

**Goose research at the Icelandic Institute of
Natural History, 1995–2001**

**Summary report to the Ministry for the
Environment**

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NÁTTÚRUFRÆÐISTOFNUN ÍSLANDS

ÁGRIP Á ÍSLENSKU

Á árunum 1995-2001 vann Náttúrufræðistofnun Íslands að viðamiklum rannsóknum á stofnvistfræði grágæsar og heiðagæsar. Sérstök áhersla var lögð á að meta veiðiálag og veiðipól stofnanna. Rannsóknir þessar voru unnar að ósk umhverfissráðuneytisins og að miklu leyti kostaðar af veiðikortasjóði. Einn helsti tilgangur rannsókna var að þróa stofnlíkan sem styðjast mætti við í ráðgjöf um verndun gæsastofnanna og stjórnun veiða úr þeim.

Merktar voru um 4500 gæsir á varpstöðvum þeirra hér á landi í samvinnu við Wildfowl & Wetlands Trust og the Highland Ringing Group; 1274 grágæsir og 3245 heiðagæsir. Auk hefðbundinna fuglamerkja voru sett á fuglana einstaklingsbundin litmerki á fót eða háls.

Grágæsir voru taldar árlega á Fljótsdalshéraði snemma vors. Erfitt er að túlka niðurstöður þeirra talninga en veðurfar virðist hafa mikil áhrif á það hversu margir fuglar komu fram hverju sinni. Þá voru grágæsir taldar á þremur völdum svæðum á varptíma. Niðurstöður þeirra talninga voru einnig óljósar; fjöldi varpfugla stóð í stað á einu svæði, fækkaði á öðru og fjölgaði á því þriðja. Samhliða merkingum var safnað upplýsingum um varpárangur gæsa og stærð unghópa.

Veiðistjóraembættið safnar árlega gögnum um veiði úr skýrslum veiðimanna. Að jafnaði eru veiddar hér árlega um 37 þúsund grágæsir og um 13 þúsund heiðagæsir. Veiði á grágæs hefur skv. þessum skýrslum dregist saman síðan 1997. Náttúrufræðistofnun safnar vængjum af veiðibráð sem hægt til þess að meta aldurssamsetningu aflans. Ungar frá sumrinu áður eru um 40% af grágæsaveiðinni en 33% af heiðagæsaveiðinni.

Mat á lífslíkum gæsa byggist á því að lesa af sem flestum litmerktum fuglum. Árlegar lífslíkur fullorðinna heiðagæsa voru talsvert hærri heldur en hjá fullorðnum grágæsum; um 81% líkur eru á því að fullorðin heiðagæs lifi af næsta ár og 73% líkur á því að fullorðin grágæsa lifi árið. Lífslíkur ungfugla á fyrsta ári voru hins vegar minni hjá heiðagæs (39%) en grágæs (47 %).

Einfalt stofnlíkan sem byggt er á framangreindum gögnum bendir eindregið til þess að hlutfall ungfugla í grágæsastofninum sé mun herra en talningar á Bretlandseyjum hafa gefið til kynna. Líkanið sýnir einnig að annað hvort er skráð grágæsaveiði hér ofmetin eða heildarstofninn vanmetinn. Hugsanlega eru báðir þessir þætti rangt metnir. Á þessu stigi er því hvorki hægt að fullyrða hversu stór íslenski grágæsastofninn er, né hvort grágæsum hafi fækkað jafnmikið á undanförunum árum og talningar á Bretlandseyjum benda til. Sambærileg vandamál eru ekki fyrir hendi hvað varðar heiðagæs. Stofnlíkan sýnir að talningar á undanförunum árum gefa raunsanna mynd af ástandi heiðagæsastofnins sem nú er talinn um 230 þúsund fuglar að hausti.

Nauðsynlegt er að afla frekari gagna um ástand og þróun grágæsastofnsins, þ.e. stærð hans og aldurssamsetningu. Náttúrufræðistofnun vinnur að endurskoðun þeirra aðferða sem notaðar hafa verið til að meta þessa stofnþætti í samvinnu við Wildfowl & Wetlands Trust. Lagt er til að hafist verði handa við frekari gagnasöfnun á þessu ári (2002) auk þess sem haldið verði áfram að vakta báða gæsastofnana.

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1 INTRODUCTION

In 1995, the Icelandic Institute of Natural History (IINH) started a research project dealing with the dynamics of hunted goose and duck populations in Iceland. The project has been funded throughout by the Ministry for the Environment (Game Fund). This report presents a brief summary of the research on geese, principally the two common breeding species in Iceland, the greylag goose and the pink-footed goose. The two species have shown contrasting population trends since 1980, and there are now almost three times as many pink-footed geese (230,000) as greylag geese (80,000) counted in autumn in Britain (Hearn 2000). Both species spend the winter primarily in Britain, and the project has been carried out in collaboration with the Wildfowl & Wetlands Trust (WWT) and the Highland Ringing Group. Geese of both species are popular with hunters in both Iceland and Britain; in Iceland, the greylag goose is the most important species. The British autumn counts have shown a 25% decline in the greylag goose population since 1990, and for this reason the species has been red-listed in Iceland (Náttúrufræðistofnun Íslands 2000).

The aim of the project has been to achieve a better understanding of the dynamics of the goose populations, and particularly how they are affected by hunting pressure in Iceland. Population modelling was expected to be an important tool in achieving this goal. In order to set up a population model or indeed to make any kind of evaluation of the effects of hunting, data on the size, composition, fecundity and mortality (hunting and natural) of the two populations were needed, and research activities were initiated with this in mind. Data collected in Britain by WWT were also used in the modelling process.

2 ACTIVITIES

2.1 Ringing

Ringing expeditions took place during the summers of 1996–2000 in collaboration with WWT staff and volunteers from Iceland and Britain. The geese were captured by rounding up flightless birds, either moulting adults or non-fledged goslings. This catching procedure required a large team of fieldworkers. Captured geese were sexed and aged before being ringed with metal and colour rings (darvic neck collar or leg ring). If possible, all geese in a catch were released at once, but when the catch was very large the geese were released in mixed age groups to facilitate family cohesion.

The plan was to ring at least 200–300 geese of each species each year. Capturing the expected number of greylag geese proved difficult in the first year (1996), but once the team had gained experience and adjusted the catching procedures, large numbers of geese were captured in each subsequent year (Table 1). Catches of pink-footed geese were on average much larger than those of greylag geese (mean: 72 vs. 31; maximum: 459 vs. 248).

Table 1. Summary of goose ringing, 1996–2000.

Year	Dates	Greylags colour-ringed			Pinkfeet colour-ringed		
		Adults	Goslings	Total	Adults	Goslings	Total
1996	25 July – 7 August	15	103	118	118	285	403
1997	19 July – 1 August	287	74	361	82	273	355
1998	18 July – 31 July	81	160	241	146	204	350
1999	20 July – 30 July	105	120	225	481	482	963
2000	17 July – 29 July	142	187	329	540	634	1,174
Total		630	644	1,274	1,367	1,878	3,245

In addition to the expeditions, twenty greylag goslings were colour-ringed by one fieldworker in August 1996–1998 in eastern Iceland. Greylag geese were ringed in the northern and eastern parts of the country, mainly in the Hróarstunga/ Hjaltastaðaþinghá area, in Skagafjörður and around Blönduós, and in the Mývatn area (Figure 1). Pink-footed geese were ringed mainly in the northern parts of the highlands (particularly Eyvindarstaðaheiði), in the eastern highlands (around Skjálfandaflljót and Jökulsá á Fjöllum), and at Þjórsárver (Figure 2). The same locations were not visited in each year (Figures 3 & 4).

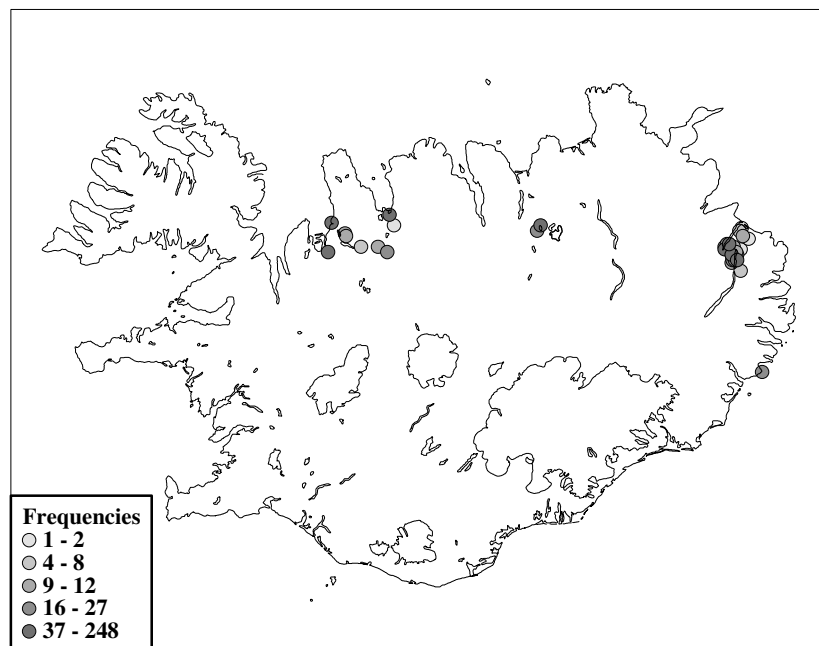


Figure 1. Greylag ringing locations, 1996–2000.

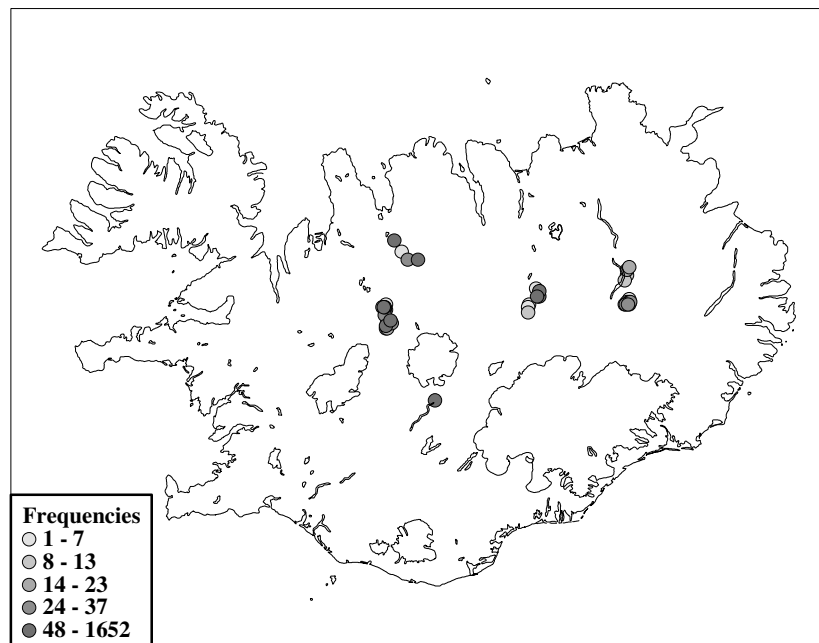


Figure 2. Pinkfoot ringing locations, 1996–2000.

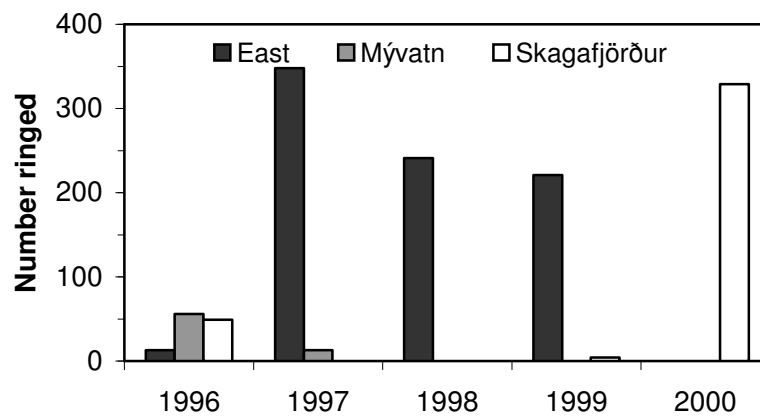


Figure 3. Geographical distribution of greylag ringing.

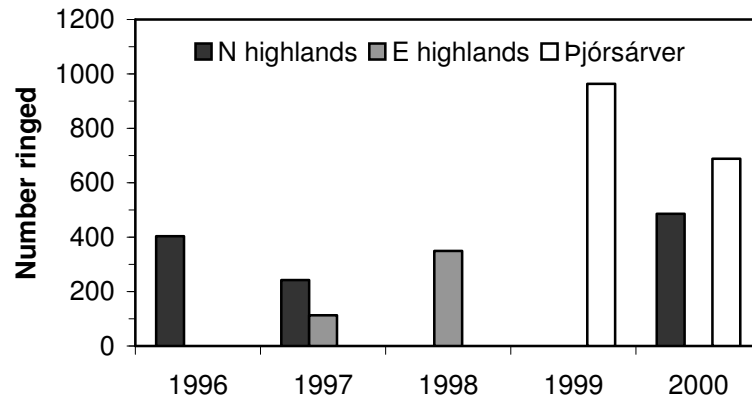


Figure 4. Geographical distribution of pinkfoot ringing.

Both species of geese have also been colour-ringed on their wintering grounds in Britain, pink-footed geese since 1987 and greylag geese since 1992. Large populations of marked individuals have thus been established, and on the basis of the estimated survival of the geese (see below), it is possible to calculate the number of marked geese alive at any given time. At present (summer 2001), geese ringed in Iceland constitute about 45% of the 1,100 marked greylag geese alive and 75% of the 2,050 marked pink-footed geese alive.

In 1999, 52 barnacle geese from the newly established Icelandic breeding population were captured; 48 of these were colour-marked with darvic leg rings. Blood samples were taken for DNA analysis, with the aim of establishing whether the Icelandic breeders belong to the Greenland or the Svalbard population.

All data on ringing and dead recoveries of geese ringed in Iceland are stored in electronic databases at IINH. By July 2001, 196 greylag geese and 192 pink-footed geese had been recovered dead. Almost all live resightings of the colour-ringed geese are made in Britain, and the information on these is stored by WWT (pink-footed goose) and the Highland Ringing Group (greylag goose). By July 2001, 617 greylag geese and 1,359 pink-footed geese had been observed alive on one or more occasions.

2.2 Goose counts

Efforts to count geese in Iceland have until now been somewhat sporadic and unsystematic. No total counts of breeding, moulting or staging greylag geese exist, though local counts have been carried out in some areas. For pink-footed geese, the situation is somewhat better; important breeding areas have been counted in some years (Arnbór Garðarsson 1997, Kristinn Haukur Skarphéðinsson og Skarphéðinn G. Þórisson 2001) and a total count of moulting non-breeders was conducted in 1992 (Kristinn Haukur Skarphéðinsson 1999).

Greylag goose: spring counts. Counts of spring-staging greylag geese have been carried out in two areas: in Fljótsdalshérað by Halldór Walter Stefánsson since 1989 (full scale from 1993, supported by the Game Fund in 1998), and at Mývatn by the Mývatn Research Station since 1974. At Mývatn, the number of staging geese

increased from 100 in around 1980 to approximately 650 in 2001 (see <http://www.hi.is/HI/Stofn/Myvatn/graheivo.htm>). In Fljótsdalshérað, the development has been much less clear, with large fluctuations from year to year (Figure 5). Weather conditions strongly affect the timing of arrival and duration of spring staging, so that counts of this type do not necessarily reflect the actual number of geese using the area.

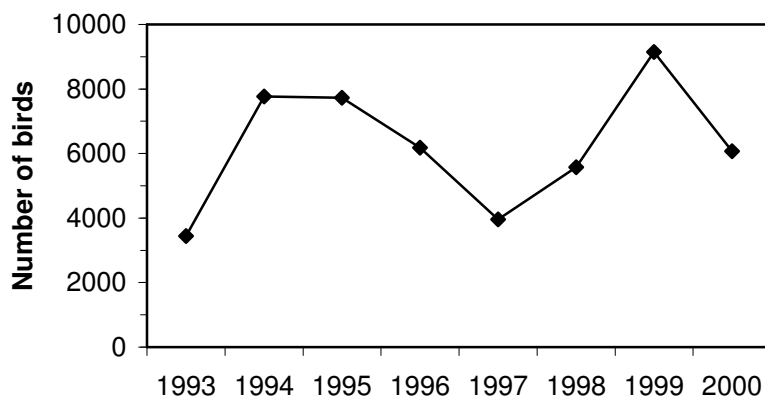


Figure 5. Spring counts of greylag geese in Fljótsdalshérað.

Greylag goose: breeding counts. Breeding greylag geese have been censused in small areas in Úthérað (Halldór Walter Stefánsson), Hvallátur in Breiðafjörður (Þorvaldur Björnsson) and Eyjafjörður (Ævar Petersen og Sverrir Thorstensen 2001). The results are inconclusive (Figure 6); in recent years, the number of breeding greylag geese has increased in Breiðafjörður, decreased in Úthérað and remained stable in Eyjafjörður. Although the geographical coverage is limited, such counts of breeding pairs may serve as a check on trends in whole-population counts at other seasons.

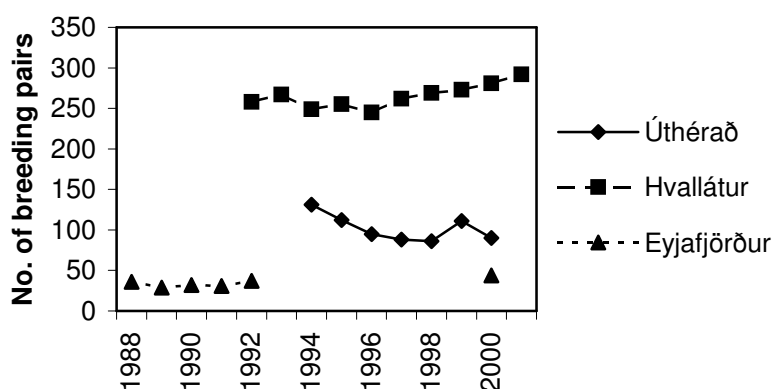


Figure 6. Counts of breeding pairs of greylag geese.

2.3 Breeding productivity

Data on brood sizes of greylag and pink-footed geese have been collected during ringing expeditions in 1996–2000, and further data on greylag goose brood size were collected during August–October 1999–2001, mostly by Halldór Walter Stefánsson. Collecting this information for pink-footed geese is very difficult because of their extreme shyness during the period when adults are unable to fly. Mean brood size at ringing was 3.6 for greylag geese and 3.0 for pink-footed geese, with some annual variation; 2000 was a particularly good year for both species. Except for 1999, the mean brood size recorded for greylag geese in Iceland in autumn (Figure 7) was higher than normally recorded in Britain in October–November (usually between 2.1 and 2.8). Surprisingly, while brood sizes were very high in Iceland in 2000 (3.7–3.8), they were close to average in Britain (2.5; R. Hearn in litt.). Unfortunately, no good data are available from Iceland for the proportion of juveniles in the population in late summer/autumn; such data would allow a comparison with the same type of data collected in Britain later in autumn. The British data are believed to be unreliable, at least for greylag geese, because juveniles are very difficult to distinguish from adults in late autumn, and because of biases in age composition of flocks (habitat, flock size, phenology).

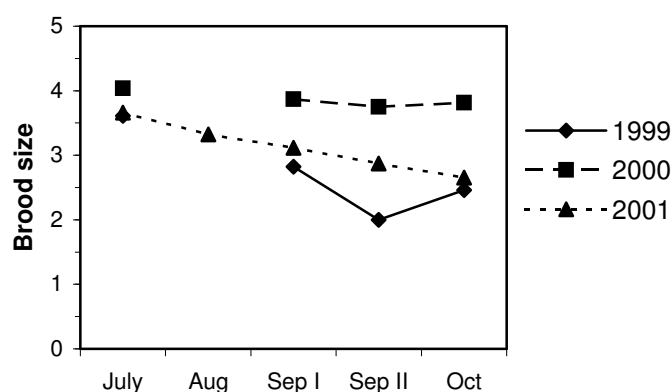


Figure 7. Brood size of greylag geese recorded in Iceland in summer and autumn. Most data are from September, which is here split into first and second halves of the month.

2.4 Hunting bag statistics

Since 1995, the Wildlife Management Institute has organized an obligatory survey of hunting bag levels in Iceland. In order to renew their licences, all hunters must submit a form specifying what they shot in the previous season. It is generally believed that the reporting is accurate, although there is some concern that over-reporting may occur when hunters go out goose-shooting in groups. The number of greylag and pink-footed geese shot increased from 1995 to 1997. Since then there has been a decline in greylag goose hunting, while pink-footed goose hunting has remained stable (Figure 8). The mean number reported shot for 1995–1999 was 37,313 greylag geese, 13,345 pink-footed geese, 3,185 white-fronted geese and 1,954 barnacle geese. In total, more than 55,000 geese are shot annually in Iceland, representing an average

of about 16 geese for each active goose hunter. Some hunters shoot many more geese, however, and the highest recorded bag for one hunter in 1998 was 900 greylag geese.

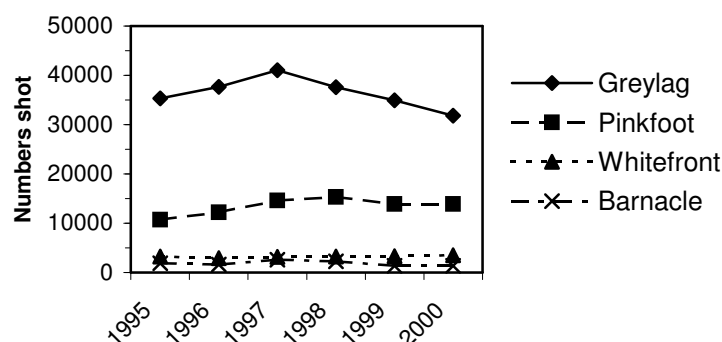


Figure 8. Numbers of geese reported shot in Iceland.

2.5 Wing survey

IINH has been collecting goose wings from hunters for aging since 1995 (on a smaller scale since 1993). Over the years, 12,427 goose wings have been collected: 8,693 greylag geese, 1,577 pink-footed geese, 1,597 white-fronted geese and 560 barnacle geese. This species composition is roughly similar to that recorded in the hunting bag survey, but with white-fronted geese over-represented and pink-footed geese under-represented in the wing survey. This suggests that not all types of hunters are equally likely to contribute to the survey. About half the contributed goose wings have come from Reytingarþjónustan (a plucking service company), and the validity of the survey depends on whether these can be considered representative of all geese shot in Iceland; preliminary tests indicate no consistent differences in age ratio between geese submitted directly by hunters and those submitted by Reytingarþjónustan.

The main aim of the wing survey has been to investigate the age composition of the hunting bag. The results show that the proportion of juveniles in the bag has been around 40% for greylag geese and around 30–35% for pink-footed geese, with some year-to-year variation (Figure 9). These annual fluctuations are parallel to those found in the autumn surveys in Britain (e.g. Hearn 2000), but the mean proportion is much higher in the Icelandic bag. This may occur either because young geese are more likely to be shot, because the proportion of juveniles declines over the season, or because one or both of the data sets are biased; as mentioned above, it is believed that autumn age ratios for greylag geese are biased low. For white-fronted geese, the annual fluctuations in the proportion of juveniles recorded in the wing survey are not related to those found in the wintering areas (A.D. Fox in litt.).

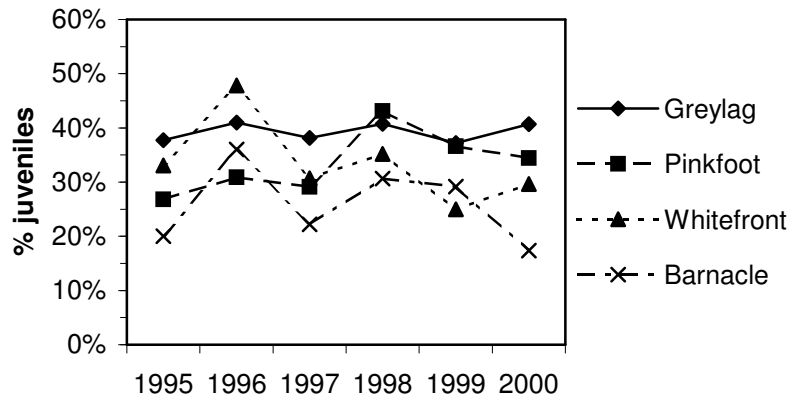


Figure 9. Proportions of juveniles in the wing survey.

In combination with the hunting statistics, the wing survey provides extremely valuable data on the age composition of the goose bag. Besides being an important component of a population model, this information can be used in conjunction with recoveries of shot marked geese to provide a rough estimate of how many geese are shot in Britain. Given certain assumptions (that the Icelandic bag statistics and wing survey are unbiased; that the probability of a shot marked goose being reported to the ringing scheme is the same in Iceland and Britain), it can be estimated that about 26,000 greylag geese and 30,000 pink-footed geese are shot annually in Britain.

2.6 Estimation of survival

Seasonal and annual survival of geese has been estimated on the basis of both live resightings and dead recoveries of geese colour-ringed in both Iceland and Britain. When both types of data are used in the same analysis, most sources of bias in the resulting estimates can be accounted for. The analyses have been carried out using the software package MARK (White og Burnham 1999), which incorporates state-of-the-art statistical methods in a user-friendly environment. The main results can be briefly summarized thus (see also Figure 10):

- Annual adult survival is substantially lower for greylag geese than for pink-footed geese (0.73 vs. 0.81, equivalent to a mean adult lifespan of 3.1 and 4.9 years, respectively). This is a new finding; previously the two species had been thought to have very similar survival rates. This difference is most pronounced in the period from ringing in summer until arrival in Britain, reflecting the higher hunting pressure on greylag geese in Iceland.
- First-year survival is lower for pink-footed geese than for greylag geese (0.39 vs. 0.47). This is caused exclusively by the very low survival of pink-footed goslings from ringing until arrival in Britain. The factors causing this high mortality are unknown, but hunting can only account for a small part of it. Other possibilities are high predation by foxes or excess mortality as a result of ringing operations; because of the large size of the catches, pink-footed geese are assumed to be more vulnerable to the latter.
- Over-winter survival is similar between the two species, and juveniles survive substantially less well than adults during this period. Other

- evidence indicates that the proportion of juveniles in the British hunting bag is very high.
- Mortality in the period from spring to summer is negligible for both species.
 - Annual survival has been fairly constant for pink-footed geese, whereas greylag geese showed higher survival in 1996–2001 than in 1992–1995. The British autumn counts show a major decline in the greylag goose population from about 1990 to 1996 and stability since then, consistent with the changes in survival.

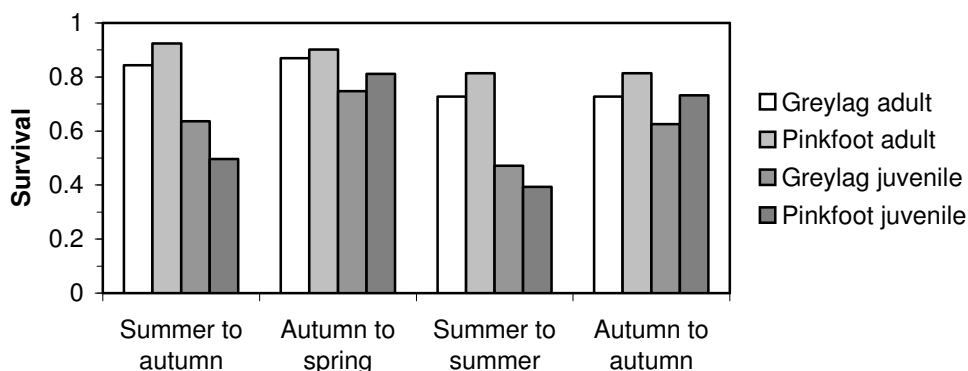


Figure 10. Summary of seasonal and annual goose survival (mean 1996–2001).

2.7 Population modelling

A formal mathematical population model, e.g. an age-specific matrix model (Caswell 2001), can be used to project future population trends under a set of assumptions. This makes it a very powerful tool for the management of wild populations: by varying assumptions about e.g. future hunting pressure, it is possible to evaluate how the population will develop. To make the model more realistic, random variation in input parameters can be included, for instance in the framework of a population viability analysis. However, this type of model requires a very high quality of data.

In order to set up such a formal model, reliable information on the key parameters of the population is needed. The basic parameters are survival and fecundity. Fecundity can be subdivided into two components: breeding output (e.g. brood size) and proportion of breeders. All parameters should be age-specific, although the number of age classes in the model need not be high (e.g. 3–4). In the case of the Icelandic goose populations, we have good information about survival and some information about breeding success, whereas virtually nothing is known about how high a proportion of the adult population breeds. At present, therefore, population modelling must proceed using simpler and less powerful techniques. This works best for the greylag goose, where most mortality is caused by hunting and therefore can be accounted for. The following discussion is largely restricted to this species.

By simply comparing the numbers of greylag geese counted in Britain in autumn and the numbers reported shot in Iceland, with their respective proportions of juveniles, it becomes clear that these figures cannot both be correct. If they were, the population

should decline very rapidly and indeed become extinct within a very few years; such a development has not been observed. Including the survival estimates reinforces this point, and also makes it clear that the proportion of juveniles in Britain in autumn must be much higher than that recorded by WWT (more than 30% rather than 15–20%). So, either the autumn counts in Britain, the hunting statistics in Iceland or both must be wrong. In order to bring the various sources of evidence into agreement, either the autumn population must be twice as high as recorded (i.e. about 160,000) or the hunting bag in Iceland must be half as big as recorded (i.e. about 18,000); in fact, of course, both data sets may be biased. It seems most likely that the autumn counts are serious underestimates, although it is not at all clear where these “missing” greylag geese are. An assumption that the survival estimates are biased (high or low) – which is considered unlikely – does nothing to solve the problem. All in all, it is at present quite unclear how large the Icelandic-breeding greylag goose population is, and therefore it is also difficult to know whether the trend indicated by the autumn counts (stability following a decline of 25%) is real.

No similar discrepancies have been found for pink-footed geese, although the basis for this conclusion is not very strong, given that most of the mortality of this species in Iceland must be due to causes other than hunting.

By back-calculation it is possible to estimate the number of successful breeding pairs needed to keep the populations stable at their present size and with present levels of mortality and breeding success. It seems that about 32,000 pairs of pink-footed geese must breed successfully (i.e., produce fledged goslings) each year; this includes the part of the population breeding in Greenland. If the autumn counts of greylags (80,000) are accepted as valid, the breeding population must contain about 11,000 successful pairs. However, if the population is twice as big (as indicated above), 22,000 pairs need to breed successfully to maintain stability.

3 RECOMMENDATIONS

Management concerns at present are focused on the greylag goose population, which is heavily hunted and presumed to be in decline. In order to provide useful advice on the management of the Icelandic greylag goose population, it is necessary to have better information on the size and composition of the population. Given that a total count of the number of breeding pairs would be impracticable, the best way to estimate the size of the breeding population would be to assess the size of the total population, the proportion of juveniles and the mean brood size at the same time, preferably before the start of the hunting season. The number of successful breeding pairs can then easily be calculated. When this information is available, much more sophisticated techniques for population modelling can be applied, and robust predictions about the impact of future changes in management (e.g. of hunting) can be made. At the Icelandic-British grey goose workshop at Hvanneyri in September 2001, one of the most important recommendations was that both countries should set up stratified surveys to collect the missing data (and/or improve the quality of existing data) on population size and age composition. Planning and design of such a survey should be started in 2002, preferably including a pilot field study.

Furthermore, the monitoring of both goose populations should continue, in order to keep track of the status and population trends of these economically important birds. The monitoring programme should contain essentially the same elements as applied in the period 1996–2000, although some adjustments could profitably be made.

- Ringing should be viewed as a monitoring tool, the main aim being not to estimate average survival (this has already been achieved), but to follow year-to-year changes in mortality, which may indicate in which direction the population is heading. A sustained ringing effort is thus necessary to enable continuous monitoring of levels of mortality/survival. The aim should be to catch and colour-ring about 200 geese of each species annually, with roughly half being goslings. If at all possible, neck collars should be used in preference to coloured leg rings. A wider geographical spread of ringing is desirable; in particular, greylag geese should also be ringed in the south and west of Iceland.
- Spring counts are probably of limited value in assessing the status of the entire populations, unless they can be standardized in a way that compensates for annual variation in timing of arrival etc. The geographical coverage and spread of breeding counts of greylag geese should be increased; such counts can provide an index of the entire population size. Important breeding and moulting areas of pink-footed geese should continue to be surveyed at regular intervals.
- The brood size of both goose species should be recorded during ringing operations. In connection with the stratified sampling scheme mentioned above, brood sizes and the proportion of juveniles in the population should be estimated in August.
- A survey should be made of the reliability of the hunting statistics, including whether over- or underreporting occurs, and whether hunters can reliably identify geese at species level.
- The wing survey should continue, and hunters should be strongly encouraged to take part. Care should be taken to involve hunters from all parts of the country and of all types (e.g. recreational, semi-professional).

- In order to facilitate future analysis and modelling of the goose populations, data from the monitoring programme should be collated and stored in a way that allows easy access. Much time and effort can be saved if all data are readily available in a standardized electronic form.

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APPENDIX 1. PUBLICATIONS RELATED TO THE PROJECT

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- Frederiksen, M. 2001. Icelandic-British workshop on grey geese, Hvanneyri, Iceland, 28–30 September 2001. Náttúrufræðistofnun Íslands, október 2001. NÍ-01021. 17 pp.

APPENDIX 2. PRESENTATIONS RELATED TO THE PROJECT

Arnór Þ. Sigfússon 1995–2000. Ca. 12–14 popular talks about geese and goose hunting (Skotveiðifélag Íslands etc).

Arnór Þ. Sigfússon 1999. Scottish Ringer's Conference.

Arnór Þ. Sigfússon 2000. Wetlands International Goose Specialist Group Meeting, Belgium.

Frederiksen, M. 2001. The greylag mystery. Guest presentation at National Environmental Research Institute, Kalø, Denmark, September 2001.

Arnór Þ. Sigfússon 2001. Goose hunting in Iceland. Presentation at Icelandic-British workshop on grey geese, Hvanneyri, September 2001.

Frederiksen, M. 2001. Four presentations at Icelandic-British workshop on grey geese, Hvanneyri, September 2001.

APPENDIX 3. PLANNED PUBLICATIONS RELATED TO THE PROJECT

The main results of the goose project will be published in a series of papers in international scientific journals. Four manuscripts are currently in preparation and will be submitted to relevant journals in early 2002. The working titles are:

Frederiksen, M., R. Hearn, C. Mitchell, A. Sigfússon & B. Swann. Seasonal survival of two species of geese breeding in Iceland.

Frederiksen, M., R. Hearn, C. Mitchell, A. Sigfússon & B. Swann. Size and dynamics of Icelandic goose populations – a reassessment of the evidence.

Frederiksen, M. Indirect estimation of the size of the British goose hunting bag.

Frederiksen, M. Loss of complete goose broods during the hunting season occurs more often than expected.