Naturalised Goose 2000

Title
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Description and Summary of Results
The Canada Goose *Branta canadensis* was first introduced into Britain to the waterfowl collection of Charles II in 1665. However even until the 1940s it was predominantly a bird of protected parks and large estates. A BTO survey in July 1953 found about 350 pairs and 750 young, and it was about then that numbers started to increase. A Wildfowl Trust survey of 1967-1969 estimated there were 10000-10500 individuals in Britain and Ireland. The 1988-1991 Breeding Atlas estimated 59500 adult individuals in all of Britain and Ireland, the large majority in Britain. In 1991 the Wildfowl & Wetlands Trust, from a survey of all feral geese on moulting sites late in the summer, reported 43871 adult birds (95% confidence limits 40716-48364) in an area south of Newcastle-upon-Tyne and east of Brecon.
The rate of increase too is uncertain. Wetland Bird Survey (WeBS) data show that, between 1960/61 and 1984/85, the UK population increased at 9.8% per annum, had slowed to 2.4% per annum by 1991, and although showing major annual fluctuations since 1987/88 indices had levelled off by 2000. However, the peak national total then was a third higher than ten years previously. This all suggested that much of the increase might have occurred on new or small sites not usually surveyed by WeBS, or on sites not surveyed for long enough to contribute to the national index.
There are similar uncertainties with the Greylag Goose *Anser anser*. As the only native breeding goose in Britain, it is now largely confined as a wild breeding bird to the Western Isles and northern Scotland. Between 1930 and 1970 flocks were re-established in many parts of Britain, sometimes as a result of introductions by wildfowling interests, and between the 1968-1972 and 1988-1991 breeding atlases, the reintroduced birds had spread rapidly over much of England. The 1991 WWT survey found 11737 re-established adults in Britain, with a further 2856 birds of unknown age. The 1988-1991 Breeding Atlas estimated 22000 adult individuals in Britain and Ireland, but this included the native wild birds and potentially an unknown proportion of late-departing Icelandic breeding birds from Scotland.
Both Canada and Greylag Geese are potentially quite important economically as both cause damage to agriculture and amenity sites, and can contribute to eutrophication of water-bodies, and so are potentially a risk to human health. In extreme cases they lead to total loss of root crop and cereal yield but more normally 50% or less is lost. Both species too are large birds -- Canada Goose weighs up to 5.4 kg and Greylag up to 4.6 kg -- that are quite tame and largely unaffected by disturbance such as noise. Hence they are a threat to air safety and have been involved in bird strikes in Britain and the Americas.
During 1999 a small-scale survey (used as a pilot for 2000) was undertaken to assess the value of a randomized stratified approach to surveying these species. This survey made it possible to estimate the change in numbers in southern Britain since the 1988-1991 Breeding Atlas and, although it was not possible to sample all habitats used by the geese during this pilot, there were strong indications that numbers of both species had increased substantially during the previous decade in some habitats. The methodological approach

and the count data of the 1999 survey were used to design and stratify, respectively, a survey in 2000 that extended coverage to habitats that were excluded from the pilot, and attempted to collect representative data from the whole of Britain.
A reanalysis of the 1988-1991 atlas data, using habitat stratification, resulted in revised estimates of 47504 Canada Geese (from the 59500 noted in the atlas) and 13372 re-established Greylag Geese (the atlas estimate of 22000 included native birds in northwest Scottish and some Icelandic breeding birds -- see above).
For the survey in 2000, 1329 tetrads were covered. From the first visit data it was estimated that there were 88866 Canada Geese in Great Britain (95% confidence limits 86127-91914) which was an increase of 166% (9.3% per annum) since 1989. Extrapolating from the maximum count made in each tetrad (to allow comparisons to be made with the 1988-1991 estimates) this figure rose to 126546 (120782-132367). The figures for Greylag Geese were 24522 (95% confidence limits 22774- 26381; and an increase of 170% (9.4% per annum)), and 36128 (95% confidence limits 32655-39668), respectively.
The new survey therefore provided no evidence of any decline in the rate of growth of the Canada Goose population, a feature which had been aided by translocation of birds in the 1950s and 1960s ironically in an attempt to limit local population growth and agricultural damage.
The increases in the numbers of both species were not consistent across all habitats. The three largest proportional increases in the Canada Goose numbers occurred in habitats which had held densities of less than 1.5 birds per tetrad in 1988-1991, especially 'lowland with some water' and 'lowland with no water' cover in southern areas. Although this 'no water cover' lowland stratum still held relatively low densities in 2000 (1.93 geese per tetrad in 2000, cf 0.63 in 1988-1991), the habitat covered 51% of Britain and supported about 47% of the British Canada Goose population. Canada Geese were perhaps in the process of colonizing 'northern upland with much water cover' in 2000. Increases in numbers of re-established Greylag Goose have arisen as a result of expansion into rural lowland habitat with little or no water.

Methods of Data Capture

Volunteer counters made two visits to a randomized, stratified sample of tetrads, the first mid-April to mid-May (breeding season), the second mid-June to mid-July (moult period). On each, counters recorded separate totals for adults and juveniles of all species of feral geese. Flying birds were not counted unless seen taking off from or landing in the tetrad. A minimum time limit of one hour was set for each visit, but counters could spend as much time as necessary to cover all habitats.
As data were collected during the breeding season and during the moult period, it was possible to derive three population estimates for each species: 1) data from the breeding season visit; 2) data from moult period visit; and 3) the highest count made in each tetrad during either visit. The last was to allow direct comparison with the 1988-1991 estimates -- only the highest 1988-1991 Canada and Greylag Goose counts from each tetrad had been archived, making it impossible to generate the preferred population estimates based solely on first-visit counts.
For the 1999 pilot, randomly selected tetrads (from those previously counted during 1988-1991 atlas) were surveyed from mid-April to mid-June following the same methods. This

enabled an unbiased, paired comparison of counts to be made. Counters spent 30 minutes in each of the four 1-km square units of the tetrad, a maximum of two hours in each tetrad. Areas that were totally unsuitable for geese (densely built up areas with no still or running waters, dense forest etc) were not covered and the time adjusted accordingly. Counters recorded the areas covered. All geese were recorded, adults separately from young birds, and as in 2000, flying birds were not counted unless seen taking off or landing.

Purpose of Data Capture

The survey aimed: 1) to update population estimates of breeding introduced Canada Geese and re-established Greylag Geese for Britain; and 2) to determine in which habitats, if any, their numbers had changed since 1988-1991 when estimates of numbers and range had been made as part of the Breeding Atlas.

Geographic Coverage

All of Great Britain.

The 1999 pilot survey was restricted to the core distribution of the target species, an area south of Newcastle-upon-Tyne and east of Brecon.

Temporal Coverage

The breeding season of 2000 with two visits: mid-April to mid-May (breeding season) and mid-June to mid-July (moulting period). (The 1999 pilot survey asked for two visits between mid-April and mid-June.)

Other Interested parties

The Civil Aviation Authority funded the whole project.

Organiser(s)

Graham Austin as part of the WeBS team.

Current Staff Contact

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Publications

The main results of the 2000 survey are in:

Austin, G.E., Rehfisch, M.M., Allan, J.R. & Holloway, S.J. 2007. Population size and differential population growth of introduced Greater Canada Goose *Branta canadensis* and re-established Greylag Goose *Anser anser* across habitats in Great Britain in the year 2000. *Bird Study* 54: 343-352.

The results of the smaller scale 1999 pilot survey are in:
Rehfisch, M.M., Austin, G.E, Holloway, S.J., Allan, J.R. & O'Connell, M. 2002. An approach to the assessment of change in the numbers of Canada Geese *Branta canadensis* and Greylag Geese *Anser anser* in southern Britain. *Bird Study* 49: 50-59.
The surveys were noticed in *BTO News* number 237.

Available from NBN?
No.

Computer data -- location
BTO Windows network in the WeBS archive area.

Computer data -- outline contents
Definitive data are held in two text files. One for bird counts, one for visits.

Computer data -- description of contents
Count file contains: Tetrad, Day, Month, Year, Species, Number of Adults, Number of Juveniles, Numbers of Birds not aged, Total (Complete) and of each species.
Visit file contains: Tetrad, Number of Visits.

Information held in BTO Archives
1400 data forms are stored among the Wetland Bird Survey boxes.

Notes on Access and Use

Other information needed

Notes on Survey Design
The survey design was based on the Canada Goose distribution recorded in the 1988-1991 Breeding Atlas, as this was considered the priority species. However, a division between northern and southern areas was defined to take account both of the northern limit of re-established Greylag Geese and the core area of Canada Geese. Simulations were undertaken to assess the suitability of the stratification for both species given the survey coverage actually achieved.
A broadly similar approach to habitat stratification was used for both the 1999 pilot and the 2000 main survey. The Centre for Ecology and Hydrology (CEH) remotely sensed 'Land Cover Map of Great Britain' data and the CEH Landclass stratification, summarized in units of 1 km^2, made it possible to divide Britain into habitat categories or strata. Exploratory

analyses showed that two of the 25 land cover classes were particularly important in determining the numbers of Canada Geese: 'proportion of water cover' and 'proportion of urbanization', and a division into 'lowland' and 'upland' helped minimize within-stratum variance. With the exception of the highest water cover strata (because of their relative rarity) the remaining strata were further subdivided into northern and southern regions. Estimates of numbers of Canada Geese were based on all data but for re-established Greylag Geese only to the south of the north/south divide.

Classification of the degree of urbanization and degree of water cover was based on the April 1997 update of the 'Land cover' dataset. The two most important categories used were:

Category 21 – 'Industrial, urban and any other developments, lacking permanent vegetation' used to derive three levels of urbanization for the survey tetrad: 'highly urbanized' -- at least 5% urban cover, 'urbanized' -- some but less than 5% urban cover, and 'rural' -- no urban cover;

Category 2 – 'Inland fresh waters and estuarine waters above the first bridging point or barrier' used to derive three levels of water cover: 'Much water cover' -- at least 5% water cover, 'some water cover' -- some but less than 5% water cover, and 'no water cover' -- no water.

The CEH Landclass stratification classifies each 1-km square into one of 32 types. These were used to derive two classes 'primarily upland' and 'primarily lowland'. A tetrad was considered to be 'upland' if over 25% of it (two to four 1-km^2 units) was classified as upland landclass type, otherwise it was 'lowland'.

To optimize counter effort, less sampling was done where few Canada Geese and re-established Greylag Geese were expected and where there were few counters. Consequently, Britain was subdivided into 'northern' (100-km grid squares from NR, NS and NT north of the Firth of Forth) and 'southern' (north to NX, NT south of the Firth of Forth and NU) subsamples for all but the three 'high water lowland' strata. The southern subdivisions were sampled more than the northern subdivisions. The then published distribution of Canada Geese to the north of this line was patchy (amnd more so further north), and that of Greylag Geese was substantially influenced by native northwest Scotland and late-departing Icelandic breeding birds. Small numbers of re-established Greylag Geese may be present in the 'north', but it was considered that the cost of losing these from the totals would be far outweighed by the risk of an inflated estimate due to flocks of late-departing Icelandic birds being included.

The three urbanization, three of water cover, two land characteristic and two geographic classifications led to 36 categories. This number was reduced to 13 following cross-tabulating classifications and combining those with similar numbers.

The sample size required to detect a 10% population change with 95% confidence was estimated using the Canada Goose numbers recorded the 1988-1991 Breeding Atlas. An implicit assumption was that the frequency distribution of change was similar to the frequency distribution of Canada Geese in that period. This was probably biased, as density-dependent factors were likely to start operating on areas with the highest goose densities, but in the absence of better information this was the only available approach. By allocating tetrads optimally to minimize the variance within the 13 strata, it was estimated that surveying 1500 tetrads from the 61509 in Great Britain, a 10% increase in Canada

Goose population size could be detected with 95% certainty. Assuming a drop-out rate of 25%, a stratified random sample of 2007 tetrads was chosen.
In the 1999 pilot the optimal allocation of tetrads had to be modified slightly, as the required number of tetrads was not always available in each stratum. For example, optimally, 52% of the survey sample (130 tetrads) should have been in 'highly urbanized lowland with much water cover', but only 61 were available for resampling. The intensive selection of this stratum was due to the high goose density and variance in this habitat. The adapted optimal allocation of tetrads led to a randomized stratified sample of 246, of the 24156 tetrads covered in 1988-1991. These 246 tetrads were from the five habitat strata that had held the highest densities of Canada Geese (and re-established Greylags) during 1988-1991: 'upland with much water cover', 'highly urbanized lowland with much water cover', 'urbanized lowland with much water cover', 'rural lowland with much water cover' and 'lowland with some water cover'. Due to Canada Geese being found at low average densities and on a small percentage of the three unsampled strata it would have required a considerable increase in sampling effort to sample all of these strata.

Specific Issues for Analysis

The population estimates for 1988-1991 obtained using data for the complete survey and the equivalent population estimates based on the 1329 tetrad samples agreed closely; and for all strata, and both species, the estimate obtained from the full data set was within the 95% confidence limits generated by the simulated 1329 tetrad survey, suggesting that the population estimates derived from the data gathered from the 1329 tetrads counted in 2000 are likely to be reliable for both species.
Of the 2007 tetrads assigned for coverage, 1329 tetrads of the target 1500 were covered during the first visit and 1035 during the second visit. The effect of this smaller-than-expected sample on the likely accuracy of the new population estimates was tested using 1988-1991 data. 1988-1991 data were available for 873 of the 1329 tetrads covered by the 2000 Goose Survey, but they had a smaller proportion of tetrads in Scotland and Wales, where counts were on average lower, than the 1329 tetrads, so direct extrapolation would not be representative. So a bootstrap approach was used.