.* 2002) or transects (see Hawkings *et al.* 2002).

5.2 Recommendation 2

Determine the level of effectiveness of dawn roost counts, dusk roost counts and feeding counts for detecting Iceland Greylag Goose.

Under current IGC methodologies, counters are encouraged to carry out dawn roost counts as the preferred method. Many roost sites are, however, counted at dusk. This may be less effective than a dawn count, as geese can flight into a roost site after dark, which could result in a (possibly severe) underestimate of their numbers, or a complete failure to detect these birds altogether. Separation from Pink-footed Geese may also be harder at dusk than dawn. In some areas, roost counts are not feasible, owing to factors such as too few counters to cover known roost sites, inaccessibility of roost sites, lack of knowledge of the roost use, or highly fickle roost use where there are many alternative roost sites.

A study that assessed the levels of effectiveness of these methods is highly desirable. Such a study would need to consider:

- 1) The effectiveness of each method in a range of areas, in order to examine whether differences in relative effectiveness occur spatially.
- 2) The degree of nocturnal movement between roost sites by Greylag Geese.
- 3) Whether a correction factor could be used to adjust counts made using less preferred methods.
- 4) The production of justified guidelines for counters on the preferred counting method.

5.3 Recommendation 3

Determine whether counters are able to estimate accurately the number of geese they detect.

Experienced counters are likely to estimate the number of birds present at a site more accurately than are inexperienced counters, yet current recruitment difficulties mean that some key sites are covered by relatively inexperienced counters. A study that investigates whether this contributes significantly to underestimates of goose numbers, and whether there is a need to provide training, is desirable.

6. Acknowledgements

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Appendix 1. Cost-benefit analysis for determining stratified survey design. Start at boxes with bold border; end at boxes with bold text.

