



Status and distribution of Icelandic-breeding geese: results of the 2018 international census

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Summary

The 59th consecutive annual census of Greenland/Iceland Pink-footed Geese and Iceland Greylag Geese took place during autumn and early winter 2018. Sites holding Pink-footed Geese were primarily surveyed in October, with additional counts in November, whilst those holding Greylag Geese were surveyed in November. Coverage in Britain was good, with most of the key sites covered. Count data were also received from Ireland, the Faroe Islands and Southwest Norway, and from Iceland where an aerial census was conducted in favourable flying conditions. Weather conditions were generally considered good during the October and November census periods with very few sites reporting underestimated counts.

Maxima of 440,891 Pink-footed Geese and 92,509 Greylag Geese were counted in October and November, respectively. The Greylag Goose figure was adjusted to account for the estimated number of British/Irish Greylag Geese likely to have been counted during this census, resulting in population estimates of 440,891 Pink-footed Geese and 58,426 Greylag Geese. Compared to the previous year, the 2018 figures represent a decrease of 14.5% in the Pink-footed Goose population and a decrease of 4.2% in the Iceland Greylag Goose population. The possible explanations for these changes in population size are discussed in this report.

Fourteen sites in Britain held 10,000 or more Pink-footed Geese in October, with Montrose Basin, Angus, holding the largest number during the census (78,320 birds). Combined counts from 28 sites that supported numbers exceeding 1% of the 2018 Pink-footed Goose population estimate accounted for 83.2% of the total October count. During the November census, three quarters (75.3%) of the Iceland Greylag Goose population was present in North Scotland, principally in Orkney.

The breeding success of Pink-footed Geese was sampled at locations in Scotland and England during October and November, with 17.9% young found amongst those flocks assessed: this being slightly higher than the previous year but lower than the previous ten-year mean of 18.1%. The mean brood size of successful pairs was 2.0 goslings. The breeding success of Iceland Greylag Geese was sampled in northern Scotland with 22.6% young recorded amongst assessed flocks, which is higher than the previous year and also the ten-year mean of 21.9%. The mean brood size was 2.08 goslings per successful pair.

1. Introduction

The Pink-footed Goose *Anser brachyrhynchus* population which breeds in Iceland and along the east coast of Greenland, winters almost exclusively in Britain (Mitchell 2002), while Greylag Geese *Anser anser* breeding in Iceland principally winter in northern Britain, with small numbers in Iceland, Ireland, the Faroes and Southwest Norway (Swann & Brockway 2002). Large concentrations of both species occur during the autumn, Pink-footed Geese particularly in East Central Scotland, Southwest Lancashire and Norfolk and Greylag Geese in North Scotland, notably in Orkney. As winter progresses, redistribution to other parts of the wintering range occurs; and estimation of the size of these populations is therefore most effective in the autumn (Mitchell & Hearn 2004, Hearn & Mitchell 2004).

The Icelandic-breeding Goose Census (IGC) has been undertaken annually since 1960 and aims to assess the size, distribution and breeding success of Greenland/Iceland Pink-footed Geese and Iceland Greylag Geese. Since 1990, two coordinated counts have been undertaken, the first in October and the second in November. These are timed to coincide with periods when these geese are most concentrated after their arrival in Britain. Pink-footed Geese arrive earlier than Greylag Geese and are, therefore, usually best counted in October. The November count allows for the later migration of Greylag Geese to be completed. Every three years, a coordinated spring count is also undertaken in order to map the distribution of birds during this important part of the annual cycle; the most recent was in spring 2018 (reported in Brides *et al.* 2018).

This report provides an overview of the 59th consecutive annual census and an update on the population size and breeding success of Greenland/Iceland Pink-footed Geese and Iceland Greylag Geese following the 2018 breeding season.

2. Methods

Dates of the coordinated counts were chosen to avoid periods of full moon as far as possible, in an attempt to minimise the likelihood of geese remaining in feeding areas overnight. Counts were conducted by a network of experienced volunteer observers and professional conservation staff over the weekends of 20/21 October (Pink-footed Geese), 10/11 November (Pink-footed Geese) and 24/25 November (Greylag Geese). There were two survey periods in November due to the need to alter the originally planned date of 17/18 November as a result of it conflicting with a conference many IGC counters were attending.

In November, an aerial survey of Greylag Geese was carried out in southern Iceland. Data from this survey were combined with ground counts undertaken elsewhere in Iceland. In previous years, non-systematic information from hunters was also taken into account, however this information was not collected in 2018.

In some cases, counts made close to these dates were included in the coordinated census if there was no reason to suspect they duplicated other counts. Most counts were of roosting geese, made either at dusk, when the birds were flying in, or at dawn, as they departed for feeding areas. In a small number of areas where roost sites were poorly known, inaccessible or infrequently used, daytime counts of feeding birds were made. Consequently, in this report the term 'site' is applied to a range of geographical areas. Most are individual waterbodies where a goose roost occurs, whilst some are feeding areas around known roosts, and others are a mixture of the two. All sites are, however, areas to which an individual count can be attributed. For the purpose of analysis, counts from the Solway Firth, Orkney, Shetland, Southwest Norway, Faroe Islands and Iceland are treated as consolidated sites. Up to 2012, geese in Caithness were counted during the daytime when they were feeding on agricultural land and the county was treated as a consolidated site. However, since 2012, roost counts have been undertaken and these are now reported separately.

If necessary, adjustments are applied to count totals in order to generate the population estimate for the Pink-footed Goose and Greylag Goose populations. These adjustments take into consideration estimated counts, for sites that were not visited at the time of the census (for both populations), and estimated numbers of British/Irish Greylag Geese (for the Iceland Greylag Goose).

An attempt was made to account for the presence of British/Irish Greylag Geese in areas where Iceland Greylag Geese were also known to winter. This involves sites in the Faroes (1,000 geese, see Discussion), Ireland (936), Shetland (3,813) Orkney (18,500, see Discussion), Caithness (1,000) and Highland (750). British Greylag Geese also occur throughout southern Scotland and northern England and where counts were thought to involve British birds, these have been deducted (see Table 2).

Where a count was not undertaken, an estimate of the number of geese present may be provided by local counters. For regularly monitored sites (those counted in at least three of the previous five years) that were not counted during the current census, and no estimate was provided by a local counter, numbers are estimated using the mean of the counts made during the relevant month during the previous five years (e.g. the mean from 2013–2017 would be used in 2018). Estimated numbers (from either source) that exceed 0.5% of the current IGC peak count total for the relevant population are added to the peak count to give the adjusted population estimate.

Increasing numbers of British/Irish Greylag Geese in core wintering areas for the Icelandic migrants, such as Orkney and the Moray Firth means that assessing the abundance of the Iceland population at wintering sites is difficult. Where there are reasonable estimates of the abundance of British/Irish Greylag Geese, these are subtracted from winter counts. However, up to date information on the status of Iceland Greylag Goose south and east of an arbitrary line from Bute to Aberdeenshire is largely lacking and, simply as a precaution, any counts obtained through the IGC from this area are discounted, as it is likely that the majority of birds in this area during November are from the British population. This is carried out as a precautionary measure but is unsatisfactory as it will likely lead to the Iceland Greylag Goose population being underestimated.

To assess breeding success, experienced observers made assessments of the proportion of young (first-winter birds are separable from older birds by differences in plumage characteristics) in

goose flocks and of brood size during the autumn. Data collected from late September to late November were used to determine the percentage of young and the mean brood size of successful pairs.

3. Results

3.1. Coverage and conditions

The number of sites covered in each month is shown in Table 1. Coverage throughout the range of both species during late 2018 was considered reasonable. Most of the important sites for Pink-footed Geese and Greylag Geese were checked in 2018. In 2018, an additional 17 sites were covered for Pink-footed Geese in October and 39 in November, and 48 additional sites for Greylag Geese in November, compared with the previous year.

Table 1. The number of sites surveyed, and the number of sites holding Pink-footed and Greylag Geese in October and November 2018.

	October	November
Number of Pink-footed Goose sites surveyed	115*	145
Number of sites holding Pink-footed Geese	84	90
Number of Greylag Goose sites surveyed	-	150
Number of sites holding Greylag Geese	-	85

*includes Loch Eye, Highland which was visited but a count was not possible due to poor visibility.

No counts of Iceland Greylag Geese were undertaken during November in Southwest Norway. However, 250 birds were counted there in January 2019 and this was used as an estimate for the November census period. This approach has been adopted for several years; guidance from local counters in Southwest Norway suggests that the winter influx of Iceland migrants (determined by the presence of marked individuals from Iceland) occurs in late October or early November and they remain there throughout the winter (A. Follestad pers. comm.).

In Iceland, Greylag Geese were counted by air and ground surveys where count conditions were reported as favourable.

Elsewhere, good weather conditions were reported for most sites in both survey periods, however poor visibility was reported from five sites in October and three sites in November; it is unknown whether these counts majorly affected the overall total. Disturbance during counting was reported from one site in October, but was not thought to have adversely affected the counts at this location.

3.2. Total numbers

3.2.1. Pink-footed Goose

Totals of 440,891 and 388,738 Pink-footed Geese were counted in October and November 2018, respectively (Figure 1, Table 2). These represent a decrease of 14.5% and an increase of 3.2%, respectively, compared to the unadjusted total counts in the same months in the preceding year. Coverage was good and no estimated counts needed to be added to the unadjusted total so the total count for October (440,891) is used as the population estimate. (Figure 2).

3.2.2. Greylag Goose

In November 2018, 92,509 Greylag Geese were counted (Figure 1, Table 2). The unadjusted November count was 2.9% higher than that recorded the previous year. Following adjustments for British/Irish Greylag Geese likely to be included in this count, a population estimate of 58,426 Iceland Greylag Geese was derived (Figure 2). This represents a decrease of 4.2% compared to the previous estimate of 60,962 geese in 2017. Coverage was good with no estimated counts needed to be added to the estimate so the adjusted count (taking in to account the deducting of British birds) for November (58,426) is used as the population estimate.

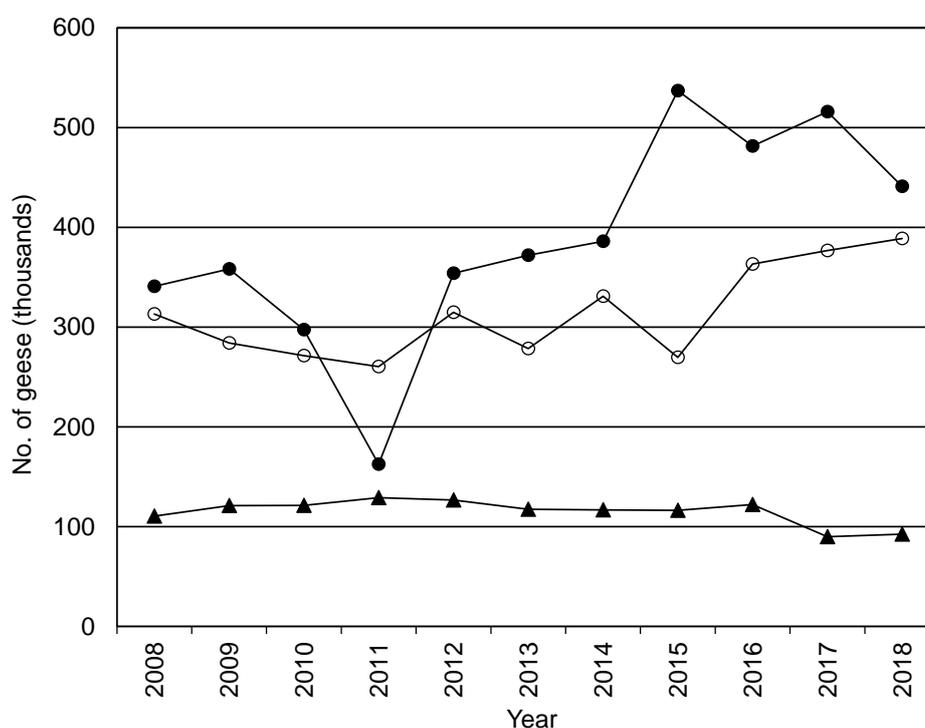


Figure 1. Peak (unadjusted) counts of Pink-footed Geese (circles) in October (filled) and November (open) and Greylag Geese (triangles) in November counted during the Icelandic-breeding Goose Census, 2008 to 2018.

Table 2. Totals of Pink-footed Geese and Iceland Greylag Geese by country and region in October and November 2018. Raw counts are shown with adjustments for non-Icelandic birds [-x]. Figures in parentheses indicate the number of sites counted.

Region/area	October 2018		November 2018	
	Pinkfoot		Pinkfoot	Greylag
Iceland*	nc		4 (1)	10,583 (1)
Norway*†	nc		nc	250 (1)
Faroe Islands*	nc		23 (1)	1,000 (9)
				[-1,000]
Ireland	nc		628 (5)	3,008 (7)
				[-936]
Shetland*	nc		3 (1)	3,813 (1)
				[-3,813]
Orkney*	nc		463 (1)	60,534 (1)
				[-18,500]
Caithness	1,298 (4)		71 (3)	2,293 (15)
				[-1,000]
Highland	40,012 (6)		25,155 (8)	1,400 (7)
				[-750]

Region/area	October 2018	November 2018	
	Pinkfoot	Pinkfoot	Greylag
Moray	10,110 (1)	26,660 (3)	1,544 (3)
Aberdeenshire	69,106 (6)	114,899 (7)	1,046 (8) [-1,046]
Angus/Dundee	90,092 (3)	nc	5 (1) [-5]
Perth & Kinross	31,817 (6)	20,761 (11)	1,978 (12) [-1,978]
Stirling/Falkirk/Clackmannanshire	2,616 (4)	0 (3)	36 (3) [-36]
Fife	7,882 (11)	19,040 (11)	43 (11) [-43]
Argyll & Bute	nc	24 (1)	342 (1) [-342]
Clyde	nc	nc	nc
Ayrshire	nc	nc	nc
Dumfries & Galloway **	11,441 (6)	7,538 (5)	0 (5)
Cumbria **	9,440 (5)	2,687 (3)	29 (3) [-29]
Lothians	5,671 (13)	6,440 (16)	1,644 (16) [-1,644]
Borders	43,023 (11)	16,088 (13)	685 (12) [-685]
Northumberland	6,940 (11)	1,792 (13)	2,016 (13) [-2,016]
Lancashire & Merseyside	54,757 (7)	49,598 (8)	0 (7)
N Wales/Dee Estuary	2,500 (1)	3,800 (2)	0 (2)
Humberside	11,763 (7)	22,181 (7)	0 (6)
Lincolnshire	nc	nc	nc
Norfolk	42,423 (13)	70,883 (14)	260 (5) [-260]
<i>Raw total counts</i>	440,891	388,738	92,509
<i>Adjustment for non-Icelandic birds</i>			-34,083
Population Estimate	440,891		58,426

* Several feeding sites consolidated.

** Counts from the Solway Firth have been split between birds counted in Dumfries & Galloway and Cumbria.

† The count in Norway was undertaken in January 2019.

nc No count received.

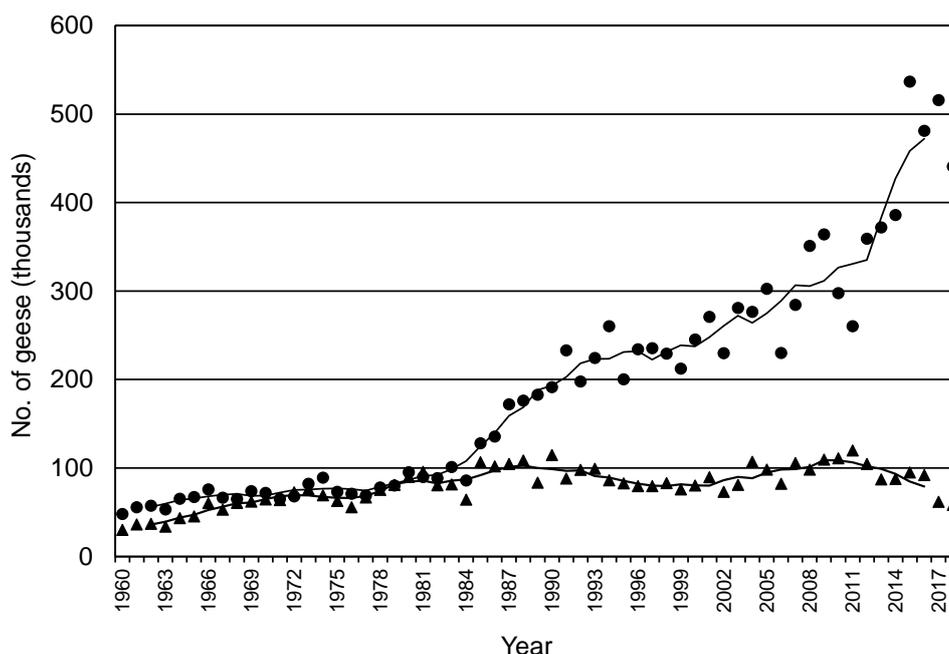


Figure 2. Population estimates for Pink-footed Geese (circles) and Iceland Greylag Geese (triangles), 1960 to 2018. The five-year running means (e.g. mean for 2016 is from population estimates for 2014 to 2018) are shown as lines.

3.3. Regional distribution

3.3.1. Pink-footed Goose

By the time of the October census, 30.0% of the population had arrived in East Central Scotland, with a further 18.0% in Northeast Scotland, 13.0% in West England, 12.6% in Southeast Scotland/Northeast England, 12.3% in East England, 9.4% in North Scotland and 4.7% in Southwest Scotland/Northwest England (Table 3, Figure 3). By November, all regions held lower proportions of birds, apart from Northeast Scotland where numbers had increased from 18.0% to 32.1% of the population, and East England where numbers had increased from 12.3% in October to 21.1% in November (Table 3, Figure 3), suggesting a north-easterly shift in the population to Northeast Scotland and south to East England.

3.3.2. Greylag Goose

By November, 75.3% of the population was found in North Scotland, primarily on Orkney, with 2.6% present in Northeast Scotland, and 3.6% in Ireland (Table 3, Figure 4). Surveys in Iceland found 18.1% of the population still in the country at the time of the November census, with much of the distribution occurring in the southwest (Table 3, Figure 5). A small percentage (0.4%) of the population was also located in Norway (Table 3). In Britain, the overlap between the British and Icelandic populations makes it difficult to determine the origin of individuals; however, it is doubtful that many Greylag Geese encountered south and east of a line drawn from Bute to Aberdeen (see Figure 4) in November are of Icelandic origin (but see Discussion).

Table 3. National and regional distribution (within Britain) of Pink-footed Geese and Iceland Greylag Geese counted during October and November 2018, expressed as a percentage of the maximum count for each species.

	Pink-footed Goose		Greylag Goose
	October	November	November
Iceland	0	0	18.1
Faroes	0	0	0
Norway	0	0	0.4
Ireland	0	0.2	3.6
North Scotland ¹	9.4	5.8	75.3
Northeast Scotland ²	18.0	32.1	2.6
East Central Scotland ³	30.0	9.0	0
Southwest Scotland/ Northwest England ⁴	4.7	2.3	0
Southeast Scotland/ Northeast England ⁵	12.6	5.5	0
West England ⁶	13.0	12.1	0
East England ⁷	12.3	21.1	0
Total	100	88.1	100

¹ Shetland, Orkney, Caithness and Highland

² Moray and Aberdeenshire

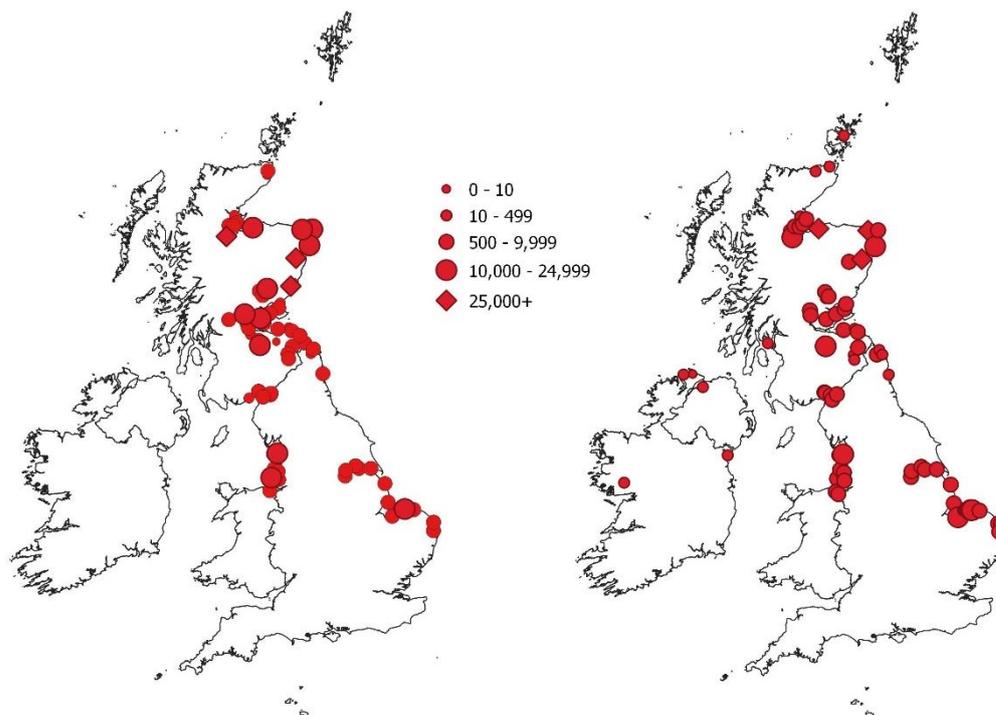
³ Angus & Dundee, Perth & Kinross, Upper Forth (Stirling/Falkirk/Clackmannan)

⁴ Argyll & Bute, Clyde, Ayrshire, Dumfries & Galloway and Cumbria

⁵ Lothians, Borders and Northumberland

⁶ Lancashire, Merseyside and North Wales/Dee Estuary

⁷ Humberside, Lincolnshire and Norfolk

**Figure 3.** Distribution of Pink-footed Geese in Britain and Ireland in October (left) and November (right) 2018.

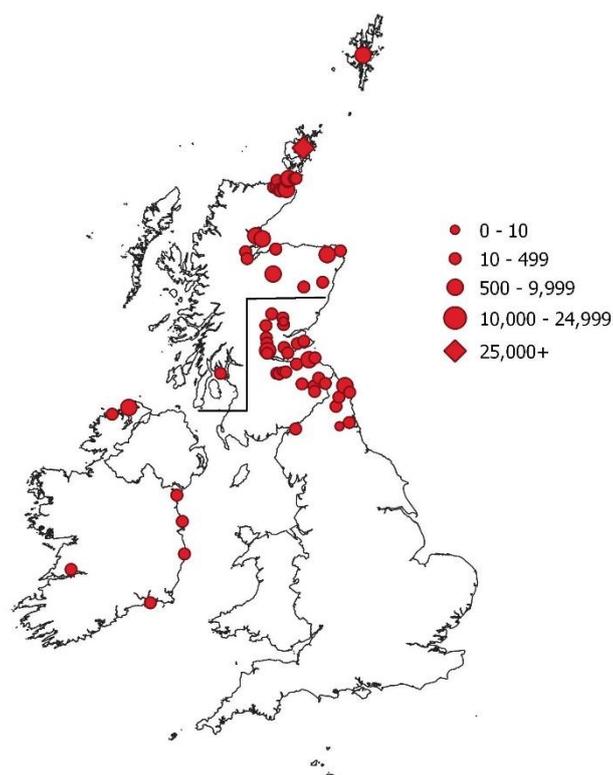


Figure 4. Distribution of Iceland Greylag Geese in Britain and Ireland in November 2018. The mapped counts do not differentiate between Icelandic and British/Irish birds. It is unlikely that many Iceland birds are present in Britain south and east of the line in November (see also Table 2).



Figure 5. Distribution of Iceland Greylag Geese in Iceland in November 2018.

3.4. Principal concentrations

3.4.1. Pink-footed Goose

Pink-footed Geese were recorded at 84 sites in October and 90 in November (Table 1, Figure 3). Fourteen sites held more than 10,000 birds in October (Table 4) and ten sites held this many in November. The number of sites holding more than 1% of the 2018 population estimate (4,408 birds) was 28 in October (Table 4) and 25 in November. In October, combined counts from the top

28 sites accounted for 83.2% of the total population and numbers at the top five sites held 39.1% of the population (Table 4).

During the October census, high numbers were recorded at Montrose Basin, Angus which held 78,320 birds (17.8% of the population estimate), Beaully Firth, Highland (25,200, 5.7%), Loch of Skene, Aberdeenshire (25,195, 5.7%), West Water Reservoir, Borders (24,200, 5.5%), Morecambe Bay, Lancashire (19,615, 4.4%) and Carsebreck and Rhynd Lochs, Perth & Kinross (18,200, 4.1%) (Table 4).

3.4.2. Greylag Goose

Greylag Geese were recorded at 85 sites in November (Table 1, Figure 4), eight of which held more than 1% of the 2018 population estimate (584 birds) (this considers Orkney and Iceland as single consolidated sites) (Table 4). The two sites supporting the highest counts were Orkney, which held 42,034 birds (71.9% of the population estimate) and Iceland, which held 10,583 (18.1%).

For the purpose of this report, Orkney is treated as a consolidated site. Appendix 1 shows the individual totals for the islands; ten of the islands held more than 1% of the population estimate in November, although these individual counts are not adjusted for the presence of Greylag Geese breeding in Orkney (thought to number *c.* 18,500 birds in total, but see Discussion).

Table 4. Sites that supported >1% of the (a) Pink-footed Goose (>4,408) and (b) Iceland Greylag Goose (>584) population estimates in October and November 2018, respectively. Note that these values are not the same as the internationally accepted threshold values for some populations that are used to identify sites of international importance: currently 5,400 for Pink-footed Goose and 980 for Iceland Greylag Goose (Wetlands International 2018). Greylag Goose counts are adjusted where possible (*i.e.* British/Irish birds have been deducted).

a) Pink-footed Goose

Site	October count	Percentage of population estimate
Montrose Basin, Angus	78,320	17.8
Beaully Firth, Highland	25,200	5.7
Loch of Skene, Aberdeenshire	25,195	5.7
West Water Reservoir, Borders	24,200	5.5
Morecambe Bay, Lancashire	19,615	4.4
Carsebreck & Rhynd Lochs, Perth & Kinross	18,200	4.1
Middlemuir, Aberdeenshire	14,500	3.3
Meikle Loch Slains, Aberdeenshire	13,000	2.9
Holkham Bay, Norfolk	12,500	2.8
Alt Estuary, Lancashire	11,810	2.7
Loch of Lintrathen, Angus	11,715	2.7
Loch Leven, Perth & Kinross	10,443	2.4
Loch of Strathbeg, Aberdeenshire	10,411	2.4
Findhorn Bay, Moray	10,110	2.3
WWT Martin Mere, Lancashire	8,912	2.0
Cromarty Firth, Udale Bay, Highland	7,350	1.7
Scolt Head, Norfolk	6,974	1.6
Folly Loch, Borders	6,032	1.4
St Fergus, Aberdeenshire	6,000	1.4
Snettisham, Norfolk	5,755	1.3

Site	October count	Percentage of population estimate
Dowlaw Dam, Borders	5,600	1.3
Moricambe, Cumbria	5,480	1.2
Thorne Moors, Humberside	5,230	1.2
Solway Airds Point to Drumburn, Dumfries &	5,141	1.2
Brow Well, Dumfries & Galloway	5,000	1.1
East Chevington Pools, Northumberland	5,000	1.1
Loch Gelly, Fife	4,600	1.0
Cromarty Firth, Nigg Bay, Highland	4,500	1.0

b) Greylag Goose

Site	November count ¹	Percentage of population estimate
Orkney Islands (all sites)	37,034	68.9
Iceland	10,583	19.7
Loch Swilly, Ireland ²	2,162	4.0
Upper Badenoch goose feeding areas, Moray	1,320	2.5
Loch Watten, Caithness ³	751	1.4
Loch Eye, Highland ⁴	655	1.2
Loch of Mey, Caithness ³	650	1.2

¹ Adjusted counts (see text and Table 2).

² Ireland includes an estimated 936 Irish birds (Table 2) that cannot be allocated to individual sites.

³ Caithness includes an estimated 1,000 British birds (Table 2) that cannot be allocated to individual sites.

⁴ Highland includes an estimated 750 British birds (Table 2) that cannot be allocated to individual sites.

3.5. Breeding success

3.5.1. Pink-footed Goose

Between late September and early November, a total of 22,089 Pink-footed Geese, in 29 flocks, were aged at various locations throughout Scotland and England. This represented 5.0% of the 2018/19 population estimate. The brood size of 610 families was also determined during this period.

Breeding success was similar to the mean for the previous decade, with flocks containing 17.9% young birds (mean 2008 – 2017: 18.1% \pm 1.21 SE) (Table 5, Figure 6). The mean brood size of successful pairs was 2.00 juveniles, which mirrors the mean recorded during the previous ten years (mean 2008 – 2017: 2.00 \pm 0.06 SE).

3.5.2. Greylag Goose

During mid-November, 1,378 Greylag Geese from 17 flocks were aged at various locations in Caithness, Scotland. This represented 2.4% of the 2018/19 population estimate. The brood size of 24 families was also determined during this period.

The percentage of young found amongst flocks (22.6%) was higher than the previous year (19.9% in 2017), and higher than the recent ten-year mean (mean 2008–2017: 21.9% \pm 0.51 SE) (Table 5, Figure 6). The mean brood size of 2.08 goslings per successful pair was lower than that of the recent ten-year mean (mean 2008–2017: 2.25 \pm 0.07 SE).

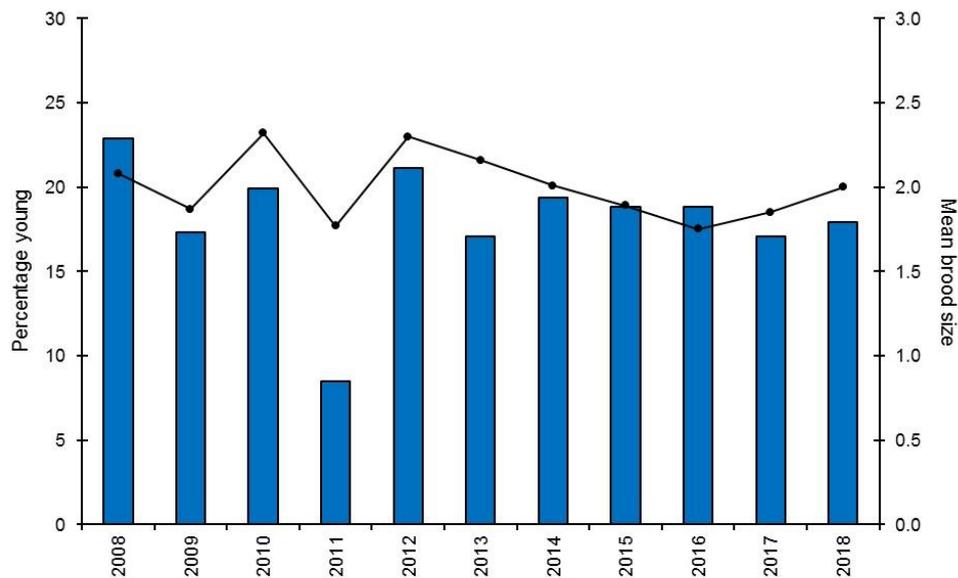
Table 5. The percentage of young in flocks and mean brood size of Pink-footed and Iceland Greylag Geese in 2018.

	Region	Time period	Total aged	% young	No. of broods counted	Mean brood size
Pink-footed Goose ¹	N Scotland	Late Oct	1,450	16.7	11	2.09
		Early Nov	250	11.2	-	-
	NE Scotland	Late Sept	1,000	28.7	56	2.20
		Early Oct	1,000	18.6	16	2.13
		Late Oct	1,500	16.1	4	1.75
	EC Scotland	Late Oct	3,700	13.6	-	-
		Early Nov	1,250	16.7	8	1.63
	SW Scotland	Late Oct	211	38.4	-	-
	W England	Late Oct	4,268	12.8	260	1.80
	E England	Late Sept	178	23.6	19	2.21
		Early Oct	6,250	21.7	190	2.09
		Early Nov	1,032	22.7	46	2.17
	Total		22,089	17.9	610	2.00
Greylag Goose ²	N Scotland	Mid-Nov	1,378	22.6	24	2.08
	Total		1,378	22.6	24	2.08

¹ Pink-footed Geese were aged between 20 September and 15 November 2018.

² Greylag Geese were aged between 15 November and 18 November 2018.

a) Pink-footed Goose



b) Greylag Goose

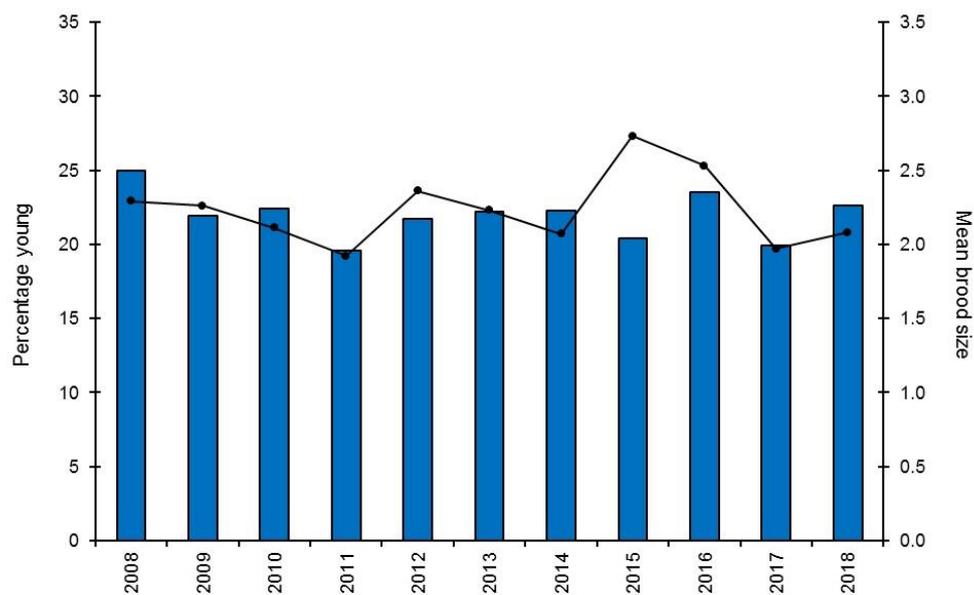


Figure 6. The percentage young (column) and mean brood size (line) found in flocks of (a) Pink-footed Geese and (b) Iceland Greylag Geese, 2008 to 2018.

4. Discussion

The 2018 Pink-footed Goose population estimate of 440,891 was 14.5% lower than the 2017 estimate (515,852) and lower than the presumed undercount in 2016 (481,341) (Figure 2). Given that recent population estimates have fluctuated considerably between years, whilst annual breeding success remained stable, with no apparent demographic explanation for a decrease in numbers, it seems likely that the 2018 population estimate was affected by a degree of undercounting. Whilst we still lack adequate information on annual survival rates and, in particular, estimates of annual harvest, the main cause of mortality, long-term monitoring of annual harvest in Iceland during 2008–2017 indicate that the bag has been largely stable and so it seems unlikely to be an explanation of the large annual variations in the numbers counted. Estimates of the number of Pink-footed Geese harvested during 2018, both in Iceland and the UK, are currently unavailable.

No estimate of the number of Pink-footed Geese in Iceland at the time of the October census was available. However, data from the tracking of Pink-footed Geese using Global Position System (GPS) highlighted that of the 42 birds with functioning tags at the time of the October census, all but one had already migrated to the wintering grounds. This suggests that some birds, though perhaps not many, were still present in Northern Iceland at the time of the census.

GPS tracking data continue to provide useful information on roosting locations used by birds throughout the wintering range and are helping to identify new roost sites that are not yet covered as part of the Icelandic-breeding Goose Census. In order to try to reduce the possibility of missing birds during future censuses, the information gained from the Pink-footed Goose tracking project will be used to identify any new sites that need to be covered.

It is possible therefore that the lack of information regarding how many Pink-footed Geese were present in Iceland during October 2018, twinned with the potential for birds to be roosting at locations in the UK not covered as part of the census, could have contributed to the lower number of birds recorded during the October census and thus the overall population estimate.

For Pink-footed Geese during November, counts submitted during a wide range of dates ranging from 6 to 29 November were used in the overall count total. Data received as part of the GPS tracking project show that a lot of movement of Pink-footed Geese did occur in Britain during this time and double counting cannot be ruled out. Nevertheless, counts submitted during November 2018 did provide useful information on site usage by Pink-footed Geese.

The breeding success of Pink-footed Geese was sampled in several regions, but at different times during the autumn. This leads to differences in the percentage young and mean brood sizes recorded both spatially and temporally (see Table 5). Successful families tend to arrive early on the winter quarters, with non-breeders and unsuccessful pairs arriving later (see Patterson & Hearn 2006) leading to a higher proportion of young recorded earlier in the autumn.

The population estimate of 58,426 Iceland Greylag Geese, although lower is not too dissimilar to that in 2017. Suggestions of a recent population decline have been previously reported (Mitchell & Brides 2017) and it is noteworthy that the population estimate in 2018 remains well below the ten-year average of 96,838 birds (2008–2017). However, the degree to which undercounting and under-estimation in Orkney affected the 2017 and 2018 population estimates remains unclear.

All sites that hold Iceland Greylag Geese were counted within 3–4 days of the coordinated census weekend, therefore the likelihood of double counting is low.

Orkney continues to hold the largest proportion of the Iceland Greylag Goose population, however, as geese from both the Icelandic and British populations are present at the time of the census, estimating the number of Icelandic birds also requires an understanding of the number of British birds present. To do this we used a combination of the most recent post-breeding census of British Greylags in Orkney, undertaken in August 2016 (21,000 birds; see Mitchell & Brides 2017), adjusted using an estimate of the number of British birds shot in Orkney between September and November 2018 (2,500 birds). Therefore, in total, 18,500 birds were deducted from the overall Orkney total to give the best possible estimate of the number of Icelandic Greylag Geese. This rather crude method would benefit greatly from annual monitoring of the size of the post-breeding

British population in Orkney alongside annual estimates of the number of birds shot there, both during the period when both populations are present and when only the British birds are present.

As information on the number of summering British Greylag Geese in Shetland is limited, it is difficult to estimate the number of wintering Iceland Greylag Geese in Shetland at the time of the census. Therefore, as a precautionary measure the count from the islands was not included in the overall 2018 total. Likewise, information on summering birds from the Faroes is limited and as a result, the total number of birds recorded there in 2018 (1,000) was also deducted from the total count. The ringing of summering birds is due to start in the Faroes from 2019 onwards (Jóhannis Danielsen pers. comm.) and will hopefully provide useful information on the winter movements of summering Greylag Geese in the Faroes.

As previously reported, large numbers of British Greylag Geese in core wintering areas for the Iceland population, such as Orkney and the Moray Firth, means that assessing the abundance of the Icelandic population during the non-breeding season remains very difficult. Up to date information on the status of Greylags south and east of an arbitrary line from Bute east to Aberdeen is largely lacking and, therefore, simply as a precaution, any counts obtained through the IGC from this area are assumed to be British birds and subtracted from the total count. However, as recently as winter 2018/19, sightings of colour-marked Iceland Greylag Geese have been sighted as far south as Northumberland (B. Swann pers. comm.) showing some overlap in the wintering population south of the arbitrary line as described above, which means there is a possibility that some Iceland Greylag Geese could have been subtracted from the overall Icelandic population total.

The monitoring of annual breeding success for the Iceland Greylag in Britain is also becoming more difficult because of the overlap in the main wintering areas (Orkney and around the Moray Firth) with British Greylag Geese and because separating birds from each population is impossible in the field. However, the results from summer counts (carried out in 2016, C. Mitchell pers. obs.) suggest that the majority of birds found in Caithness in winter are from Iceland and it is in this county only that age counts were undertaken. However, difficulty was experienced in finding good numbers of geese for ageing in Caithness in November 2018 which led to a very low sample size.

Given the increased difficulty in ageing Iceland Greylag Geese on the wintering grounds and with the discontinuation of the annual wing survey of harvested birds in Iceland, which provided additional information about breeding success, it would be advantageous to explore options to sample the geese in the field in Iceland prior to migration in order to assess the breeding success of this population. However, this does pose problems since temporal changes in surveillance from November (wintering area) to August/September (in Iceland) will make the comparison of annual results difficult and so therefore a period of overlap whereby both methods are used should be implemented.

The annual surveillance of Iceland Greylag Geese remains challenging. In order to better understand the apparent decrease in population size in 2017 and 2018, greater coordinated effort between the UK and Iceland is needed, particularly in identifying any potential gaps in coverage in Iceland and ensuring coverage is as comprehensive as possible. It would also be useful to undertake late summer surveys of British Greylag Geese in Orkney, Shetland, Caithness and the Moray Firth to gain better estimates of the number of resident birds. Furthermore, it is important to initiate the annual collection of hunting bag statistics in the UK to better understand hunting pressure on wintering Iceland Greylag Geese. The reinstating of regular colour-marking of Iceland Greylag Geese, or even increasing the use of telemetry, would potentially provide up to date information on autumn distribution in Iceland, timings of migration and the distribution and movements on the wintering areas. Colour-marking would also allow annual survival rates to be calculated; this would be particularly useful given the uncertainty with the total counts.

Continued collaboration between the GSMP and colleagues in Iceland is crucial to maintaining the effectiveness of our long-term annual monitoring of Icelandic-breeding goose species.

5. Acknowledgments

This census is part of the long-term Goose & Swan Monitoring Programme (GSMP), which monitors the abundance and breeding success of the UK's native goose and migratory swans during the non-breeding season. GSMP is organised by the Wildfowl & Wetlands Trust (WWT) in partnership with the Joint Nature Conservation Committee (JNCC) and Scottish Nature Heritage (SNH).

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Appendix 1. Greylag Goose counts at individual sites in Orkney in November 2018.

Site	November count	% of the unadjusted 2018 population estimate
West Mainland	27,582	6.5
East Mainland	7,366	1.6
Shapinsay	4,276	4.6
Sanday	2,413	2.6
Stronsay	4,547	4.9
South Ronaldsay	2,535	2.7
Westray	2,591	2.8
Eday	1,902	2.1
Rousay	2,164	2.3
North Ronaldsay	765	0.8
Papa Westray	1,293	1.4
Egilsay	875	0.9
Graemsay	480	0.5
Burray & Hunda	458	0.5
South Walls, Switha, Melsetter	416	0.4
Gairsay	359	0.4
Flotta	175	0.2
Wyre	268	0.3
Muckle Green Holm	60	0.1
Hoy and North Walls	9	0.02
Total	60,534	35.6

Given the increasing difficulty in separating the two populations and the absence of up to date information on numbers of resident British Greylag Geese on Orkney, counts have not been adjusted to take into account the estimated number of British Greylag Geese in Orkney.