Icelandic Greylag Geese wintering in Britain in 1960-1971

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The Wildfowl Trust has, since its inception in 1946, devoted substantial efforts to the study of the distribution and abundance of wild geese in Britain. There are two justifications for doing so: first, to ensure that man-made threats to the birds and the places where they live are recognised promptly; second, geese visiting Britain provide exceptionally favourable material for investigating the population dynamics of large, mobile and long-lived animals. From both points of view the protracted investigations made by the Trust are increasing greatly in value as they are continued. Long runs of information are needed to give perspective and pattern to changes from year to year and from place to place that might otherwise appear haphazard or be incorrectly attributed to unimportant causes. This paper brings up to date accounts by Boyd (1959, 1963) of the winter distribution of Greylag Geese *Anser anser* in Britain and amplifies recent reports on annual changes in their numbers (Ogilvie, in Sedgwick, Whitaker and Harrison 1970; Boyd 1972).

There are small numbers of native Greylags breeding in Scotland and feral Greylags are now found in several parts of Scotland and England. This account is focussed on the much more numerous immigrants from Iceland. Over most of their present winter range those immigrants do not normally encounter the native and feral geese (Figure 1), though they do so regularly in Wigtownshire and the status of some small groups found elsewhere, particularly in the Inner Hebrides, remains uncertain.

The principal source of information is a series of censuses conducted in early November each year since 1960, in which nearly all the known haunts of Greylags have been inspected regularly. Additional data are provided by similar censuses made in March from 1963 to 1967 and by observations made within the framework of the National Wildfowl Count scheme (Atkinson-Willes 1963) during the months October-March at some of the roosts used by Greylags. Observations made in several localities in October and November on the proportion of young geese and on family size are also helpful in understanding the changes in total numbers from year to year.

To anticipate results reported in later sections, the wintering population has greatly increased and the increase has been accompanied by substantial quantitative shifts in distribution though little change in range. As in nearly all studies of mobile animals, the analysis of causes of change is complicated by the imperfections of the data. Whether intensification of effort in counting or in other ways could improve the interpretation of the results sufficiently to justify substantial additional costs is a point for discussion.

The November censuses are conducted concurrently with those of Pink-footed Geese *Anser brachyrhynchus*. An account of the procedure was given by Boyd and Ogilvie (1969) in their report on changes in Pinkfoot numbers and need not be repeated at length. The method is to station observers at or near each roost known to be used at all regularly by either species and for the geese to be counted either while feeding nearby, on the roosting site itself, or while flying into or out of the roost. More than one count is obtained wherever possible, by duplication of observers and by the participants making repeated counts. When large numbers of geese are involved it may be necessary to estimate in units of 10, 50, or 100, rather than count individuals. The counts are restricted to one weekend, that closest to 10th November, by which date immigration of both species is virtually complete. Comparatively little shooting of Greylags occurs in Britain prior to that date, so that the number determined represents the total of adults and birds of the year that left Iceland and survived migratory flights of 950 to 1,500 kilometres.

Though the counting skill of the observers may differ and bad weather may make the task difficult, thus introducing an inescapable lack of rigour, the November censuses have proved reasonably self-consistent, although the same claim cannot be made for the numbers of geese recorded in the monthly Wildfowl Count samples.

The March censuses, though consistent with each other, failed to record sufficient geese to be compatible with the November figures, probably because in late March some geese do not consistently return to roost on permanent water and also because emigration may have begun. Even an extensive network of observers scrutinizing well-known tracts of country used by geese could not always be relied upon to produce a 'total count' at this time of year. Both Greylags and Pinkfeet are aggregated in larger flocks in autumn than later in the winter and are also then much less prone to 'park out' (Brotherston 1964) in grass fields or on moss or wetlands. It is justifiable to assert that the November counts from 1960 to 1971 have included a very high proportion of all the Icelandic visitors and that the proportion missed has not had a seriously distorting effect either upon the picture of year to year change or upon the pattern of distribution in early November.

In some ways Greylags are easier to find and to count than Pinkfeet: they less often occur in large flocks (of over 1,000 birds); they rarely fly more than a few kilometres to feed; they often leave the roost well after sunrise and return to it long before sunset; and relatively few frequent large estuaries which are difficult to oversee completely. The disadvantages in counting Greylags are that they occupy a larger number of roosts; their range includes parts of the country that are topographically complicated and with few local bird-counters; and they have a greater propensity for shifting from one roost to another on successive nights. The differentiation of immigrants from 'locals' in areas where there are native or feral geese is a difficulty confined only to Greylags amongst the British geese, and a difficulty that is growing with the spread of feral birds, though in the national aggregate errors in classification cannot have been important during the period of this study. A small proportion of the immigrants moves on to Ireland, but the number reaching there by early November is negligible. Even in mid-winter there are now fewer than 1,000 Greylags in Ireland (Cabot 1969), although the great decline in Greylag abundance during the previous twenty years (Ruttledge and Hall Watt 1958) has been checked since about 1966 (Flegg 1971).

Numbers in early November

The records of geese found in the November inventories are assembled in Tables I and II. Though most of the roosts are listed separately, some that are close together and are used concurrently or alternatively are grouped for simplicity. Records from scattered sites used infrequently are also amalgamated (for example in 'other Fife') to save space. Sufficient examples of individual sets of numbers remain to give an impression of the variability found at sites in persistent use and also to illustrate that some roosts ceased to be used during the last decade,

Table I. Numbers of Icelandic Greylag Geese found in Scotland and England in early November, 1960-1971.

Roosts listed from north to south and grouped by regions (see Figure 1). To reduce the size of the table, counts from nearby roosts that are used as alternates are grouped, as are records from infrequently used sites. In those cases the maximum number of sites used is shown in parenthesis after the group name. The rounding-off is that of the observers. No entry = not searched; — = no geese seen. Observations of native and feral geese have been omitted.

Region and site	*1960*	*1961*	*1962*	*1963*	*1964*	*1965*	*1966*	*1967*	*1968*	*1969*	*1970*	*1971*
Moray												
Orkney	—	—	—	—	—	28	—	—	45	26	—	—
Dornoch F. (2)	—	—	9	200	28	18	—	—	—	—	—	—
L. Eye	—	91	230	500	207	1750	1850	750	320	650	820	680
Cromarty F.	150	120	250	322	—	260	—	80	1700	600	—	500
Munlochy	4000	—	95	220	250	—	—		—	259	390	500
Beauly F.	406	—	164	—	349	40	700	350	335	374	50	281
Alturlie (2)	—	200	230	—	—	—	—	—	115	—	—	40
Moss-side				286	200	300	860	26	—	240	10	—
Findhorn (3)	—	—	—	—	110	—	—		552	21	—	46
L. Spynie	1220	472	850	798	1350	850	750	630	240	320	580	480
Insh			24	85	37	300	35	110	170	—	—	
Aberdeen												
L. Strathbeg	53	1166	1008	1200	3734	2200	3338	2000	800	4380	2600	4500
Ythan (3)	46	654	500	500	1200	326	642	3000	3610	9371	2070	4281
Kemnay		390	100	695		—	200	270	210	275	240	200
L. of Skene	—	—	—	—	150	—	330		190	700	1500	390
Angus and Perth												
Montrose	210	300	98	430	324	51	176	—	300	130	300	140
Forfar (2)	150	—	—	—	500	—	735	—	—	200	150	370
Lintrathen (2)	2150	4630	5900	4450	3350	3100	5050	5750	8480	9200	9800	8150
Blairgowrie (8)	3360	7330	7300	7030	10000	7370	15850	13050	10300	8650	12070	7690
Strathtay		225	89	47	514	150	340	1200	150	450	500	700
Rannagulzion	—	—	850	104	44	500	—	—	—	500	500	—
Drummond	2750	2800	2800	2984	4312	6000	10242	8050	9766	6116	7040	6290
Carsebreck	1150	3430	5500	4500	2337	4130	2400	3000	8280	780	5590	4470
L. Vennacher										180	20	162
L. Rusky	400		530	35	250	—	1	—	—	—	—	—
L. of Menteith	30	—	24	395	—	130	210	970	670	220	1000	600
Dupplin (3)	2302	40	390	780	380	690	1020	1925	1080	790	530	1500
Glenfarg	—	—	—	—	—	—	866	—	—	720	1500	410
Monikie	110	—	—	—	—	—	—	—	—	—	280	—
Firth of Tay	350	2000	366	120	1242	—	514	—	720	—	—	10
Fife and Kinross												
Cameron R.	2000	900	400	1500	1500	150	250	250	250	300	100	450
Kilconquhar	25	3	—	—	12	250	—	230	370	—	380	1896
Ballo	—	—	9	—	10	—	450	—	5	—	—	—
Carriston	—	—	—	—	—	—	—	150	185	850	40	650
other Fife (7)	100	—	16	22	70	—	28	640	63	—	—	36
L. Leven	—	350	1500	340	1200	1200	2180	680	1189	1013	1700	2520
Alloa	83	14	15	—	12	—	—	—	16	—	10	—
SE. Scotland												
Cobbinshaw	—	—	—	—	—	—	—	40	13	40	12	120
Harperrig	30	—	145	440	900	296	160	300	58	1800	750	270
Threipmuir	250	420	150	400	1050	800	250	580	140	450	—	110
Westwater	—	—	—	—	—	—	—	3	24	30	—	—
Portmore	—	—	—	—	710	—	420	—	—	700	310	360
Gladhouse	25	240	280	280	500	300	320	950	1090	800	2350	680
Watchwater	95	210	290	180	280	300	220	260	520	580	250	415
Hoselaw							50	450	312	440	650	930
other Lothians	—	—	30	—	300	25	190	—	10	1110	64	50
West Scotland												
R. Endrick	—	340	400	451	—	336	300	900	450	870	400	800
Lenzie	—	—	365	—	27	—	45			429	360	570
Hamilton (2)	14	—	—	—	—	—	—			—	—	—
Lochwinnoch (2)	50	8	—	—	—	—	—	—	—	6	—	—
Ayrshire (4)	63	62	243	166	161	1	10	—	164	10	100	366
Bute												
Bute (5)	1650	1220	2200	530	690	6300	3500	2500	3010	685	1150	1640
Arran		902		410			300	150		—		
Argyll												
Crinan	100	159	500	300	300	114	500	300	527	300	330	300
Carse					700	400	350	330	350	350	250	350
Kintyre (4)				220	190	400	221	117	383	369	110	828
Colonsay	436	142	109	83	—	13	—					
Islay			450	—	665	217	120	170	300	180	200	210
Solway												
C. Kennedy (3)	700	3800	3800	65	1630	3080	1850	800	300	2000	2500	2500
Bladnoch	407	500	80	300	—	—	125	6	384	363	530	704
Wigtown Bay	—	350	—	—	100	40	400	89	54	—	—	—
Fleet Bay (2)	—	34	111	—	80	21	80	100	—	15	10	—
L. Ken	—	325	250	150	900	250	117	350	395	300	580	550
Threave	350	360	550	120	220	1500	500	155	500	500	500	600
E. Kirkcudbright (3)	—	—	—	—	—	—	—	600		340	550	599
Lochmaben (2)	544	244	325	200	317	157	340	187	100	—	240	277
Caerlaverock	340	100	400	7	120	80	360	—	30	272	240	30
other Dumfries	—	—	—	—	—	—	—	—	—	55	420	325
Rockcliffe	—	72	150	—	—		9	—	250	—	40	14
Eden Valley							300	120	700	900	900	700
Northumberland (2)	25	39	132	300	105	150	135	150	110	480	480	757
Lancs. and West'd												
Kent est.	120	120	209	213	73	43	79	—	—	—	—	—
other (2)	12	—	—	26	—	—	—	38	—	—	—	—
Total (to nearest hundred)	26300	34800	40400	32400	43800	44400	58100	52600	60800	61800	64500	62600

while other new sites were adopted, sometimes as substitutes for those abandoned. In most cases of marked change some alteration in local circumstances can be found that might account for the shift. Since our concern here is with the national picture and a search for causes of broader scope, a detailed examination of particular cases would be inappropriate, but a few may help to show how changes in the site itself may be important.

In the south-east of Scotland, where most roosts of both Pink-footed and Greylag Geese have long been on man-made reservoirs, newly constructed reservoirs have quickly been occupied by geese. Watchwater, completed in 1954, is the most important one to be taken over by Greylags. Few Greylags have attempted to use the Westwater Reservoir, which has become a major haunt for Pinkfeet. The return of geese to Cobbinshaw Reservoir, which was probably the most important goose roost in the Lothians 30-40 years ago, seems to have followed some reduction in the human disturbance which had led to its desertion. A former haunt of some note, the Clyde valley from Bothwell Bridge to Hamilton Low Parks (listed in Table I as 'Hamilton'), was finally abandoned shortly after 1960, because of disturbance and destruction of some of the best feeding and roosting areas by motorway construction and other irrreversible activities. In a few places, however, Greylags have persisted very close to heavily-settled and industrialized areas. The group using a flooded mining subsidence at Lenzie is a striking example. In Perthshire, the desertion of Loch Rusky followed disturbance by fishing and boating. At Rescobie Loch, near Forfar, where sailing continues well into the autumn, the geese have managed to increase. The Lake of Menteith provides another instance of a site formerly much used by geese that fell out of favour during the 1950's and has now been reoccupied, despite increased human activity.

A site-by-site review of the changes during the decade does not itself lead to a full understanding of how the increase in the total population from 26,300 in November 1960 to 64,500 in November 1970 has been achieved and accommodated. It is helpful to group the roosts into regions and compare the changes within and between them (Table II). The boundaries used (shown in Figure 1) are drawn through geographical breaks between groups of roosts. No convenient breaks occur in east central Scotland, where the administrative county boundaries between 'Angus and Perth' and 'Fife, Kinross and Clackmannan' are followed, except that the whole of the Firth of Tay is assigned to Fife. (In recent years, although Greylags feeding on both the north and south shores have roosted on the inner firth, more have fed in Fife than in Angus or Perth; that was not so before 1960.)

Table II. Regional totals of Icelandic Greylag Geese found in Scotland and England in early November, 1960-1971. Thousands of geese, to nearest 0.1; + = less than 50.

Region	*1960*	*1961*	*1962*	*1963*	*1964*	*1965*	*1966*	*1967*	*1968*	*1969*	*1970*	*1971*
Moray	5.8	0.9	1.9	2.5	2.5	3.5	1.9	1.9	3.5	2.5	1.8	2.5
Aberdeen	0.1	2.2	1.6	2.4	5.1	2.5	4.6	5.3	4.8	14.7	6.4	9.4
Angus and Perth	13.0	20.7	23.8	20.9	23.3	22.1	37.4	33.9	39.7	27.9	39.3	30.1
Fife and Kinross	2.2	1.3	1.9	1.9	2.8	1.6	2.9	1.9	2.1	2.2	2.2	5.6
SE. Scotland	0.4	0.9	0.9	1.3	3.7	1.7	1.6	2.6	2.7	6.0	4.4	2.9
West Scotland	0.1	0.4	1.0	0.6	0.2	0.3	0.4	0.9	0.6	1.3	1.3	1.7
Bute[1]	1.7	2.1	2.2	0.9	0.7	6.3	3.8	2.6	3.0	0.7	1.2	1.6
Argyll[2]	0.5	0.3	1.1	0.6	1.9	1.1	1.2	0.9	1.6	1.2	0.9	1.7
Solway	2.3	5.8	5.7	0.8	3.4	5.1	4.1	2.4	2.7	4.8	6.5	6.3
Northumberland	+	+	0.1	0.3	0.1	0.2	0.1	0.2	0.1	0.5	0.5	0.8
Lancs. and West'd	0.1	0.1	0.2	0.2	0.1	+	0.1	+	0	0	0	0
Total	26.1	34.8	40.4	32.4	43.8	44.4	58.1	52.6	60.8	61.8	64.5	62.6

Notes:
1. Bute count liable to be seriously incomplete in 1960, 1962, 1964-65.
2. Argyll count certainly incomplete in 1960-1963 and probably incomplete throughout period.

In nearly all years a few roosts likely to have been occupied had either not been discovered or could not be inspected at the time of the census. However, the numbers missed were small in relation to the national total and it has seemed better to base most of the subsequent descriptions on the unadjusted counts, rather than engage in more or less elaborate exercises in interpolation. The national totals used here differ slightly from those published by Ogilvie (1970) and Boyd (1972) for that reason and also because

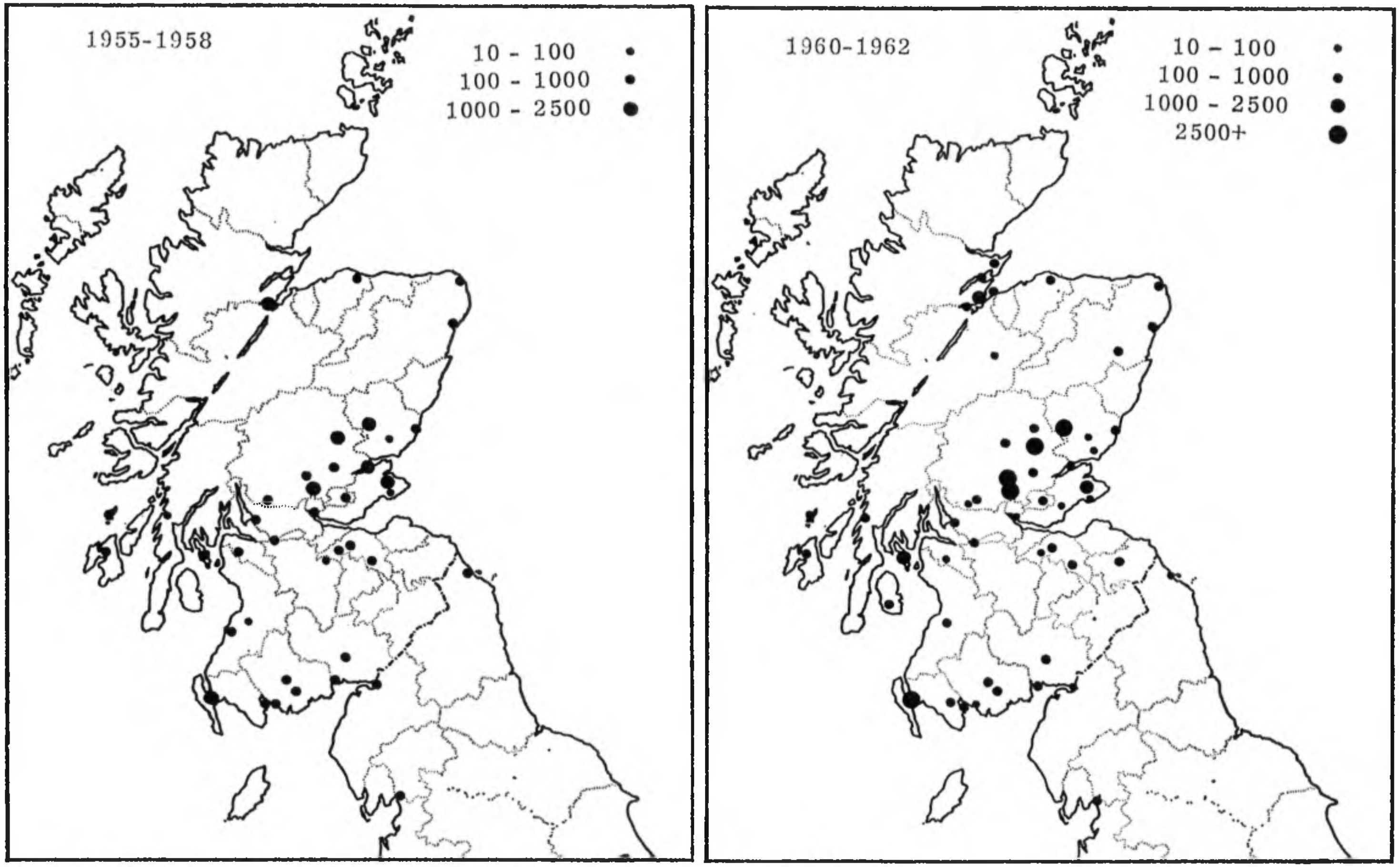


Figure 1. Distribution of roosts of Icelandic Greylag Geese in Britain. (a) 1955-58 (adapted from Boyd 1959). (b) 1960-62 (adapted from Atkinson-Willes 1963).

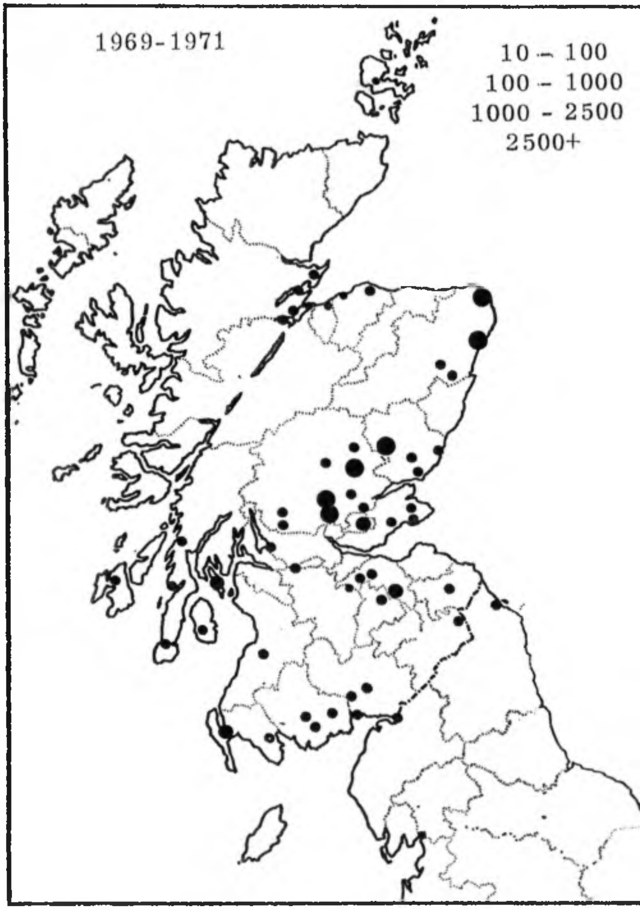
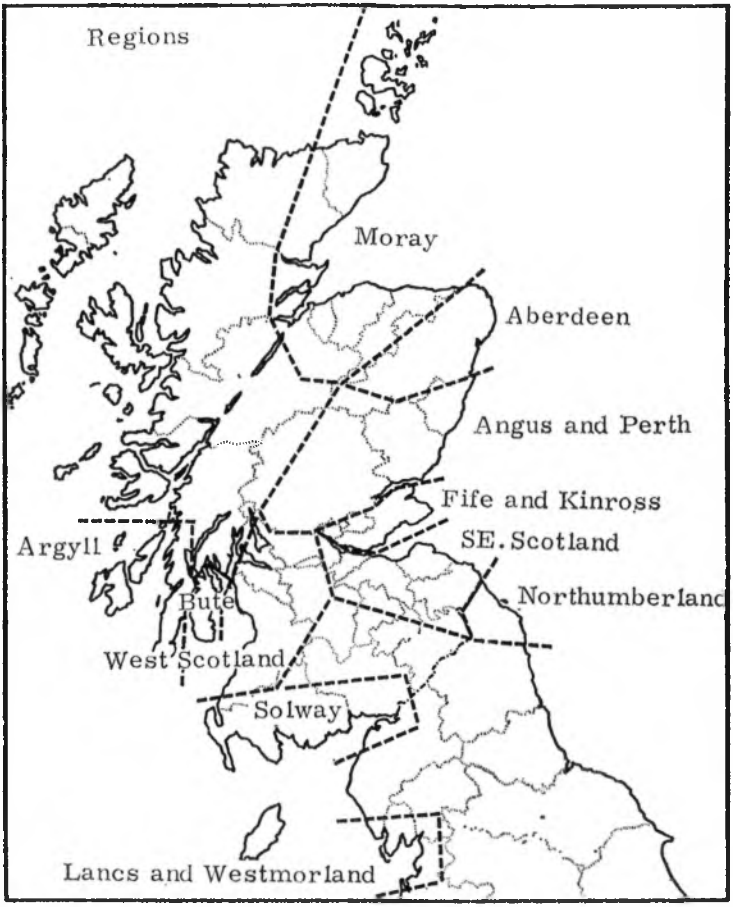


Figure 1. (c) 1969-71. (d) Regional boundaries and names.


Regions
Moray
Aberdeen
Angus and Perth
Fife and Kinross
SE. Scotland
Northumberland
Argyll
Bute
West Scotland
Solway
Lancs and Westmorland

of the exclusion from Table I of all geese believed to be feral or native.

The decision to use unadjusted counts leads to difficulties in estimating changes in numbers in two regions, Bute and Argyll. Buteshire comprises the islands of Bute and Arran and the two have been treated together in compiling Tables I and II. But the irregularity of observations on Arran makes it preferable to consider only records from the group of roosts on the island of Bute in looking at trends. The data from Argyll are particularly unsatisfactory. The haunts of Greylags in Kintyre and Knapdale were not covered adequately until 1964. None of the Inner Hebrides other than Islay has been reported on regularly, and some, perhaps all, of the geese there may be native or feral rather than Icelandic. Thus it seems best to omit Argyll from the comparisons between regions.

Table II shows marked differences between regions in the rate of population growth and in the scale of fluctuations. These may be appreciated more easily from Figures 2 and 3. The changes in regions are compared with the national growth in Figure 4 by means of five-year moving averages standardised to a base of 100 in 1962. This suggests that the rate of growth in Angus and Perth has largely determined that for the population as a whole, if only because that region has held almost three-fifths of the Greylags in Britain in November throughout the 1960's. More interestingly it suggests that, whereas the rate of gain nationally has been nearly linear, in Aberdeen and south-east Scotland it has been accelerating in recent years.

In Angus and Perth the steady growth has been upset in two recent years, 1969 and 1971, when, apparently in response to an unusually early and clean pick up of the cereal harvest in those counties, the numbers fell there noticeably. The consequent redistribution to other areas is seen most clearly in Aberdeen and in Fife/Kinross. In the former area, however, there has been an independent increase affecting both major haunts, the reasons for which are not clear. The furthest north area, Moray, shows no

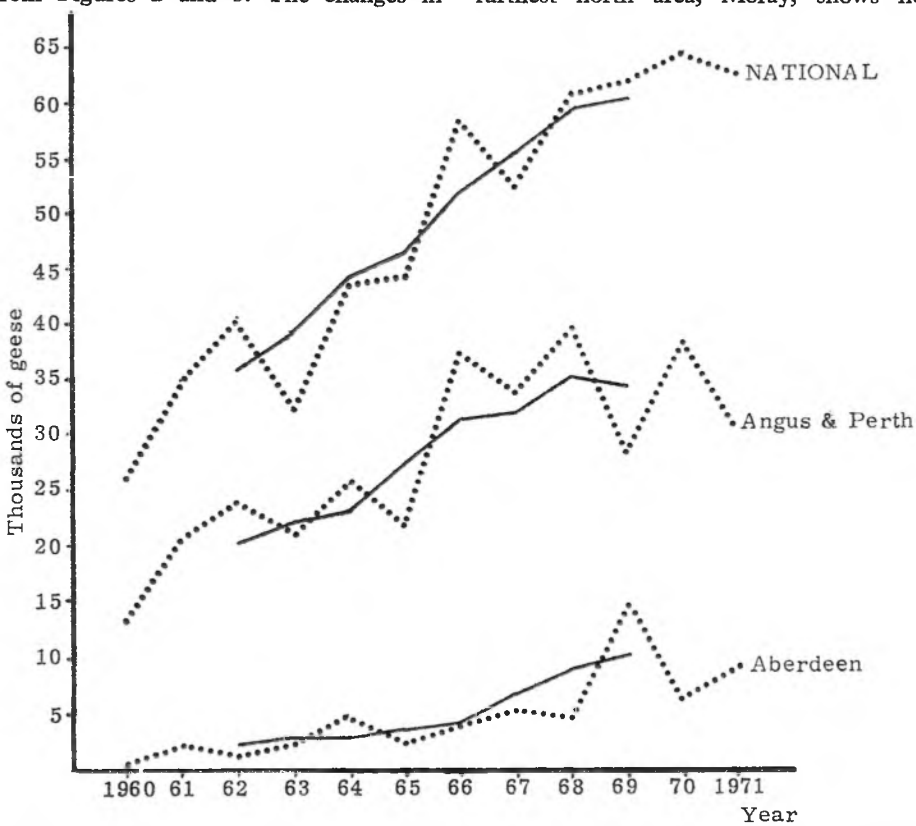


Figure 2. Numbers of Icelandic Greylag Geese found in Britain in November, 1960-1971. The middle and lower series of points record the numbers in Angus and Perth and in Aberdeen respectively. The solid lines are 5-year moving averages.

trend, but considerable fluctuation within the limits of the relatively small numbers involved. A similar pattern was true of Fife/Kinross until the recent upsurge, which may, however, be associated with the abnormal situations of 1969 and 1971. It is perhaps surprising that more changes have not taken place in this area in view of the massive alterations in Angus and Perth immediately to the north. The very small numbers in West Scotland and in Northumberland also showed a surge in recent years which can be linked with 1969 and 1971.

The most marked variations over the period can be seen on the Solway where

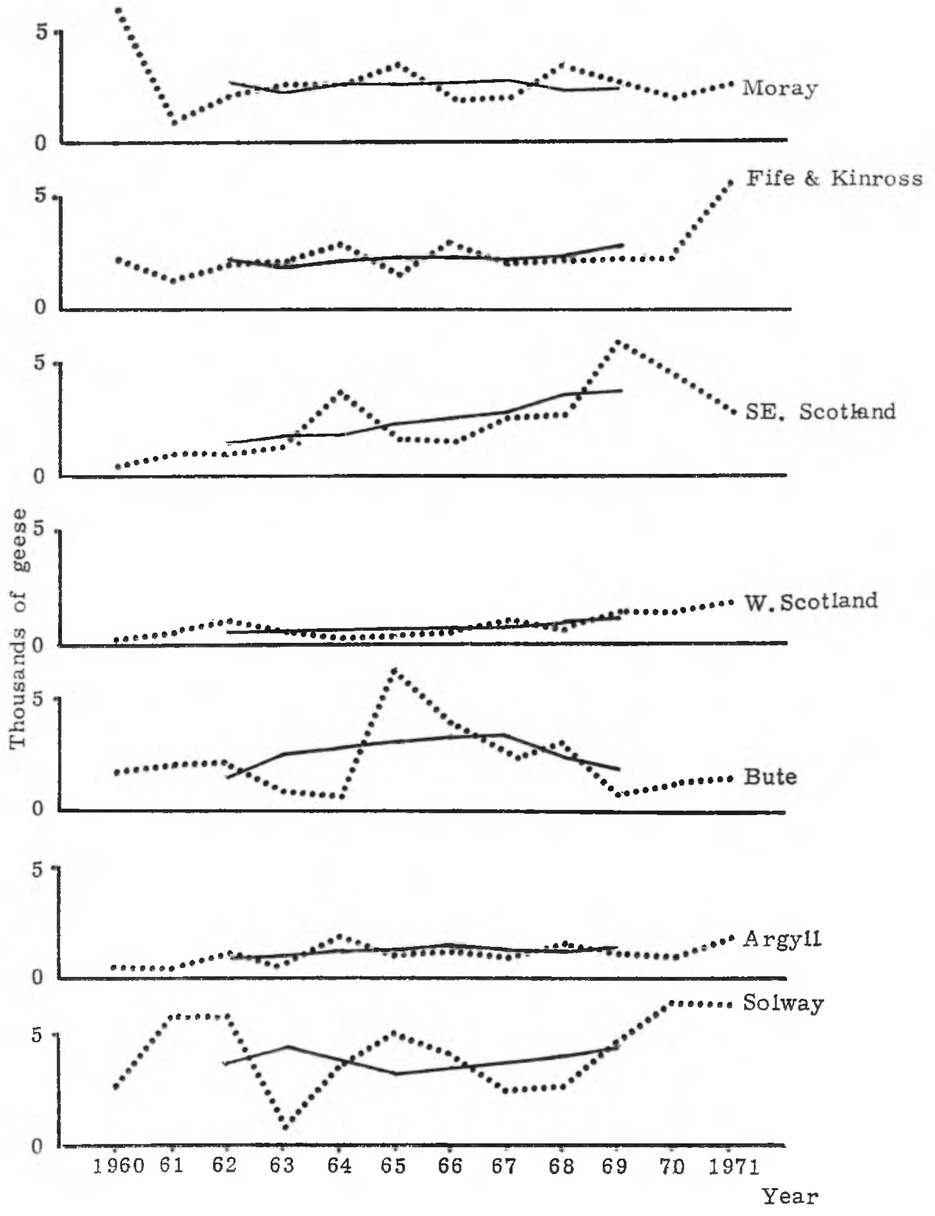


Figure 3. Numbers of Icelandic Greylag Geese found in different regions of Scotland and northern England in November, 1960-1971, with 5-year moving averages. (Aberdeen, and Angus and Perth, see Figure 2.)

there have been successive periods of high and low numbers. There is no obvious explanation for this. The only clear example of absolute decline comes from the north-west of England where the small and long-dwindling stock of immigrant Greylags has just about disappeared. On Bute, where a decline is noticeable since the mid-1960's, there have been determined attempts to reduce the number of wintering Greylags following complaints of agricultural damage.

The growth of the Icelandic Greylag population as a whole can only have been achieved by an excess of recruits over losses. The only way in which redistribution within Britain can have assisted that result is by reducing losses. However the distribution in early November is most unlikely to be decisive in determining losses, because November is not a critical period for food supplies, hard weather or mortality due to shooting. Thus a crucial question becomes: do the geese found in various sites in November experience correspondingly different mortality during their subsequent stay in Britain? Alternatively, has a reduction in losses been associated with changes in mid-winter distribution not necessarily related to the distribution in early November?

The question cannot be answered directly, because there are no data measuring losses due to shooting or to other causes. The simplest indirect

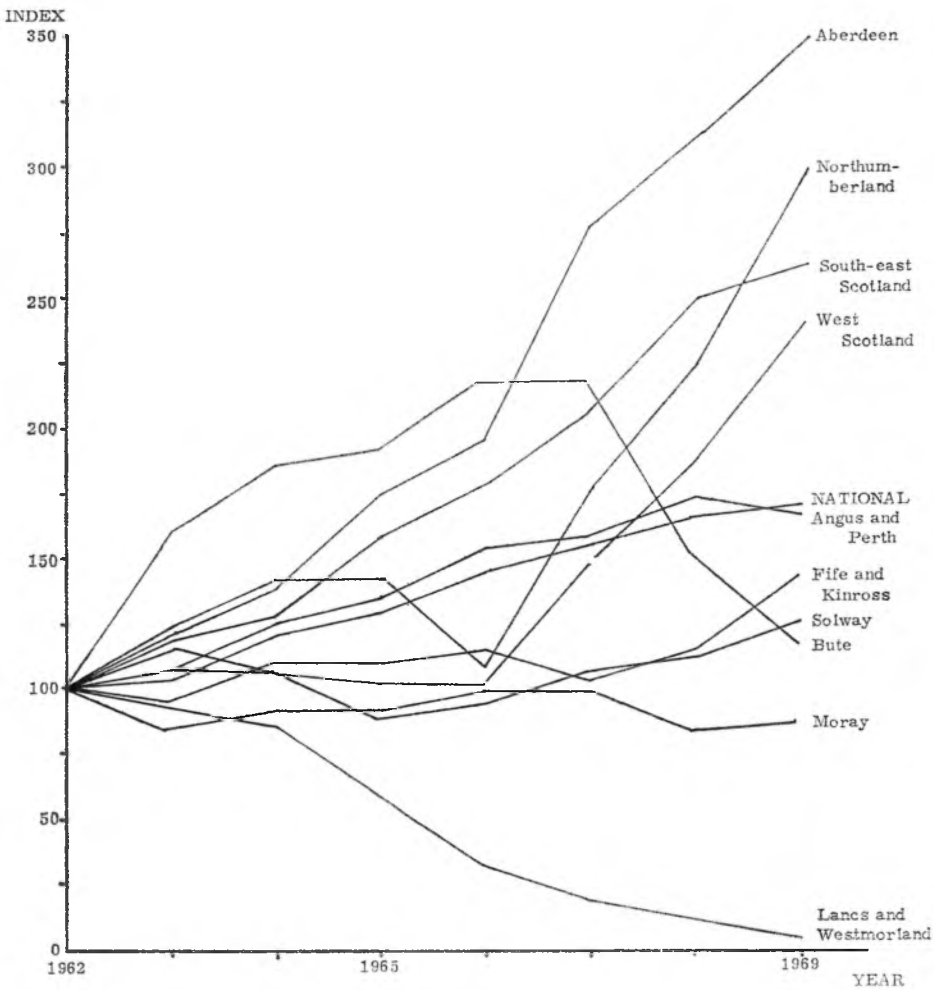


Figure 4. Relative changes in regional abundance of Icelandic Greylag Geese in Britain in November, 1960-1971, as shown by 5-year moving averages standardised to 1962 = 100.

measure will in principle be provided by a comparison of the results of the November censuses with those made in a similar fashion in late March, when censuses were attempted in 1963-67. The March counts, assembled by regions and by years, are summarised in Table III. Table IV records apparent regional changes from November to March. Over the five winters, three regions (Moray, West Scotland and Bute) showed substantial increases in average numbers from the autumn to the spring. Since no immigration was likely to have been occurring on a detectable scale in midwinter (though very small numbers of Greylags from Europe occasionally straggle to England, especially during hard winters (Atkinson-Willes 1963)) and since the population was being depleted by deaths, those regional increases clearly reflect internal movements which are also demonstrated by the substantial decreases recorded in Aberdeen, Angus and Perth and south-east Scotland. There is indeed a paradox in the results, which seem to show the highest rates of winter loss in those regions where the rate of increase from November to November has been greatest.

Recoveries of ringed Greylags from 1950 onwards had shown a tendency for those marked in east Scotland in the autumn to move south and west in the course of the winter and it had been inferred that such shifts were due to the generally greater severity of the weather in the east (Boyd 1959). The observations in 1963-1967 were consistent with such an explanation.

A supplementary approach is available using the month by month records from roosting sites visited by observers taking part in the National Wildfowl Count scheme. Their observations are made on the Sunday closest to the middle of the month (the range of dates was 12th-18th), from September to March. There are virtually no Icelandic Greylags in Britain in September and immigration is still gathering momentum in mid-October, so that most interest lies in the numbers seen from November to March.

These counts are designed to record the numbers of ducks present and therefore observations are made during the hours of daylight, rarely early or late enough to record roosting geese. However, Greylags more than other geese are prone to visit their roost during the day, and also to flight home up to two hours before sunset.

Table III. Numbers of Icelandic Greylag Geese found in regions of Britain in late March, 1963-1967. Thousands of geese, to nearest 0.1; + = less than 50.

Region	*1963*	*1964*	*1965*	*1966*	*1967*	*Mean*
Moray	2.5	2.7	6.0	1.8	2.7	3.2
Aberdeen	1.2	0.8	2.8	3.0	5.4	2.6
Angus and Perth	5.9	10.0	9.5	12.2	17.7	11.1
Fife and Kinross	0.7	1.8	2.3	0.8	4.4	2.0
SE. Scotland	0.2	+	+	1.3	0.7	0.5
West Scotland	1.3	1.1	1.2	1.3	0.5	1.1
Bute	5.6	2.4	2.8	2.9	5.9	3.9
Argyll	1.3	1.1	1.4	0.5	1.7	1.2
Solway	5.0	2.6	5.1	3.4	3.9	4.0
Northumberland	0	0	0	0	+	+
Lancs. and Westmorland	0.3	0.2	0.2	0.2	0.2	0.2
Total	24.0	22.7	31.3	27.4	43.1	29.8

Table IV. Changes from November to March each winter in numbers of Icelandic Greylag Geese found in different regions of Britain, 1962-63 to 1966-67. Thousands of geese, to nearest 0.1.

Region	*1962-3*	*1963-4*	*1964-5*	*1965-6*	*1966-7*	*Mean*	*March/Nov.* %
Moray	0.6	0.2	3.5	− 1.7	0.8	0.7	+ 28
Aberdeen	− 0.4	− 1.6	− 2.3	0.5	0.8	− 0.6	− 19
Angus and Perth	−17.9	−10.9	−13.8	− 9.9	−19.7	−14.4	− 56
Fife and Kinross	− 1.2	− 0.1	− 0.5	− 0.8	1.5	− 0.2	− 10
SE. Scotland	− 0.7	− 1.3	− 3.7	− 0.4	− 0.9	− 1.3	− 74
West Scotland	0.3	0.5	1.0	1.0	0.2	0.6	+113
Solway	− 0.7	1.8	1.7	− 1.7	− 0.2	0.2	+ 5
Balance of total	−16.3	− 9.6	−11.6	−17.0	−14.9	−14.0	− 32

The Wildfowl Count sites regularly covered hold a substantial proportion of the total of Greylags, although the sample is biased, in relation to the known distribution in November, by an over-representation of Fife, the Lothians and island of Bute, and by under-representation of Angus/Perth and of the Solway. The sites used in preparing the subsequent analysis are as follows:

Moray: L. Eye, Beauly Firth, L. Spynie; *Aberdeen:* L. Strathbeg, R. Ythan and Slains L., L. of Skene, Kemnay; *Angus and Perth:* Lintrathen Res., L. Kinnordy, L. Rescobie, Forfar L., L. of Lowes, Butterstone L., L. Clunie, L. Marlee, L. Stormont, Haremyre; *Fife:* Lomond Reservoirs, Carriston Res., Kilconquhar L., Cameron Res., Eden estuary, Tullibody I. (Clackmannan); *SE. Scotland:* Threipmuir Res., Gladhouse Res., Harperrig Res., Portmore L.; *West Scotland:* south-east L. Lomond (R. Endrick mouth), Lenzie L., Barr L., Castle Semple L., Croot L., Martnaham L. Shankston L.; *Bute:* Lochs Ascog, Dhu, Fad, Greenan, Quin; *Solway:* Caerlaverock NNR., Lochs Arthur, Milton and Rutten, L. Ken, Wigtown Bay.

Because of the vagaries of the sample, which is affected by irregularities in coverage as well as by the exaggerated fluctuations to be expected in any sub-sample, it seems better to group the data in periods of three seasons than to consider each season separately.

The grouped data are displayed in Table V covering the period 1960-61 to 1968-69. The totals of 'goose months' indicate a rate of population increase similar to that derived from the November censuses. The index at the foot of that table, in which changes through the winter are standardised against a value of 100 for November in each period (thereby eliminating the effect of growth in total numbers) makes a point of some interest. The growth of the October index from the early to the later years of the decade implies that the proportion of Icelandic Greylags arriving in Scotland

Table V. Changes in regional abundance from October to March as indicated by Wildfowl Count records for 1960/1 to 1968/69.
Sites used are listed in Appendix 1. Monthly figures are 3-year means, in thousands, to nearest 0.01. The small samples from Argyll and England are omitted.
Period 1, 1960/1 to 1962/3; 2, 1963/4 to 1965/6; 3, 1955/7 to 1968/9.

Region	*Period*	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Thousands of "goose months"*
Moray	1	.1	1.0	.4	.2	.3	1.1	3.1
	2	.3	1.3	1.6	1.7	2.1	1.5	8.5
	3	.7	1.1	.4	1.0	.3	.5	4.0
Aberdeen	1	.2	.4	.5	.3	.4	.4	2.2
	2	1.3	1.4	1.4	1.3	.5	.6	6.5
	3	1.8	2.5	.7	3.0	1.6	1.9	11.5
Angus and Perth	1	1.1	2.4	.9	.6	.8	1.1	6.9
	2	1.1	4.0	3.2	.7	1.0	.4	10.4
	3	2.1	5.6	4.3	3.8	1.7	.7	18.2
Fife	1	.1	.9	.7	.2	.2	.3	2.4
	2	.5	1.1	.8	.7	.8	.8	4.6
	3	.4	1.2	.7	1.4	2.2	1.6	7.5
SE. Scotland	1	.1	.1	0	.1	0	0	.3
	2	0	.9	.4	.4	.2	.1	2.0
	3	1.0	1.1	1.0	.3	0	0	3.4
West Scotland	1	0	.3	.2	.3	.5	.1	1.4
	2	.1	.5	.3	.2	.6	.2	1.9
	3	.1	.2	.2	.2	.4	0	1.1
Isle of Bute	1	0	1.5	2.4	2.8	1.4	2.0	10.1
	2	.1	1.9	2.4	2.7	1.4	2.1	10.6
	3	.2	1.6	3.9	4.1	1.9	1.7	13.4
Solway	1	0	.2	.7	.6	.4	.4	2.3
	2	0	1.5	1.3	.9	.5	.6	4.8
	3	.8	1.1	.9	1.1	.4	0	4.3
Total	1	1.6	6.8	5.8	5.1	4.0	5.4	28.7
	2	3.4	12.6	11.4	8.6	7.1	6.3	49.3
	3	7.1	14.4	12.1	14.9	8.5	6.4	63.4
Index (Nov. = 100)	1	24	100	85	75	59	79	
	2	27	100	90	68	56	50	
	3	49	100	84	103	59	44	

by mid-October has been rising rapidly.

W. B. Alexander (in Fisher 1951) in a diagrammatic summary of the migrations of Greylags to and from Britain indicated arrivals throughout October and continuing until mid-November. By 1960 it was our general impression that in most years few migrants were delayed later than the first week of November and this seems to have continued to be so, except perhaps in 1969. Dr. Finnur Gudmundsson has confirmed that few Greylags remain in Iceland after the beginning of November (pers. com., Dec. 1971).

The decrease in the March index, coupled with the lack of change in that for February, suggests that a corresponding increase in emigration prior to mid-March has been occurring. Alexander suggested that emigration began early in March, a possibility risked when selecting a date late in the month for the end of winter censuses. However, Dr. Gudmundsson knows of no evidence that the geese are now returning to Iceland earlier in the spring, the main return of Greylags being in April.

This evidence of changes in the timing of the mass of migration has an immediate implication, that the apparent losses from early November shown by the late March censuses may be due to emigration as well as deaths. (For a direct estimate of mortality during the winter a census in February would be far more useful. However, it would be very liable to interference from bad weather, which was why the census was deferred until March.)

If emigration has not begun in February the change in the sample counts from mid-November to mid-February might be expected to serve as a measure of mortality. Certainly the aggregate sample shows a substantial, and very similar, drop in each of the three periods used. But, as will emerge after the later section on recruitment, an apparent reduction of 41-45% in the population from November to February is too large to be consistent with the year to year changes shown by the November inventories. Regionally, the inconsistencies are worse. Presumably this is because the geese do not redistribute themselves in such a way that the sample of roosts observed tends to contain a constant proportion of the geese in the region.

At the least, analysis of the Wildfowl Count data has shown that even full Greylag censuses at frequent intervals would be unlikely to provide measures of mortality distinguishable from the effects of local and long-distance movements.

Seasonal and regional distribution of ringed Greylags

Greylags have been ringed in Iceland, as goslings or as moulting adults, from 1929 onwards. The numbers marked have been small, so that the subsequent recoveries are too few to demonstrate changes in distribution or mortality, with one striking exception. Of 15 recoveries in the British Isles before 1950, six were in Ireland and nine in Scotland; there was only one recovery, in Moray, between 1950 and 1960; since 1960 there have been 12, 11 in Scotland and only one in Ireland.

The number of Icelandic Greylags ringed in Britain is rather larger (1,247) but nearly a third of them were marked in the period 1950-1953 and catches of 609 in Perth and Angus in November 1963 and 88 in Bute in February 1966 provide the only samples in the last decade. By November 1971, 315 recoveries had been reported, 180 after autumn 1960. Such limited numbers cannot provide detailed information on distribution changes or mortality but are sufficient to produce evidence of several important characteristics.

A similar withdrawal from Ireland, and northern England, is evident in the recoveries of British-ringed Greylags: from 1950 to 1955 there were eleven recoveries in Ireland and two in England. From 1955-56 to 1959-60 there was one in Ireland and one in England. Since 1960 there have been no recoveries in Ireland or England.

Little of interest can be learned from recoveries about changes in distribution within Scotland, perhaps largely because the samples ringed at different times were caught in different places, so that the tendency for most recoveries to occur relatively close to the place of ringing obscures any evidence of shifting (Table VI).

Recoveries in Iceland of Greylags ringed in Britain give no indication that geese taken together in winter are especially liable to return to the same part of Iceland; but it is rather unlikely that such association would be revealed by recoveries scattered thinly over many years. A more important result is that the numbers of recoveries in Iceland have formed a relatively constant proportion of the numbers ringed, irrespective of the place or period of marking (Table VII). This is consistent with observations by Dr. Finnur Gudmundsson and Dr. Arnthor Gardarsson (pers. com., Dec. 1971) that the kill in Iceland has not risen greatly, despite the increasing number of

Table VI. Regional distribution of recoveries in the British Isles of Greylag Geese ringed in Britain 1950-1966.

	Where and when ringed						
Where found	*Dumfries/ Kirkcudbright 1950-53*	*Montrose 1952*	*Kinross 1953*	*Braco (Perths.) 1959*	*Blairgowrie/ Coupar Angus 1963*	*Bute 1966*	*Total*
Moray, Aberdeen	1	1	1	3	9	1	16
East central Scotland	5	13	36	12	66	—	132
Solway	21	7	15	6	10	—	59
Bute	5	—	—	4	1	4	9
Other Scotland	5	2	2	2	7	2	15
England	1	2	—	—	—	—	3
Ireland	6	1	5	—	—	—	12
Total	34	26	59	27	93	7	246
recoveries within 20 miles	12	4	13	6	37	4	76
as % of recoveries in same region	57	31	36	50	56	100	50
as % of all recoveries	35	15	22	22	40	57	31

Greylags and their fondness for cultivated areas, especially young grass. Complaints led to a change in the law in 1965 to permit shooting by farmers at any time when damage was occurring, but this has not led to substantial increases in the number shot. Hunting of geese for sport was almost unknown in Iceland until very recently. Some now occurs, particularly in the south-west, but it is still insignificant.

When recoveries in Britain are related to the numbers marked in different places at different times the proportions recovered are seen to have fallen greatly in recent years, after remaining high and steady during the 1950's. This suggests either a fall in the proportional kill or in the proportion of ringed birds shot that are reported. Remarkably enough, though the number of British recoveries has fallen the annual mortality, as estimated from the recovery series (i.e. numbers recovered 1, 2 . . . n years after ringing) has actually increased, from 23.1 ± 2.9% prior to 1956 (Boyd 1957) to 34.0 ± 2.29% for the geese marked in 1963. (In each case the mortality was calculated by the method due to Haldane (1955).) Such an increase could conceivably be due to a rise in losses due to causes other than shooting. Using the method due to Hickey (1952) to estimate such losses fails because the estimated annual mortality does not increase with an increase in the recovery rate, an unusual occurrence. It seems likely that the high estimate is an artefact, due to the vulnerability of this and similar methods of estimates to departures from the assumption of constant annual survival and constancy of reporting.

The Greylag recoveries are too few to allow the question to be resolved but an analogous situation has arisen in the recoveries of Pink-footed Geese ringed in Britain and Iceland from 1950 to 1959, which will be discussed elsewhere (Boyd and Ogilvie, in prep.). For the Pinkfeet, and so most probably for the Greylags also, it seems likely that the estimated value of the hypothetical constant annual mortality is seriously biased upwards, particularly for recent years.

Table VII. Changes in the recovery rates in Iceland and Britain of Greylag Geese marked in Britain 1950-1966.

		Recovered within 5 years of marking					
		in Iceland		*in Britain*		*Total recovered so far*	
Marked	*Number released*	*Number*	*% of marked*	*Number*	*% of marked*	*Number*	*% of marked*
1950-1952	134	8	6.0	31	23.1	46	34.3
1953	285	10	3.5	73	25.6	99	34.7
1963	104	3	2.9	25	24.0	33	32.7
1966	613	30	4.9	84	13.7	126	20.5
1959-1961	88	5	5.7	6	6.8	11	12.5
Total	1224	56	4.6	219	17.9	315	25.2

Recruitment

Under favourable conditions of lighting an experienced observer with a good telescope can distinguish Greylag Geese in their first autumn from older geese at distances of up to 300 metres and it is possible by protracted watching to recognise family parties, of parents accompanied by 1-8 young. Geese caught for ringing in rocket-nets can also be identified as 'young' or 'adult', though family parties cannot be recognised. The collection of information on brood sizes and the proportion of young geese is, however, laborious and often frustrated, so that the annual samples summarised in Table VIII are small in proportion to the total population.

Among Pink-footed Geese in Britain, Boyd and Ogilvie (1969) showed that over the period 1950-1968 both the mean brood size and the proportion of young (first winter) birds tended to decline, reaching very low levels in 1967 and 1968. Regular information on the recruitment of young Icelandic Greylags was not collected until 1958. Figure 5 shows that, as in the Pink-foot, there was a downward trend in both mean brood size and the proportion of young from 1958 to 1968. In 1969, and in 1970, both statistics were considerably higher. (In the Pink-footed Goose too there was evidence of improved breeding success in both those years.) However, the 1971 data indicate that the halt in the downward trend may have been only temporary.

The cause of the decline in mean brood size and relative numbers of young during a period of rapid increase in the size of the total population cannot be inferred from the numerical data alone and too little is known about the factors affecting reproductive success to pusue the topic in detail.

The reduction in mean brood size was associated with a virtual disappearance of broods of five or more and an increase in the proportion of families with only one young bird. Where useful samples from different regions were obtained in one year there was no evidence of local differences in mean brood size or in the proportion of single-young families or of large broods.

There are few indications of regional differences in the proportion of young in some, though not in most, years. Over the period 1959-1965 the proportion of young birds on Islay was 37.9%, compared with 27.0% in Angus and Perth. It is quite likely that the Greylags visiting Islay are well segregated in winter from those visiting eastern Scotland; they may indeed not be Icelandic birds at all. In general, however, the differences between regional samples in any year do not exceed those between subsamples from within a region. Given the low level of precision attainable in the field in censusing the population, it seems adequate to treat the entire population as homogeneous with respect to the proportion of young birds in any year, although there are important differences from one year to another.

Population budgeting

If the observed age ratios in the annual samples can be taken as estimates of the ratio in the entire Icelandic population, it is possible to estimate from the successive

Table VIII. Mean brood size and proportion of young Greylag Geese observed in Britain each year in late October and early November, 1958-1971.

	No. of geese inspected			*5-year*		*Mean*	*5-year*
Year	*total*	*1st w.*	*1st w. total*	*moving average*	*No. of broods*	*brood size*	*moving average*
1958	750	216	.288		17	2.88	
1959	318	110	.346		29	3.44	
1960	694	302	.435	.377	62	3.45	3.33
1961	883	353	.400	.355	8	3.75	3.22
1962	1126	358	.318	.341	23	3.13	3.13
1963	1715	472	.275	.296	35	2.31	3.06
1964	1415	391	.276	.266	13	3.00	2.84
1965	1115	235	.211	.224	21	3.09	2.57
1966	1070	266	.249	.181	17	2.65	2.37
1967	1297	143	.110	.173	68	1.78	2.16
1968	975	59	.060	.181	32	1.31	2.01
1969	581	138	.238	.167	60	1.97	1.85
1970	830	208	.251		33	2.36	
1971	1618	283	.175		128	1.85	
Sum	13319	3534			548		
Mean			.265			2.31	

November censuses both the number of recruits and the losses suffered from one census to the next. The difference between the total count in year (n) and the number of adults in years (n+1) is a measure of the losses, convertible to a crude mortality rate (d) by expressing the difference as a proportion of the total count (N) in year (n).

In November most families still comprise two adults with varying numbers of young (although later in the winter rather more families have only one adult). Thus the number of successful parents may be established by multiplying the number of young geese by 2/(mean brood size): 'successful parents' here having the restricted meaning of adults that have not only reared young to the flying stage but also brought them safely through their first southward migration. If it is assumed that mortality rate does not vary with age, it is also possible to calculate the presumed age composition of the population by applying the successive yearly survival rates (s=1−d) to each cohort of young geese.

The results of some of these calcula-

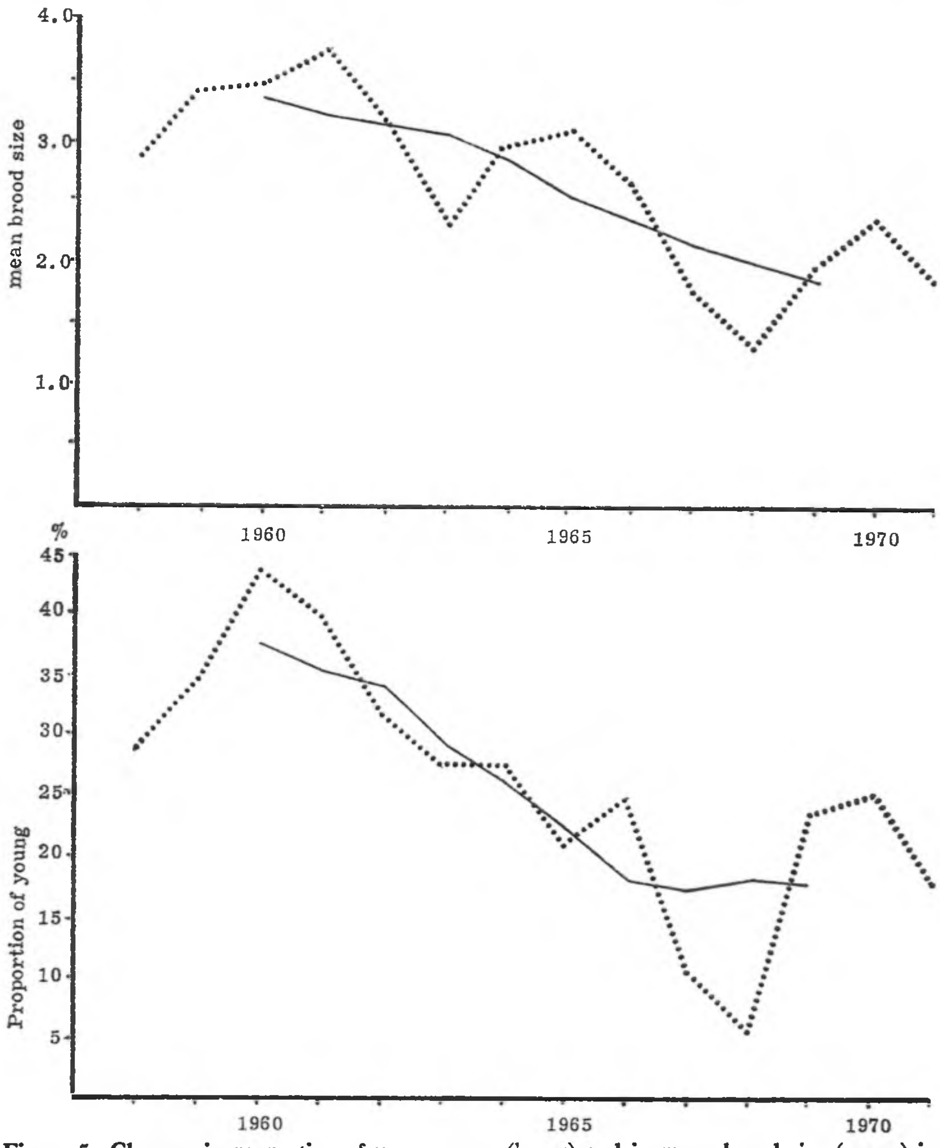


Figure 5. Changes in proportion of young geese (lower) and in mean brood size (upper) in autumn samples of Icelandic Greylag Geese, 1958 to 1971, with 5-year moving averages.

tions are illustrated in Figure 6, the numerical values being given in Table IX.

When the estimates of annual survival rates from the census results and the estimates of adult survival from recoveries of ringed geese are brought together (Table IX), it is clear that the two are not fully compatible after 1960-61. As already noted, the recoveries suggest a relatively high annual mortality, not tending to diminish. The census results require much lower annual losses, culminating in the absurdity of a survival rate of 107%

Figure 6. Estimates of the proportion of mature birds (over 3 years old) in the Icelandic Greylag Goose population in Britain, November 1960-1971; and of the proportion of mature birds that were parents.

Table IX. A population model for the Icelandic Greylag Geese in Britain in November, 1960-1971. Estimates in thousands of geese: 'mature' geese are those more than 3 years old, that could have bred in preceding summer.

Year	*Young geese* Y	*Parents* P	*Mature geese* M	*Parents/ Mature* P/M	*Mature/ Total* M/N	*Total geese* N	*Survival* % *(census)*	*Survival* % *(ringing)*
1960	11.5	6.7	6.9	.97	.26	26.3	79.5	80.5
1961	13.9	7.4	7.7	.96	.22	34.8	79.0	51.1
1962	12.9	8.2	9.1	.90	.22	40.4	58.2	73.9
1963	8.9	7.7	9.5	.81	.29	32.4	97.8	64.6
1964	12.1	8.1	15.5	.52	.35	43.8	54.9	59.0
1965	9.4	6.1	18.3	.33	.41	44.4	98.2	68.1
1966	14.5	10.9	24.7	.44	.48	58.1	80.6	57.9
1967	5.8	6.5	27.4	.24	.52	52.6	(107.0)	—
1968	3.7	5.7	37.2	.15	.61	60.8	77.5	—
1969	14.7	14.9	37.7	.40	.61	61.8	78.2	—
1970	16.2	13.7	33.8	.41	.52	64.5	80.0	—
1971	11.0	11.9	30.0	.40	.48	62.6	—	—

from November 1967 to November 1968 and with very few deaths in 1963-64 and 1965-66. While we do not have any good quantitative information on the scale of Greylag shooting in Scotland in recent years, there seems no reason to believe that in each of these three winters the kill fell below 1,000 birds. The explanation of the anomalies must be in terms of censusing and sampling, rather than biology. Possibly the rate of increase of the total numbers in November has been exaggerated by growing efficiency in locating flocks of Greylags or by greater generosity in estimating the numbers within flocks. Alternatively, the sampling for the proportion of young birds may have been unrepresentative, with few or no observations in recent years in places where young geese were plentiful, or with some unwitting changes in the criteria for identifying young geese. The choice of explanations seems likely to remain a matter of opinion, rather than rational decision, and is not of great importance if the limitations of the original data are kept in mind when they are being used for analysis. It is evidently impracticable to produce detailed year-by-year estimates of high reliability.

Yet the lack of precision should not be allowed to obscure several very clear trends. There can be little doubt that from 1960 to 1970 the Icelandic Greylag population more than doubled its size and that while it was doing so the number of potential breeders (geese three years old or more, and possibly some of those two years old) increased four or five times. But the estimated proportion of mature geese that brought young to Scotland fell very greatly (Table IX); for several years at the start of the decade most of them seem to have been successful, while in 1969 and 1970 only two-fifths may have succeeded and in 1967 and 1968 the situation was even worse. This decline in success was accompanied by a marked reduction in the number of large families.

An increase in total numbers not accompanied by an increase in recruitment of young birds can only have been achieved in one of two other ways. Either there was a reduction in the mortality rate of full-grown geese or the concept of the population as a closed one ceased to be appropriate and recruitment by adult immigration was occurring. Despite the minor complications due to native and feral geese, and to the changing role of Ireland as a wintering place, there is no evidence at all of the occurrence of immigration on the necessary scale.

Attempts to detect changes in mortality, nationally and regionally, by means of sample counts having proved inconclusive, this study has identified two major problems for further investigation without offering explanations for either. First, if the death rate of full-grown Greylags has been falling, and continues to fall, what has caused the change? Second, was the reduction in effective fertility during the last decade due to intra-specific regulating mechanisms rather than to extrinsic factors? If so, what were they?

If under some conditions nearly all the mature geese can be successful parents, are those conditions likely to obtain, even if only once, in the next few years? If so, the relative levelling off in numbers from 1966 to 1970 could be followed by another upsurge. Where could 80,000-100,000 Greylags, with similar numbers of Pinkfeet, be accommodated, in Iceland and in Britain?

Wild geese and conservation policy

There are two themes that have emerged repeatedly from the Wildfowl Trust studies of wild geese that have still to be acted upon by those organisations with statutory responsibilities for wildlife conservation. The first is that censuses and surveys, however well they may describe what has happened, do not provide an adequate basis for forecasting what may happen in the future. Successful prediction calls for understanding of the causes of change, which can only be obtained by research into all phases of the annual population cycle. The most obvious and important subjects for research include a study of breeding groups in Iceland. Their breeding biology has hardly been examined. This must, however, be linked with more detailed work in winter. Comparatively little is yet known about the factors governing fertility among wild geese though there is increasing evidence from North America that the condition of the birds in late winter and spring is at least as important as the state of the Arctic nesting grounds (C. D. MacInnes, unpub. report). Thus the study of Greylags before they leave Britain in the spring could be of considerable value. This paper has brought to light several other areas where our knowledge could usefully be greatly improved. In particular we need better monitoring of the changes in distribution that take place both between and within winters, and to discover the reasons behind them. We have all too little understanding of the effects of, among other things, food supply, disturbance and shooting pressure. Yet without such knowledge we may be forced to guess and could get the answers seriously wrong.

Superficial monitoring is cheap, easy and obvious and should be continued. Research is rather more expensive, and may fail to provide ready or agreeable answers; and the financial climate is unpropitious for increased funding. This relates to the second theme: in Britain, and in most other countries where any efforts at wildfowl conservation are being made, policies have been based on the idea that what are most needed are ameliorative and restorative measures to offset the consequences of the destruction of wetlands and the harmful effects of other human activities. Yet most of the geese visiting Britain are flourishing, despite the manifest dangers in being alive, so that the problems they pose are those of abundance rather than decline. In such circumstances continued over-simplified emphasis on 'protection' leads to anachronistic absurdities. The Greylag Geese in central Scotland provide an excellent example.

The latest legislative act (1967) intended to improve the welfare of wild geese in Britain made it illegal to offer dead wild geese for sale. The intention was to diminish the incentive for a few market hunters to kill very large numbers of geese. This legislation had scarcely come into force before farmers in Perthshire were complaining more loudly than ever of the alleged damage wrought by the greatly increased numbers of geese and were seeking special rights and assistance in killing or driving off the birds. Effective conservation activities should be based on thorough biological knowledge, with an appreciation of the dynamic capabilities of wildfowl populations, which enable them to solve most of their own problems more ably, and certainly far more speedily, than men can do. This is not a justification for indolence but a stimulus to action, to prove wrong the dictum of Benjamin Jowett: "Research, research, a mere excuse for idleness. It never has achieved, and never will achieve, any results of the slightest value."

Acknowledgements

Over the years several hundred people have helped to accumulate the information on which this study is based. We are fortunate indeed in having had their help, and in having been able to spend more time than most of them in watching and counting geese ourselves.

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Summary

Greylag Geese *Anser anser* breeding in Iceland winter in Scotland, with very small numbers in the north of England and in Ireland. Counts made in Britain in early November each year since 1960 show this population to have increased from about 26,000 in 1960 to over 64,000 in 1970, the rate of growth having slowed since 1966. The geese have been concentrating increasingly in the east and north-east of Scotland, both in November and later in the winter. Mean brood size fell from 3.45 in 1960 to 1.31 in 1968, returning to 2.36 in 1970 but was 1.85 in 1971; the proportion of young birds fell correspondingly, from 43.5% in 1960 to 6.0% in 1968, returning in 1969 and 1970 to very close to the period average of 25.0%. The number of mature geese in the population increased 4-5 times during the decade. In 1960-1962 most of the mature geese in the population seem to have brought families to Scotland; subsequently the proportion of successful mature birds fell to only about 15% in 1968 and to 40% in 1969-1971. The gross annual mortality rate estimated from the census and age ratio data was only 13.3%. The true rate is probably somewhat greater. There is no good evidence of a trend in annual mortality during this period.

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