

NGF/8/99

National Goose Forum

Monitoring Requirements for Goose Populations in Scotland to Underpin the Developing National Strategy

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Purpose of Paper

The purpose of this paper is to outline the current goose monitoring undertaken in UK, and to identify gaps where further work is needed so as to underpin any future policy on managing wintering and native goose populations in Scotland.

Background

It is likely that any policy developed by the National Goose Forum and put to Ministers will require an ongoing monitoring programme designed to support its implementation. There are likely to be two aspects to this monitoring:

1. What might loosely be defined as **compliance monitoring**, which serves to assess whether measures that are being applied as part of any national strategy (such as payments under a management scheme) are being used in an appropriate manner, and that obligations placed on 'entrants' to any management scheme are being undertaken. Hence, the purpose of compliance monitoring is simply to confirm that any obligations or requirements of any management scheme are being adhered to. This might, for example, require checks on timing of fertiliser application on refuge areas, or reseedling of areas included within refuge areas. This paper will not deal any further with compliance monitoring, as this can only be determined once the policy framework is in place. Monitoring obligations are likely to fall on the competent authority running or managing the scheme.
2. The second type of monitoring relates to the provision of information on species populations, information that can be used to inform further development of policy, and the success of existing management measures. This is simply termed **population monitoring**. Clearly, information on the size and distribution of species populations is likely to be fundamental to any monitoring scheme, but a range of other information may need to be collected. It is this type of monitoring that is explored further in this paper.

What is monitoring?

As a place to start, it is perhaps easier to define what activities are not monitoring, rather than define monitoring itself. The gathering of basic survey data is not monitoring, although survey data may be used to develop a longer term monitoring programme. Furthermore collection of data for research is also not monitoring, though monitoring data may be used as part of research programmes (as has occurred with the Population Viability Analyses undertaken by WWT and IZ for SNH and the Scottish Office). Monitoring programmes are characterised by the systematic collection of data over an agreed geographical area using consistent methodology, and at periodic (and usually regular) intervals. Monitoring data may either sample the population or exceptionally, if the population is small enough, or restricted in its distribution, cover the whole population (an example of the latter being the Scottish wintering population of bean geese *Anser fabalis* or the Svalbard population of barnacle geese *Branta leucopsis*). However, given the dispersed nature of the populations of most wintering species of goose, such as the Greenland population of barnacle geese (*Branta leucopsis*), annual surveys may only sample the population, though for species populations like the Greenland population of barnacle geese where the majority individuals winter on Islay, annual counts do sample the majority of the population every year.

It is usual, when collecting data on population counts, to gather additional information on other demographic parameters, and for geese these generally include age structure (juveniles and adults are usually the only age classes that can be reliably distinguished in the field), as well as flock size, location, and habitat features. In populations that have a significant proportion of marked individuals (leg rings or neck collars), data may also be gathered on individual identity and any association with other individuals (i.e. birds still in family parties). Such data is of enormous value to both research and monitoring programmes in that it allows reliable estimates of dispersal (emigration and immigration into and out of different subpopulations) as well as annual survival, breeding performance (and how this varies with age) as well as habitat selection. Much of this data is of considerable research value, but its importance in monitoring programmes should not be underestimated.

Legal Obligations

The UK has a number of national and international obligations with respect to the conservation of goose (and swan) populations as a consequence of the terms of the **Ramsar Convention**, the **EC Directive on Wild Birds**, and under the **African Eurasian Waterbird Agreement** arising from the Bonn Convention. Nationally, requirements to monitor sites designated under the Wildlife and Countryside Act, 1981 may be implied, and are currently being discussed as part of the agencies **Common Standards Programme**.

As a result of these obligations much monitoring is already being undertaken, and it is likely that such monitoring will provide much of the information sought by Government for monitoring any policy developed by the Scottish National Goose Forum and agreed by Ministers. The arrangements for collecting most of this data are covered by an agreement between the Joint Nature Conservation Committee (JNCC) and Wildfowl and Wetlands Trust (WWT), under a formal partnership agreement. No other partner is involved in this contract and it may be worth considering whether any other party such as the Scottish Office wish, to become a formal party to the agreement. A component of this is dedicated wholly to the gathering of data on geese and swans. Although the outline of this contract has already been given in a previous National Goose Forum paper, the broad provisions within this contract will be repeated here under monitoring discussion for each species population. The purpose of this is to establish what monitoring that may be required is already in place, and what additional monitoring may be required over and above that already in place. Other monitoring work is carried out by a number of voluntary groups (such as the Greenland White-fronted Goose Study Group), or through national wildfowl monitoring schemes such as WEBS (Wetland Bird Survey) - a partnership between JNCC, BTO, WWT and RSPB.

What Needs Monitoring?

This can be divided into two separate considerations:

1. Which species populations need monitoring, and
2. What demographic parameters need monitoring?

The answer to the first question is simple, and relates to those species that regularly breed and winter in Scotland, and those that only spend the winter here, i.e. the migratory species. For avoidance of doubt these nine species populations are as follows:

- Icelandic/Greenlandic population of pink footed geese (*Anser brachyrhynchus*)
- Icelandic population of greylag geese (*Anser anser*)
- Feral population of greylag geese (*Anser anser*)
- Native population of greylag geese (*Anser anser*)
- Tundra bean geese (*Anser fabalis fabalis*)
- Greenland population of barnacle geese (*Branta leucopsis*)
- Svalbard population of barnacle geese (*Branta leucopsis*)
- Greenland white-fronted geese (*Anser albifrons flavirostris*)
- Canada geese (*Branta canadensis* possibly two sub-species *B.c. maxima* and *B.c. canadensis*)

The second question is less easy to answer, but monitoring for one of the above species populations may include some or all of the following:

i) Total or sample population size. If the latter, then the total population needs to be counted at less frequent but regular intervals or, the sample population counts should be capable of being extrapolated to total population size (within certain confidence limits).

ii) Age structure. In most cases this will be proportion of juveniles only as opposed to adults (which will include pre-breeding birds, non-breeding birds and adult breeders). Associated with this is the need to record family party size for successful breeders. Such data is generally strongly correlated with the proportion of juveniles in the flock, but can be useful in interpretation of simple juvenile: adult ratios, as a related figure, the proportion of adults of breeding age returning with offspring is a valuable piece of information in it's own right.

iii) Location. Many species populations are aggregated into subpopulations which may have relatively little interchange with other subpopulations. This type of population structure is sometimes referred to as a metapopulation. Individual subpopulations may exhibit dynamics different from other subpopulations, so it is important that count units and subpopulations are defined as part of any overall monitoring scheme for a species population. There should be a general presumption in favour of retaining as much information in data sets rather than aggregating count units or subpopulations.

iv) Habitat. Records of habitats used by feeding and possibly roosting flocks may be invaluable in looking at differential use of particular habitats over time. Such information generally needs to be collected at a relatively fine scale resolution and may not be appropriate or possible for each species population. For some species roost counts do not give rise to information on feeding habitat use (e.g. most grey geese).

v) Sightings of marked birds. Such information provides estimates of age dependent survival rates, and how these vary with location and over time. Sightings also provide good data on emigration and immigration rates between individual subpopulations. This may be particularly valuable if, for instance management regimes vary across Scotland and as a result differential emigration/migration is expected. This information would certainly be required if, for example, it was the deliberate intention of any management strategy to encourage dispersal of some geese away from existing concentrations into areas of lower density or areas of former occurrence.

vi) Annual mortality data. For species subject to hunting the majority of winter mortality results from hunting and licensed shooting, so it is important that some statistically reliable estimate of total bag should be recorded. At present this is not done. How this might be achieved is outwith the scope of this paper but it might be on a sample basis, but a bag return basis from all hunters is by far the best option.

Full bag return data is likely to be more difficult to obtain under current UK hunting law, but such data is likely to be much more accurate, assuming actual bag returns are accurate. Any sample strategy will have an associated error, and would have to be appropriately stratified according to type of wildfowler. For species subject to licensed shooting only, license returns would be needed, though this data is already gathered by SOAEFD in Scotland (as the competent authority for such licensing).

Species Accounts

1 Icelandic/Greenlandic population of pink footed geese

9.1 Population size. This population is counted at the main wintering roost sites in autumn, when it tends to be aggregated into relatively few wintering sites across UK (mainly in Scotland). Counts are undertaken on fixed days in October and November. For the purpose of assessing population size, the October count is considered the more reliable. As winter progresses the populations disperses over a wider area of the UK, and it becomes increasingly difficult to census the whole population. A series of mid-winter and spring counts undertaken by WM- on contract to SNH showed that only an average figure of 68% of the autumn peak count were counted in mid-winter and that this figure dropped to 43% in spring (Mitchell *et al* 1996). The survey work also showed that distribution changed markedly throughout winter, and that this was heavily influenced by winter weather conditions. It is essential that autumn roost counts continue, and that sufficient support is given (currently via the MCC, contract to WWT) to maintain a reliable network of count sites and counters, who are largely enthusiastic volunteers. The lack of spring counts other than WEBS means that distribution in Scotland at this time of year is not fully known.

9.2 Age Structure. Early in the autumn/winter period, a number of geese are aged, although only juvenile geese can be recognised with any confidence. For example in 1997 some 15,000 pink footed geese were aged (out of a total autumn count of 235,000). This is sufficient to assess the overall breeding productivity (after migration mortality has occurred) before winter shooting in UK has had a major impact on the population. The geographical distribution of age counts is unknown, and it is recommended that SNH, MCC and WWT investigate this further to determine whether there is any evidence of bias towards particular areas, and hence possible bias in the estimate of breeding success/proportion of juveniles in the population.

9.3 Location. Counts are undertaken at about 133 sites in UK, and the principal roost sites are listed in the annual report. As explained above, the population then tends to disperse over a wider area and the proportion within these principal sites declines with time. Given the changes that may occur with weather it is difficult to know exactly which areas will hold large concentrations

as winter progresses, and this 'flexibility' by the geese may make adapting management schemes to all but the largest and most predictable concentrations difficult.

- 9.4 Habitat use. Few data are collected as the majority of counts are at night-time roosts. Some site specific data are collected, generally on a short term basis. It is thus currently difficult to track national trends in habitat use by wintering pink footed geese.
- 9.5 Sightings of marked birds. Very few pink footed geese are ringed at present in Iceland or UK, and there are no extant colour ringing projects that the author is aware of. Given the large size of the population and the mobility of pink footed geese in UK, very large numbers would have to be marked to obtain useful data on autumn - spring dispersal and movements. The lack of marked birds means that estimates of survival are based on inter-annual changes in population sizes (i.e. 'crude' survival rates).
- 9.6 Annual UK mortality. It is likely that the principal source of mortality in winter is from hunting. At present we have no reliable estimate of this mortality though Reynolds and Harradine (1996) estimated the UK annual pink footed goose mortality to be about 25,000. The reliability of this estimate is questionable given the low return rate for the questionnaire based survey that they (BASC) undertook.

2 Icelandic population of greylag geese

- 9.1 Population size. This population is counted at the main wintering roost sites in autumn, when it tends to be aggregated into relatively few wintering sites across UK (mainly in Scotland). Counts are undertaken on fixed days in October and November. For the purpose of assessing population size, the November count is considered the more reliable. As winter progresses the populations disperses over a wider area of the UK, and it becomes increasingly difficult to census the whole population. A series of mid-winter and spring counts undertaken by WWT on contract to SNH showed that only an average figure of 54% of the autumn peak count were counted in mid-winter and that this figure dropped to 43% in spring (Mitchell *et al* 1996). The survey work also showed that distribution changed markedly throughout winter, and that this was heavily influenced by winter weather conditions. It is essential that autumn counts continue, and that sufficient support is given (currently via the MCC contract to WWT) to maintain a reliable network of count sites and counters, who are largely enthusiastic volunteers. There is some concern that the estimate of the greylag population is less precise than that for pink footed geese, and it is recommended that this matter be investigated further by SNH, MCC and WWT. Changes in distribution and use of different areas, could

under some circumstances lead to misleading estimates of the inter-annual change in population size, especially over long periods. The lack of spring counts other than WEBS means that distribution in Scotland at this time of year is not fully known.

- 9.2 Age Structure. Early in the autumn/winter period, a number of geese are aged, although only juvenile geese can be recognised with any confidence. For example in 1997 some 5,000 greylag geese were aged (out of a total autumn count of 80,000). This is sufficient to assess the overall breeding productivity (after migration mortality has occurred) before winter shooting in UK has had a major impact on the population. The geographical distribution of age counts is unknown, and it is recommended that SNK MCC and WM investigate this further to determine whether there is any evidence of bias towards particular areas, and hence possible bias in the estimate of breeding success/proportion of juveniles in the population.
- 9.3 Location. Counts are undertaken at about 133 sites in UK, and the principal roost sites are listed in the annual report. As explained above, the population then tends to disperse over a wider area and the proportion within these principal sites declines with time. Given the changes that may occur with weather it is difficult to know exactly which areas will hold large concentrations as winter progresses, and this 'flexibility' by the geese may make adapting management schemes to all but the largest and most predictable concentrations difficult.
- 9.4 Habitat use. Few data are collected as most counts are at roosts. Some site specific data are collected, generally on a short term basis. It is thus currently difficult to track national trends in habitat use by wintering greylag geese.
- 9.5 Sightings of marked birds. Very greylag are ringed at present in Iceland or UK, and there are no extant colour ringing projects that the author is aware of. Given the size of the population and the mobility of greylag geese in UK, very large numbers would have to be marked to obtain useful data on autumn - spring dispersal and movements. The lack of marked birds means that estimates of survival are based on inter-annual changes in population sizes (i.e. 'crude' survival rates).
- 9.6 Annual UK mortality. It is likely that the principal source of mortality in winter is from hunting. At present we have no reliable estimate of this mortality though Reynolds and Harradine (1996) estimated the UK annual greylag goose mortality to be about 17,500. This is in addition to the estimated 36,000 shot in Iceland before autumn migration (i.e. before the autumn count). The reliability of this estimate is questionable given the low return rate for the questionnaire based survey that they (BASC) undertook.

3. Federal/naturalised greylag population

- 9.1 Population size. Given that this population mixes in with the wintering Icelandic population to a very limited extent, a separate estimate for winter is probably difficult to arrive at. However, Delaney (1991) estimated the UK breeding population as being about 22,000. Large numbers breed throughout England, and given their sedentary nature probably winter in much the same area. The biggest concentration in Scotland is in the south-west away from the main concentrations of Icelandic greylag geese. Feral/naturalised greylag geese are likely to be surveyed again in 1999/2000 (i.e. this year, as part of WeBS).
- 9.2 Age Structure. Some locally derived data may be collected annual but there is no systematic monitoring of this population.
- 9.3 Location. The survey referred to above gives a good idea of location during breeding season. Winter distribution is poorly known.
- 9.4 Habitat use. No systematic data collection.
- 9.5 Sightings of marked birds. Some ringing does take place on a local scale, but not 'nationally'. There is no urgency for such work so far as the National Goose Forum is concerned.
- 9.6 Annual mortality. Not known, though data could be collected as part of any recording scheme for bag sizes by wildfowlers.

4 Native greylag goose population

- 9.1 Population size. A regular annual census of native greylag geese is carried in the Uists, Tiree and Coil. Numbers elsewhere are not monitored regularly, although there is provision for a full survey every 10 years (the next is due in 2005/16). The most recent count from 1994/95 estimated a total population size of about 9000 birds. The small numbers of summering birds in Sutherland and Caithness have been surveyed in recent years (since 1994), but it is not clear if this has continued as an annual event. Numbers in Harris & Lewis and elsewhere are small (-100-200) and it is not known if there is any regular counting at these sites.
- 9.2 Age structure. Counts of productivity are obtained on Uist (i.e. numbers of juveniles) and recently, from Tiree and Coil. No data is available from other locations.
- 9.3 Location. The counts undertaken in the main summering and wintering locations suggest that most birds are relatively site faithful, although the Caithness & Sutherland birds appear to have distinctive wintering areas.

Movements of native greylag geese are still poorly understood, although recent work undertaken or funded by SN1H is designed to improve our understanding of movements between the different island populations. Intensive work in the late 1980s on Uist has also been undertaken.

- 9.4 Habitat use. Good data on habitat use has been collected on Uist and current monitoring work continues to gather appropriate data. Improved counts on Coil and Tiree also give data on habitat use, as does some of the work in Caithness and Sutherland.
- 9.5 Sightings of marked birds. Data from ringing projects undertaken on the Uists, Loch Loyal (Sutherland) and more recently on Coil and Tiree, has led to an increased understanding of movement patterns.
- 9.6 Annual mortality. There has been insufficient ringing for the collection of annual survival data, and most data are calculated from annual changes in adult and juvenile numbers. Some direct estimates of annual hunting mortality is available from Uist and recently, Tiree and Coil.

5 Tundra bean geese

- 9.1 Population size. The only population present in Scotland is a small flock centre on the Slammanan area in central Scotland. This is counted with a high degree of accuracy every year and currently approximates to about 150 birds. Counts are coordinated by a group of volunteers, and given the current population size and area of occupation, this arrangement will continue for the foreseeable future.
- 9.2 Age Structure. Birds can be aged with difficulty. However, the small sample size means that this is unlikely to be a reliable estimate, given that the origin of these wintering birds (within the known breeding range) is unknown.
- 9.3 Location. Detailed information is gathered by volunteers. The main fields used by bean geese in Scotland are already well-known, but any changes should be picked up by normal monitoring by the Bean Goose Study Group. All monitoring is undertaken voluntarily and is not covered by the MCC contract with WWT.
- 9.4 Habitat Use. See above.
- 9.5 Sightings of marked birds. At present the population is not marked and there are no plans to do so, nor is there any urgent requirement for this.
- 9.6 Annual mortality. As sample sizes (i.e. population size) is small, there are no reliable estimates of mortality. However, crude survival estimates could be

obtained from juvenile/adult numbers. This implies a 'closed' population which may or may not be true.

6 Barnacle Geese (*Branta leucopsis*) : Svalbard population

- 9.1 Population size. The Svalbard population of barnacle geese is regularly counted each year by coordinated counts on the Solway. The quality of count data is good, although there are some concerns that as the population expands the count accuracy may decline. There is a crucial problem with a potential for double counting when large flocks move from one location to another. This means that counting over more than one day is potentially mis-leading and exaggerated counts can result. A further concern is that an increasing number of Svalbard barnacle geese may be wintering away from the Solway. At present it is probable that numbers are small, but consistently small flocks of barnacle geese are found at various locations along the east coast throughout winter. In contrast with the situation some 10-20 years ago, the full number of birds do not now arrive on the Solway until late winter, meaning that population counts have to take place in late winter rather than late autumn. A further complication is that more birds are wintering on the English side of the Solway (especially on Rockcliffe Marshes).
- 9.2 Age Structure. Detailed information on this population is gathered by WWT as part of the long term population study that they have been engaged in over many years. This is one of the most intensive and valuable long term monitoring studies of a relatively long lived bird in the UK, and it is highly desirable that the data gathering continues.
- 9.3 Location. At present, good data is gathered on the use of different locations by this population. The need for such data under the Solway Barnacle Goose Management Scheme, and the work of WWT ensures that the level of data collection is sufficient. In the long term as the population expands (which it is currently doing) areas outwith those normally counted may be increasingly used. Counting such areas around the Solway (especially on the English side of the Firth) and at other (mainly east coast) locations will become increasingly important as the population expands.
- 9.4 Habitat Use. Use of agricultural land is largely understood, as well as use of the semi-natural merse habitat. As the population expands it will be important to ensure that adequate data is gathered on use of different habitats.
- 9.5 Sightings of marked birds. The population is one of the most well marked goose populations in the UK. Ongoing research work and new work on Svalbard and at Caerlaverock will mean that the proportion of the population marked may well increase (the percentage has been declining recently as fewer new birds are marked to replace those dying). At one time as many as

25% of the population were thought to be marked but the proportion is much lower now.

- 9.6 Annual adult mortality. With a high proportion of marked birds annual survival rates are easily calculated. There is though a need to ensure that new birds are marked both on the wintering grounds as well as the breeding grounds to ensure an unbiased sample. Survival rates are thought to be age dependent, so that as sample sizes decrease annual estimators of adult survival become increasingly imprecise, hence the need for a steady addition of new marked birds into the population.

7 Barnacle Geese (*Branta leucopsis*): Greenland population.

- 9.1 The Greenland population of barnacle geese is only counted regularly at some of its main wintering areas. This includes Islay as well as Tiree, Coil and Orkney. A small but significant part of the population winters on offshore islands along the western and northern coasts of Scotland, and cannot be counted on a regular basis. The only effective means of counting these areas is by aerial survey in late winter or early spring. JNCC contract WWT to undertake such counts on a five-yearly basis (with the last published count undertaken in 1993), coinciding with a count for all Ireland coordinated by the National Parks and Wildlife Service. A count should have been undertaken in March 1999 - details of the success of this have yet to be passed onto SNH. In the light of possible changes to management of this population, the need for more frequent counts needs to be considered. A consequence of a more interventionist management regime on Islay might be that barnacle geese may increase their use of alternative areas, such as the offshore islands along the northern and western coastline of Scotland.
- 9.2 Age Structure. The age structure of samples of the Islay barnacle goose population are determined each year. Elsewhere either data is not gathered or it is very limited. Gathering of the Islay data is largely dependent on one person, and this is not done under any form of contract to SNH. Obtaining the proportion of juveniles in the population is essential to understanding population demography, and the National Goose Forum may consider it necessary to ensure that this data is gathered both systematically and on a long term sustainable basis in the future. While counts elsewhere are undertaken on a periodic basis by aerial survey, age ratios are not possible, but it should be possible to obtain data from places such as Tiree, Coil and Orkney.
- 9.3 Location. The main means of determining wintering location is via the aerial survey. The importance of this survey is listed above and possible for an increase in the frequency of counts. A small proportion of the population

winters in Ireland (similar in size to that on sites in Scotland outwith Islay). The counts in Ireland are coordinated with the aerial counts in Scotland.

- 9.4 Habitat Use. Reliable data is gathered during the annual monitoring of Islay, and other locations in Scotland. The aerial survey data, given its infrequent nature and low replication is by inference, less reliable. Most barnacle geese use intensive agricultural land, particularly fertilised pasture dominated by agricultural grass cultivars. Use of islands and areas with a predominance of semi-natural vegetation has decreased as areas such as Islay, Tiree and Orkney have increased farming through greater reseeding and fertilisation of pasture.
- 9.5 Sightings of Marked Birds. Large numbers were marked on Islay during several periods of intensive study, especially those of Percival when based at Glasgow University. Since then there have been fewer birds marked but some are caught each winter, and regular sightings of ringed birds are recorded. Marking of birds elsewhere is unknown. The ringed birds are largely resighted on Islay but records originate from other Scottish islands as well as a few sightings from Ireland. It is clear that the Islay population is not closed, though in practice relatively few birds disperse from Islay and birds seem to be highly site faithful from one winter to the next

8 Greenland white-fronted geese (*Anser albifrons flavirostris*)

- 9.1 Population Size. Regular counts are undertaken in all wintering areas, including those in Ireland and Scotland where the bulk of this species population winters. A number of co-ordinated counts are undertaken each winter in Ireland, Wales, and Scotland ('international count days') during autumn and spring where an estimate of the total population is arrived at (barnacle geese are also counted on these days). Some areas such as Islay are intensively counted as part of the Islay goose Management Scheme. Other areas such as Coil, Tiree, Kintyre are also covered, and a number of sites covered by WeBS (Wetland Bird Survey) also contribute data to the population counts. Data quality is good, though is dependent to a large extent on a network of volunteers including members of the Greenland White-fronted Goose Study Group.
- 9.2 Age Structure. Counts of juveniles (and hence productivity) are also assessed in spring and later in the year(?) Data is gathered from a range of sites in Scotland and includes brood sizes as well as the ratio of adult birds to juveniles in different flocks. Data is generally absent for many of the smaller flocks, though data from the predominant area in Scotland (Islay) is excellent with often 50% of the birds aged. Good data is also available from Ireland.

- 9.3 Location. The large network of volunteer observers strongly suggests that few locations remain uncounted, and it is unlikely that any significant aggregations are missed. While changes in the use of certain areas is known (with some flocks appearing and others disappearing, it is believed that the count network adequately covers the current range of this species population. Some concern has been expressed about poor coverage in parts of Scotland, but these are areas holding small numbers of birds and the overall significance of these missed birds (if any) is not likely to be great.
- 9.4 Habitat. Given the wide network of counters, habitat use is well known. Use of 'traditional' habitats such as bogland has declined considerably and no flocks are now believed to use this habitat exclusively anymore. A notable switch has occurred across the range onto agricultural crops in the autumn and winter period, with a move onto grass in spring. Thus the autumn and spring counts will reflect this varying use of different agricultural habitats. Bogland may still be important for some flocks especially at night when roosting (when some feeding also occurs).
- 9.5 Sightings of marked birds. A certain amount of ringing has taken place on Islay, in Ireland (mainly on the Wexford Slob) and in Greenland. Periodic expeditions to Greenland by the Greenland White-fronted Geese Study Group increase the number of marked birds in the population. It is important that numbers of marked birds are maintained in the population, especially if the population is to be actively managed.
- 9.6 Annual mortality. The data on individually marked birds can be used to derive annual mortality data for Greenland white-fronted geese, as well as crude survival rates from the juvenile/adult ratio in different flocks. However, at present, the data have only been sufficient for crude survival estimates, as the re-sighting data is not sufficient for age-specific mortality rates. This situation may need to be addressed, if further population modelling under management is required.

9 Canada Geese (*Branta canadensis*)

- 9.1 Population. Canada geese are introduced, and generally associated with anthropogenic habitats, especially urban parks, designed landscapes and other artificial waterbodies. Most Canada geese are counted on the monthly WeBS counts (and most occur in England). At present it is thought that about 60-70% of the population are covered by WeBS and this is thought sufficient to monitor population trends. JNCC contract WWT to produce a report on introduced and feral geese every 5 years (with the next survey/report due in 1999/2000). This will use the network of WeBS counters and will also cover other naturalised/feral species.

- 9.2 Age structure. Little systematic data is gathered, but some local studies (most unpublished) have gathered such data.
- 9.3 Location. This is largely gathered from Atlas surveys (of breeding birds) and WeBS counts. Some significant sites may be missed.
- 9.4 Habitat Use. See above.
- 9.5 Sightings of marked birds. Again some localised studies have been undertaken, but nothing systematic has been published. Of some interest is the moult migration of immatures, non-breeders and failed breeders from English Midlands and Yorkshire to the Beaulieu Firth. Why this pattern has been established is unknown, especially as these birds have a 16% lower survival than birds remaining in their natal area.
- 9.6 Annual adult mortality. No data on adult survival has been obtained but ringing returns are thought to be adequate if such an analysis was needed (but very low priority).

Alert Limits

Monitoring by itself often produces copious amounts of data but the interpretation of this data is a different matter. Population parameters rarely remain static and as a consequence populations will always show changes in numbers (or whichever parameter is being measured) from year to year. Even a 'stable' population will fluctuate from year to year around an unchanging mean value.

It is therefore essential that some process is developed that can interpret observed changes in population parameters, so that 'significant' changes are highlighted at an appropriate stage (generally when we are confident that significant change is occurring but before that change is theoretically irreversible). The statutory conservation agencies, in conjunction with BTO are currently developing a methodology of **alert limits** for a range of bird species, that highlight significant changes from one year to the next. Such alert limits are being developed for several monitoring schemes currently underway (such as the Breeding Bird Survey and the Wetland Bird Survey).

Alert limits may relate to the magnitude (and direction) of change (e.g. how fast a population is declining), or they may also relate to the comparison of actual parameter values (e.g. population size) when set against some pre-determined threshold levels (often known as **limits of acceptable change - LACs**). An example of these LACs might be a situation where it is decided that one goal of population management is not to let the population fall below 25,000 or exceed 40,000. The former value is the **lower limit of acceptable change**; the upper

value is **upper limit of acceptable change**. The disadvantage of reliance on limits of acceptable change is that they take no account of how fast (or slow) a population is declining or increasing: change is often difficult to reverse and a population declining rapidly may continue to do so for some time after a lower limit of acceptable change is triggered, simply because the intrinsic processes operating cannot be 'switched' on or off with immediate effect.

It may well be, that as part of the overall goose management strategy some work will need to be developed which set alert limits for the various goose populations which will serve to inform and act as a modifier of the various management options that government eventually adopt for Scotland's wintering goose populations. In an earlier paper the concept of **Adaptive Resource Management** was referred to: monitoring goose populations is an essential component of that process, such that any management strategy can only be evaluated in the light of the effect on population demographic parameters.

Conclusions

1. Overall it is suggested that Scotland's goose populations are currently well monitored, especially in relation to the determination of winter population size. Current monitoring arrangements which rely on a combination of approaches, appear to be sufficient for the detection of long term population trends in most if not all species populations.
2. Given this there are some concerns, listed below:
 - Grey goose counts are undertaken in autumn. Later in the year (especially during spring) counts do not 'find' the majority of the wintering population, and the distribution and habitat use are less well known than in the autumn. It may be necessary to remedy this situation, though how is unclear at present. The possible change in roost usage by greylag geese, even in autumn remains a possibility and the concern is that such long term change may make adequate population monitoring increasingly difficult.
 - Wintering grey goose mortality is poorly understood in the UK as most grey geese mortality is likely to come from shooting, and there are currently no reliable data on goose bags in UK. This is a serious omission.
 - The geographical distribution of aged counts in grey geese is a matter that needs looking at, principally so as to confirm or refute the view that measured values of productivity and age structure reflect the 'true' picture.
 - There may be some merit in increasing the number of grey geese that are marked in the wintering population. Some work is already underway for 'native' greylag geese in an attempt to understand their dispersal and mortality.

- There is a need to ensure that monitoring methods for the Svalbard population of barnacle geese are adequate, especially as the distribution of the population may be changing as the population increases, and the possibility that some birds are wintering elsewhere.
 - The periodicity of counts for Greenland population of barnacle geese is currently 5 years. At present the proportion of the population wintering elsewhere is relatively small, but under revised management this could change. Given this situation the periodicity of these counts may need to be reviewed.
 - Greenland white-fronted geese are well monitored, but there has been some concern that the counts in some parts of the range are not adequate. Further investigation is needed.
 - Feral and non-native geese are adequately monitored.
1. In the final analysis, the structure of a monitoring programme is dependent on the needs of the various organisations participating and/or commissioning the work. For wintering and native geese the actual monitoring requirements will depend heavily on the management measures that Ministers decide to implement.
 2. Any strongly interventionist management regime, will require a relatively high level of monitoring which will include population size but also other population demographic parameters (breeding productivity, mortality, and dispersal being the key parameters).
 3. It is likely that monitoring requirements will need to be reviewed when a policy framework has been agreed, and before implementation of that policy.

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