

PINK-FOOTED GEESE *ANSER BRACHYRHYNCHUS* ON THE MOORFOOT HILLS, SCOTLAND, IN SPRING 1952-1981

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William Brotherston, watching Pink-footed Geese roosting at Fala Moor Loch and feeding on the north slopes of the Moorfoot Hills, Midlothian, Scotland, recorded changes in numbers in spring, the influences of weather and farming practices, sexual behaviour and emigration. Mean peak numbers were about 3,500 in early April, with the highest count of 7,037 on 10 April 1981. The mean number of 'goose-days' in March and April was about 230,000 (from 120,000 in 1970 to 400,000 in 1972). More geese were present after mild winters and in warm Aprils. The numbers of geese increased with the area of improved grass, but seem not to have been affected by the numbers of full-grown sheep present. Sexual activities at the roost began in mid-April. The mean date of large northward departures was 1 May (range 19 April to 10 May). Nearly half the migratory movements were seen when the airflows over Scotland seemed unlikely to assist passage to Iceland, though large departures were most likely to occur with following winds.

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Much information about the numbers and distribution of wildfowl wintering in Britain has been obtained from monthly counts made by a network of amateur observers since 1947 (Atkinson-Willes 1963, Owen *et al.* 1986). Those counts, mostly made between September and March, are of little help in studying the emigration of geese from Scotland in spring and the conditions which affect it. Fortunately, some observers continue to look at geese until they migrate. One of the most acute and persistent of these observers was William Brotherston, who watched the Pink-footed Geese roosting on Fala Moor Loch from 1952 until his death in 1981. He visited the loch nearly every Saturday while geese were present and also made notes on the geese while they were feeding on the farmland on the north slopes of the Moorfoot Hills, summarising his earlier observations in Brotherston (1964). That account says little about events in spring. This note makes use of

his observations from March to May over the entire 30-year period, reporting: (1) changes in goose numbers, within and between years; (2) their relationship to changes in local farming and variations in winter and spring weather; (3) the timing of emigration; and (4) records of social and sexual behaviour.

Few observers make such full and careful notes as did Mr Brotherston. He also took the unusual precaution of arranging for a typewritten transcript of his notebooks to be made, now in the library of the Scottish Ornithologists' Club. He noted whatever appeared of interest about the birds he saw in the area around his weekend cottage at Garvald, 24 km SSE of Edinburgh, while paying special attention to the geese roosting on Fala Moor Loch, 11 km NE of Garvald and 22 km SE of Edinburgh. Both Pink-footed and Greylag Geese *Anser anser* roost on Gladhouse Reservoir, 13.5 km WSW of Fala Loch, where, from 1963 onwards, Lyndsay Young counted

the geese leaving at morning flight on Sunday after Mr Brotherston had counted the evening flight at Fala on Saturday. As it is unlikely that geese moved from one roost to the other during the night, the combined counts can be taken as estimates of the total numbers of geese using the north slopes of the Moorfoot Hills. On many of his evening watches Mr Brotherston was accompanied by Robert Walker, who farmed at Middleton Mains, 4.5 km west of Fala Moor Loch, in one of the areas most used by feeding geese. Mr Brotherston's diaries include many comments by Mr Walker, on farm activities, as well as on geese.

For a standardised way of testing whether farming practices may have affected spring use by geese, I obtained from the Scottish Record Office the annual June agricultural census data for the three parishes covering most of the feeding areas of the geese - Borthwick, Crichton and Fala & Soutra. The fit between the boundaries of these parishes and the areas used by geese is not exact, because the parishes include many unsuitable areas and the geese sometimes fed in Humber parish, to the east of Soutra. Yet changes from year to year in crop areas and livestock numbers in the three parishes should serve as a guide to conditions found by geese in the spring. Because the annual estimates of crop yields by The Scottish Office of Agriculture, Environment and Fisheries Department are not made at the parish level, I have used those for the south-east region of Scotland (though unable to obtain them for the years after 1971). I estimated weather conditions at Middleton Mains from monthly records of mean daily temperature and total precipitation at Blackford Hill, 17.6 km NW, adjusting them for the differences in altitude and exposure according to procedures described by Birse & Dry (1970) and White & Smith (1982). 'Winter' was defined as December-February, with March-April as 'spring', most geese leaving no later than the first week of May.

Results

Most counts were at seven-day intervals, with some additional ones, especially in later years,

and a few gaps in March, nearly always due to snow blocking the road over Fala Moor. There seem to have been many arrivals and departures of geese, and the counts varied in accuracy and precision, many of the geese sometimes not arriving at the roost in the evening until the light was very poor. Thus neither the peak counts nor the estimates of use can provide more than a rough guide to the total numbers of geese visiting the area.

Three ways of summarising the numbers of Pink-footed Geese using the Moorfoot Hills each spring, from 1 March until departure, are: (a) the mean number present in each 5-day period, 1952-1981 combined; (b) the highest count in each spring; and (c) annual estimates of total goose-days, made by multiplying by 15 the mean of all counts in each half of March and April and by 10 the mean for 1-10 May, and summing the products.

Figure 1 shows that, on average, numbers more than doubled between early March and early April, peaking at nearly 3,500, stayed above 2,800 until about 21 April, then dropped rapidly. In most years only a few hundred remained at the end of the first week in May and all but a few stragglers had gone by the end of the second week. The two graphs showing annual variations (**Figures 2 and 3**) offer rather different pictures, though both show increasing numbers through the 1950s, with inter-annual fluctuations through the 1960s and 1970s. A surge in peak numbers from 1977 to 1981 was not reflected in the estimates of total use. The upper lines on each graph, from 1963 onwards, are based on counts on the same night at Gladhouse Reservoir and Fala Moor Loch.

In five years, the peak count at Fala was in March (1953, 1955, 1971, 1974, 1976). In 1970 it was on 3 May. In all other years the peak was in April. In 1952-1962 (counts at Fala only) the estimated number of goose-days was higher in March than in April in 8 of 11 years. In 1963-1981, when counts were also being made at Gladhouse, goose use was greater in March than April in 9 of 19 years. Few Pink-footed Geese were seen at Gladhouse in April in most years. These discrepancies between peak numbers and monthly use show the impracticality of estimating from weekly counts

the lengths of stay of geese in the spring; whether there was usually a core of 'residents' staying several weeks and supplemented briefly by birds on passage, or a continual turnover, is not clear.

While the growing numbers of geese found at Fala tracked the increases in the size of the total British population through the 1950s, from 1960 onwards this was not so. Nor did the local and national peaks and troughs coincide. This suggests that, although in the 1950s the numbers of geese using the Moorfoots may have been determined in part by the total size of the population, total numbers became less important after the population exceeded 40,000. There are at least two ways in which the numbers of geese visiting the Moorfoots may have been limited. If visits by parties of geese depended upon prior knowledge of the area by some of those individuals, the number of visitors might have been determined chiefly by the size and success of particular groups in their breeding or wintering areas. If that were so, there might be little or no relationship between the 'carrying capacity' of the Moorfoots and the numbers of geese using the two roosts there. Alternatively, the numbers of geese staying in the area each spring may have been largely determined by variations in local food supplies. The inter-annual variations are large enough to encourage a search for relationships between them and indicators of local conditions in spring. The peak count and the estimate of total use were very low in 1970 and exceptionally high in 1972.

Weather and goose use

In 1952-1981, the estimated mean daily temperatures at Middleton Mains were 2.6°C (s.d. 1.06) in winter (Dec-Feb), 3.9°C (1.46) in March and 6.4°C (0.96) in April, with no significant trends. Using departures from the means of > 1 s.d. to identify cool and warm months and seasons, there were four cool and four warm winters and Aprils and, for March, six cool and five warm. Temperatures in April seem to have been independent of those earlier in the year, while three cool winters and a

warm one were followed by similar conditions in March. In 1958, 1962, 1969 and 1974 March was cooler than the mean winter temperature. March 1957 and 1961 were 'very warm' ($> \text{mean} + 1.96 \text{ s.d.}$).

In 1963-1981, for which goose numbers at both Fala and Gladhouse are available (**Table 1**), there were more geese after warm winters ($r = 0.642$, $p < 0.01$) and in warm springs ($r = 0.561$, $p < 0.01$). There were similar associations in 1952-1962, when counts were made only at Fala. Using accumulated frost-degree-days as a measure of winter severity, and the date when the mean daily temperature first exceeded 5.6°C as an indicator of the arrival of spring, produced similar results.

Winter precipitation averaged 146 mm (s.d. 45), tending to increase through the period. The driest winters were 1952-53 (43 mm) and 1958-59 (52). The wettest were 1976-77 (263) and 1977-78 (214). There were no significant correlations between goose use and precipitation, either in winter or during March-April.

The association of goose abundance with winter and spring temperatures is presumably through the encouraging effects of warm winter air and soil temperatures on the resumption of grass growth and of spring temperatures on the rate of growth (see, for example, Bergthorsson 1985, Collins & Cummins 1996).

Farming and geese

Variations during the 30-year period in farming activities that might have affected the geese involve both changes in the areas of grass and cereals being grown in the three parishes and changes in the numbers of livestock. In 1976 the crop areas ceased to be comparable with those in 1952-1975, for reasons that are unclear (A.Reid, *in litt.*).

From 1952-1975, the total area under cereals averaged 3,260 acres (from 2,410 in 1962 to 3,717 in 1968). Cereal stubbles were heavily used by geese in the autumn, but few arable fields were left unploughed until spring. Thus a large shift from growing oats (little used by geese) to barley (greatly favoured) was of little

importance in spring, when nearly all feeding was on improved grass. A lack of association between cereal acreages and spring goose use is therefore not surprising.

In spring, the geese fed much more on improved grass than on other crops, so that grass conditions were likely to be of prime importance. As sheep were potential competitors with geese for the 'early bite' of grass after being turned out from their winter pens, changes in sheep numbers and productivity might also have had some influence on the distribution and length of stay of geese. On several farms, attempts were made to frighten off geese from grass needed for ewes with young lambs.

The total area under grass averaged 7,570 acres, decreasing at an average rate of 68 acres a year. The estimation of the extent of improved grass available to geese is complicated by several changes made by The Scottish Office Agriculture, Environment and Fisheries Department in the ways of classifying areas under grass. The area of grass under seven years old (or, after 1963, of rotation grass) seems to be the best measure of available improved grass. Between 1952 and 1975 it averaged 5,040 acres, with no sustained trend (range 3,498-1957 to 6,688-1962).

In 1952-1975, the number of goose-days was positively correlated with the area of improved grass ($r = 0.446$, $p < 0.02$; 0.339 ; $p < 0.1$ after partialling out the upward trend in goose use). In 1954-1971, for which I have records of hay yields in south-east Scotland, more geese used the Moorfoots in years when the subsequent hay yield was above average than in years when yields were low ($n = 18$, $r = 0.489$, $p < 0.05$; after partialling out the time trends $r = 0.452$, $0.1 > p > 0.05$).

Though the geese spent most daylight hours feeding on improved grasslands, in the second half of April and early May, shortly before leaving, increasing numbers were noted on rough grass or on the mosses that served as "rest stations and parking out stations" (Brotherston 1964), i.e. sitting during the day, or roosting, on uplands, rather than returning to the loch or the reservoir. On 13 April 1967, there were large numbers on the north side of

the Blackcastle dip: "pre departure routine as well as grass availability I am sure". Because most of these sites were on hilltops, above the observer, it was often difficult to judge how many geese were feeding and how many resting. Several notes refer to the use of bogs, or wet spots, on these upland sites in April, notably at Esperston Moor: eg [4 April 1969] "where natural grass is growing, especially at damp rushy bits... walking to drink at the gushet". The presence of water that can be walked to is also an attraction to Pink-footed Geese in south-west Iceland in spring (pers. obs.). The plants on unimproved uplands presumably start growing later than the improved grass mixtures, so that the geese using those areas were probably taking the 'early bite'.

Small parties of geese were often noted feeding on 'brairded' (sprouting) barley in April. This was not new; R.Walker had seen large flocks of geese gathered on the fields at Half Law Kiln in late spring in 1943 or 1944, eating brairded oats and barley, and on a farm near Libberton in 1945 and 1946 (diary, 18 April 1964).

"The geese come into direct competition with park sheep for the supply of grass at just that period of the year when the park lambing in the upland area is coming or has begun, the usual dates for its commencement being 14th to 21st March" (Brotherston 1964). This suggests that growth of improved grass mixtures was beginning in mid-March, about two weeks ahead of the dates estimated from the equations using the conventional air temperature of 5.6°C as the trigger for the start of growth (Birse & Dry 1970).

Social and sexual behaviour

Most of the time the geese fed in flocks of several hundreds, though these often split into smaller groups as the geese depleted the best feeding patches in one field and moved to others. There are several notes of pairs becoming conspicuous within flocks early in April, though only one of five separate pairs settling to feed well away from the main group, as they often do in lowland Iceland in late April

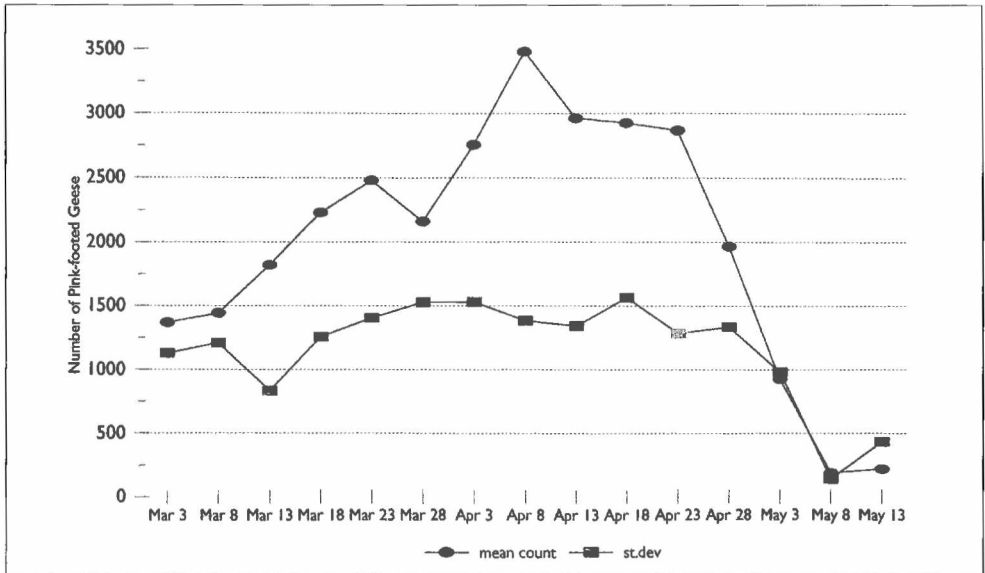


Figure 1. Changes from March to May in mean numbers of Pink-footed Geese roosting on Fala Moor in 5-day periods, pooled for all years, 1952-1981.

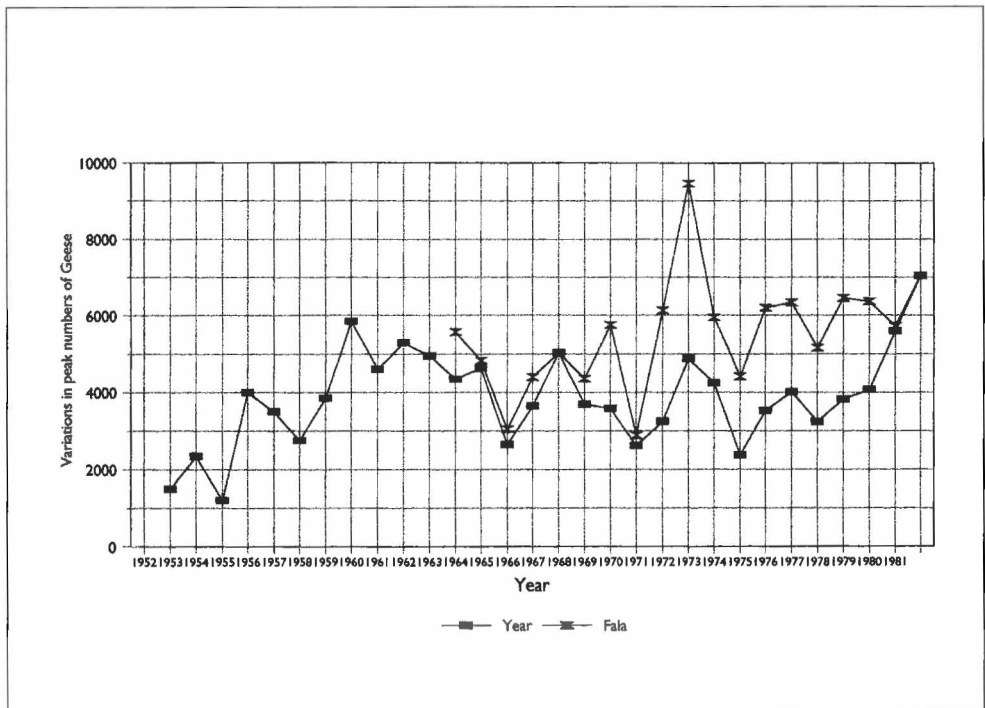


Figure 2. Annual variations in the peak numbers of Pink-footed Geese roosting on Fala Moor in spring, 1952-1981 and also at Gladhouse Reservoir, 1963-1981.

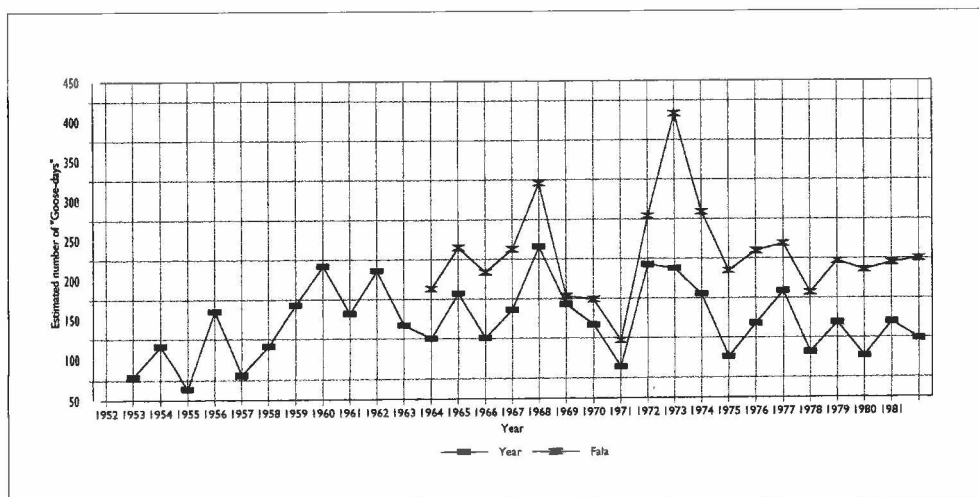


Figure 3. Estimated numbers of 'goose-days' spent on the Moorfoot Hills in spring by Pink-footed Geese roosting on Fala Moor and Gladhouse Reservoir.

and May (Fox, *et al.* 1992).

There is a reference to an aerial chase on 3 April 1965 and three more were noted in early May. These chases usually involve the pursuit of a female plus male by a second male, the exact relationships rarely becoming apparent. They can be seen at most times of year, though most often in spring.

There are notes of geese arriving at the roost in separate pairs as early as 3 April 1971 and 4 April 1969. From early April onwards there are increasingly frequent notes in the diary of social and sexual activities at the roost, though it was often difficult to make out exactly what was happening in the dusk. 'Head dipping' is a form of pre-copulatory behaviour; 'slapping' [of the water], 'trampling' and 'treading' all seem to refer to attempts at copulation. There were four notes of apparently sexually-motivated activities between 1 and 10 April, 12 between 11-20, 18 between 21-30 and 17 between 1 and 12 May (when the numbers of geese were usually small). Completed copulations were noted only four times: on 16 and 23 April 1966, 1 May 1965 and 9 May 1964. Boyd & Fox (1992), describing sexual activities of geese in Iceland on 30 April and 1 May 1991, had not seen copulations in Scotland, but Boyd saw several at the Loch of Strathbeg on 20 April 1993. The lack of notes on behaviour at the

roost before 1963 may be due to the relative infrequency of observations at Fala Moor Loch in April and May in the early years of the study (only 30 visits in 10 years). In 10 of the subsequent 19 years there were no, or only single references, to behaviour at the roost. In view of the general thoroughness of reporting in the diaries, it seems possible that the sexual development of the geese may have been less in some years than in others. It is perhaps worth noting that in six of the nine years when sexual activities were most apparent the percentage of young seen in flocks in Scotland in the following autumn was above average, while it was below average in six of the 10 years when little activity had been noted in spring.

On 17 May 1964, at the edge of the loch: "many down breast feathers, in two large packets - do birds strip feathers in mating play?" There are two more references in later years to heaps of feathers seen in late April, but no further comments. Fighting male geese often pull out feathers from their opponents, but I know of no records of down-pulling away from nests.

Spring migration

On 30 April 1961: "big departure [from Fala] at 0630, about 3000 going north with good south

Table 1. Association of numbers of Pink-footed Geese (in thousands of 'goose-days') using the Moorfoot Hills in March and April with estimated seasonal and monthly mean temperatures at Middleton Mains in those months and in the preceding winter. Records of combined numbers roosting at both Fala and Gladhouse (F + G) are available between 1964 and 1981 ($n = 18$); at Fala, 1953-1981 ($n = 26$). Correlation coefficients shown only where $p < 0.05$, * = $p < 0.01$, ** = $p < 0.001$.

Fala + Gladhouse			Numbers at Fala only		
Temperature in:	March	Spring	March	April	Spring
Winter		0.642	0.496*		
April				0.608**	
Spring		0.561*			0.472*
Accumulated					
frost degree-days	-0.520*				
>5.6°C in spring		0.516			
1st day temp.					
>5.6°C		-0.458			

wind behind them and a full moon". Most of the other diary references to goose migration are based on reports by others, or are notes of geese seen and/or heard passing over Garvald or Edinburgh. Some are of birds arriving from the south, usually 'the Solway', either settling or continuing on. There are too few notes from any single year to provide a full picture. There are three records of migrants in March, but these are most unlikely to have been geese leaving for Iceland, so are not used here. There were 17 records in April (only three earlier than 24th) and twelve between 1 and 13 May. All records of large flights were between 28 April and 3 May. The mean date of first spring sightings in Iceland is 23 April (H. Boyd unpublished).

There are several notes in the diaries on the weather conditions under which large departures must have occurred between visits, all referring either to anticyclones or to southerly winds. The directions and strengths of winds at Fala are not necessarily related in consistent ways to weather conditions further

north in Scotland. I have attempted to match the dates of 'emigrations' from Fala against the predominant airflow over Scotland each day between 16 April and 15 May, in the sixteen springs in which some migration was recorded. These daily airflows were determined by Mayes (1991, and unpub.), who applied the classification system devised by Lamb (1968) for the British Isles as a whole to four different regions (Scotland, Ireland, south-west England and south-east England). On many days the dominant airflow over Scotland differs from that for the whole British Isles (Wheeler & Mayes 1997). Lamb identified seven principal and nineteen 'hybrid' types, leaving a few days unclassified in most months.

For the years in which there were any records of emigration, I compared the frequency of days with conditions over Scotland probably favourable for migration to Iceland (identified as anticyclones, southerly and easterly winds, and any hybrids including those elements) with the days on which

migrants were seen or emigration was thought to have occurred. Migration was noted on 15 (7.85 %) of 191 days with favourable winds and on 14 (5.0 %) of 289 days when conditions over Scotland may have been unfavourable. The difference in proportions is not statistically significant. The probability of migration is perhaps determined more by the internal state of the geese than by the weather. Departures in the peak period (26 April - 5 May) were seen on 20/160 (12.5%) of days, compared with only 9/320 (2.8%) of days between 16 and 25 April and 6 to 15 May. Migration was noted on 12/59 (20.3%) of days with favourable winds during that peak period, compared with only 3/132 (2.3%) of the favourable days earlier and later, even though the proportion of days with favourable conditions was slightly higher ($132/320 = 41.2\%$) before and after the peak period than during it ($59/160 = 36.9\%$). Nearly half (14/29) of the noted movements occurred on days when the dominant airflow over Scotland did not seem to be favourable: eight during the peak period, two earlier and four later. Perhaps not all the departures led to flights to Iceland. Alternatively, the geese may have been able to take advantage of winds not identifiable from the dominant flow over Scotland. There are too few records of movements to allow these alternatives to be explored thoroughly.

The mean date of reported first arrivals in Iceland in spring (23 April) coincides with the mean date of first occurrence over Scotland in April of weather systems with strong southerly components (H.Boyd, unpublished). Most of the major departures from Fala were seen on or after 28 April.

Discussion

This account conveys little of the characteristic style of Mr Brotherston's diaries, or of his sustained enthusiasm for watching evening flights at Fala Moor Loch, often in miserable weather.

There are no very surprising findings here. Nor should there be, given the published knowledge of the behaviour of Pink-footed Geese in Scotland in spring (Newton &

Campbell 1970, 1973, Newton *et al.* 1973, Bell 1988, Fox *et al.* 1994, Bell & Newton 1995), and previous studies of the influence of weather on their migration (most notably Williamson 1968) and their subsequent breeding success (eg Fox *et al.* 1989). Yet how geese respond to changes in the availability of food is still not well understood. Presumably, the mild winters and springs that encouraged geese to use the Moorfoot Hills more heavily were not limited to the immediate vicinity; why they came and stayed here rather than elsewhere is a difficult question to answer. What local changes occurred after 1981, as the total number of Pink-footed Geese wintering in Britain grew to over 200,000, will emerge from a review of goose counts in south-east Scotland being made by A. Brown.

If we are ever to be able to make reasonably reliable guesses at the causes and consequences of future changes in the numbers and distribution of geese, we will need many more long-term studies. Changes over time are continual and, so far, rarely foreseen. The perennial problem for observers is to keep up with the geese, not to get ahead of them. Yet if conservation is to be effective in a sustained way, rather than 'fire-fighting' as problems emerge - too many geese here, regretted declines there - we need some apparatus to improve the ability to look ahead. Studies such as this, made by a patient and objective observer in his favourite haunt, are valuable contributions to that larger aim.

I am greatly indebted to the late William Brotherston, not only for the information in his diaries but for his active help and encouragement while I was living in Edinburgh in 1965-1967. Mrs Helena Brotherston allowed me to make use of the typewritten version of the diaries now deposited in the library of the Scottish Ornithologists' Club. John Ballantyne helped me to use the library and made useful comments on an early draft of this paper. I am indebted to Dr M.V. Bell and Dr A.D. Fox for comments on a later version. Dr Julian Mayes kindly provided me with a copy of his Regional Airflow Classification for 1950-1996. The Scottish Record Office supplied the agricultural census data and the Scottish

Centre of the Meteorological Office the Blackford weather records.

References

- Atkinson-Willes, G. L. (Ed.). 1963. *Wildfowl in Great Britain*. HMSO, London.
- Bell, M.V. 1988. Feeding behaviour of wintering Pink-footed and Greylag Geese in north-east Scotland. *Wildfowl* 39:43-53.
- Bell, M.V. & Newton, S. F. 1995. The status and distribution of wintering Pink-footed and Greylag Geese in east-central Scotland. *Scottish Birds* 18:24-50.
- Bergthorsson, P. 1985. Sensitivity of Icelandic agriculture to climatic variations. *Climatic Change* 7:111-127.
- Birse, E. L. & Dry, F.T. 1970. *Assessment of Climatic Conditions in Scotland*. Soil Survey of Scotland. Macaulay Institute for Soil Research, Criagiebuckler, Aberdeen.
- Boyd, H. & Fox, A. D. 1992. Sexual activity of Pink-footed Geese *Anser brachyrhynchus* at a staging area in Iceland. *Wildfowl* 43:117-120.
- Brotherston, W. 1964. The numbers and behaviour of geese in the Lothians and Berwickshire. *Wildfowl Trust Annual Report* 15:57-70.
- Collins, J. F. & Cummins, T. (Eds.). 1996. *Agroclimatic Atlas of Ireland*. Joint Working Group on Applied Agricultural Meteorology. Dublin.
- Fox, A. D., Gitay, H., Owen, M., Salmon, D. G. & Ogilvie, M.A. 1989. Population dynamics of Iceland-nesting geese. *Ornis Scandinavica* 20:289-297.
- Fox, A. D., Boyd, H. & Warren, S. M. 1992. The phenology of spring pre-nesting feeding in Iceland-nesting geese. *Ecography* 15:289-295.
- Fox, A. D., Mitchell, C., Stewart, A., Fletcher, J.D., Turner, J.V.N., Boyd, H., Shimmings, P., Salmon, D.G., Haines, W.G. & Tomlinson, C. 1994. Winter movements and site-fidelity of Pink-footed Geese *Anser brachyrhynchus* in Britain, with particular emphasis on those marked in Lancashire. *Bird Study* 41:221-234.
- Lamb, H. H. 1968. British Isles weather types. *Geophysical Memoirs* 116. Meteorological Office, London.
- Mayes, J. 1991. Regional airflow patterns in the British Isles. *Int.J.Climatol.* 11:473-491.
- Newton, I. & Campbell, C. R. G. 1970. Goose studies at Loch Leven in 1967/68. *Scottish Birds* 6:5-18.
- Newton, I. & Campbell, C. R. G. 1973. Feeding of geese on farmland in east-central Scotland. *Journal of Applied Ecology* 10:781-801.
- Newton, I., Thom, V.M. & Brotherston, W. 1973. Behaviour and distribution of wild geese in south-east Scotland. *Wildfowl* 24:111-121.
- Owen, M., Atkinson-Willes, G. L. & Salmon, D.G. 1986. *Wildfowl in Great Britain*. Second edition. Cambridge UP.
- Wheeler, D. & Mayes, J. (Eds). 1997. *Regional Climates of the British Isles*. Routledge, London.
- White, E. J. & Smith, R. I. 1982. *Climatological Maps of Great Britain*. Institute of Terrestrial Ecology, Penicuik, Midlothian.
- Williamson, K. 1968. Goose emigration from western Scotland. *Scottish Birds* 5:71-89.