



The abundance and distribution of
British Greylag Geese in Orkney,
August 2015

**A report by the Wildfowl & Wetlands Trust to Scottish Natural
Heritage**

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Summary

1. A survey involving field counts of British Greylag Geese on the Orkney archipelago counted 21,354 birds in late August 2015, a 6.8% decrease on the number counted there in August 2014. The mean density of geese on agricultural land was 0.55 birds ha⁻¹.
2. A sample of geese was aged and 27.0% were young. The mean brood size was 3.38 young per successful pair. If the proportion of young is indicative of the whole population in Orkney then there were potentially 1,706 successful breeding pairs of Greylag Geese in Orkney in summer 2015.
3. Greylag Geese were found primarily on improved grass fields (72.9% of those counted, excluding those recorded as flying or on waterbodies). The geese showed a strong preference for improved grass and avoided rough grassland and heather moorland. Where the habitat was recorded, 2.8% of the geese were in arable fields, of which the majority were on harvested stubbles.
4. Between ~20,000 and ~23,000 Greylag Geese have been counted in Orkney during late August from 2012 to 2015, suggesting that the rapid increases in numbers up to 2012 (of c. 19% per annum) has stopped and that, due to increased shooting of the summering stock, the population trend has stabilised.
5. Suggestions are given to explain the modest discrepancy between the expected population level in summer 2015 estimated by SNH, and the number counted. These include:
 - i. The August 2015 census may have slightly under-estimated the number of birds present;
 - ii. The estimate of the percentage young in Greylag Goose flocks in August 2015 may have over-estimated breeding success;
 - iii. Of the 9,550 Greylag Geese reported shot between October 2014 and the end of the hunting season, the bag may have comprised a higher than estimated proportion of British Greylag Geese;
 - iv. There may have been inaccuracies in the reported bag either during the pilot scheme and/or during the open season;
 - v. The SNH schema is relatively crude and other factors not included in the model may affect projections (for example, the age/sex ratios of shot birds and or immigration/emigration rates).

Introduction

The largely sedentary British Greylag Goose *Anser anser* population is increasing in abundance and distribution in Scotland, with breeding now occurring over much of the mainland, Western Isles and Northern Isles (Mitchell *et al.* 2010a). Local increases in the number of British Greylag Geese have led to an increase in reports of damage to agricultural economic interests and the implementation of pilot adaptive management projects by the Scottish Government and Scottish Natural Heritage (SNH) on islands including the Uists, Tiree and Orkney.

The British Greylag Goose (hereafter Greylag Goose, unless referring to the Iceland population) is the only native species of goose breeding in Britain. At the end of the 18th century, the species had a much wider distribution within Britain, breeding in many areas of Scotland and more locally in England, Wales and probably Ireland (Holloway 1996). However, during the 19th century, numbers began to decline and it seems likely that over-hunting, and the drainage and cultivation of the fens, were responsible for the extinction of the species in England and Wales. A remnant population, probably numbering fewer than 500 birds, persisted in the 20th century in the Outer Hebrides (see Mitchell *et al.* 2010b for a review).

There is no evidence that Greylag Geese bred in Orkney in the 18th, 19th or the first 80 years of the 20th century; records suggest that presumed winter migrants from Iceland were encountered regularly on passage and small numbers occasionally over-wintered (Booth *et al.* 1984). The lack of breeding records seems somewhat surprising given the wealth of suitable habitat available for breeding, although the same lack of evidence of breeding is true of Shetland. In the early 1980s, c. 50 Greylag Goose goslings from Anglesey (but descended from South Uist stock – see Mitchell *et al.* 2010b) were released on Shapinsay, Orkney over a period of three years. It is thought that the colonisation of Shapinsay, the Kirkwall area and nearby uninhabited islands resulted from these releases. The first breeding record is of a pair in Birsay in 1985. However, whether nesting elsewhere in Orkney resulted from this introduction is unknown. An alternative possibility is that wintering birds (from the Iceland population), perhaps involving some individuals injured by shot, began to over-summer in Orkney rather than returning to their usual breeding grounds in Iceland. In addition, a small number of neck-collared individuals from the mainland British population (marked at Loch Loyal, Sutherland), were seen in Orkney, from 1997, including at least two with broods of young and one incubating a clutch of eggs. Part of the colonisation may therefore have occurred naturally from mainland Scotland. It is also possible that a combination of all three sources may have been involved in the establishment of breeding Greylag Geese in Orkney. However, up to 2000, colonisation of the islands had been rather modest, and less than 100 pairs were thought to be nesting throughout Orkney (Meek 2008).

A comprehensive survey of Greylag Geese in Orkney was carried out in July 2008, at a time when the geese were moulting. Allowing for a small amount of double counting and flocks being missed, the total in that year was estimated at c. 10,000 birds (range 9,000 to 11,000). Breeding pairs and post-breeding flocks were recorded on almost all islands in the archipelago, and it is thought that the proximity and mixture of moorland breeding areas, remote and safe offshore islands, large inland lochs, and intensively managed grasslands all helped to fuel the increase in numbers.

In order to manage British Greylag Geese in Scotland, regular assessments of the status and distribution of the geese are required. This is particularly pertinent in Orkney where the Scottish Government and SNH have initiated a pilot adaptive harvest management system to manage Greylag Goose abundance. Assessing the abundance and annual productivity of Greylag Geese in Orkney in summer will therefore provide essential baseline data for the demographic modelling required by this process.

Three late summer archipelago-wide surveys have been carried out prior to this survey. A survey in late August 2012 estimated 21,367 Greylag Geese (Mitchell *et al.* 2012), the 2013 survey estimated 20,242 geese (Bridges *et al.* 2013) and the 2014 survey estimated 22,911 geese (Mitchell *et al.* 2014).

Methods

Field counts

Following the methods employed in late August 2012 (see Mitchell *et al.* 2012), Greylag Geese were counted in Orkney during late August 2015, a time when the geese have completed their moult and have moved to feeding areas on the main islands. Local observations in previous years, and the results from the 2012, 2013 and 2014 late August surveys, suggest that the geese would largely be using agricultural land by then. This is a time which potentially brings them into conflict with agricultural economic interests, and so an understanding of the distribution of the geese in late August was therefore considered desirable. The survey in 2015 aimed to ensure that all habitats were adequately checked.

WWT staff liaised with professional and volunteer goose counters in Orkney to arrange coordinated 'look-see' coverage of agricultural land and natural wetland habitats in late August 2015, covering the same areas checked during annual winter counts. Land was checked for geese by following the road network and stopping at suitable vantage points. Counters were also asked to walk to vantage points, where necessary, to check areas not visible from the road. In addition, accessible areas of moorland were also checked, especially where re-seeded fields were adjacent to moorland and where moorland held grass patches. No minimum time limit was set for each site and counters could spend as much time as necessary to thoroughly check surrounding areas for feeding geese. Counters were asked to record information on flock size, exact location and the broad habitat class that the geese were using. Smaller offshore islands were either visited (e.g. Graemsay) or checked using telescopes from vantage points on larger islands if access to the islands proved difficult (e.g. Switha).

Age counts

Greylag Geese within a sample of flocks encountered were aged as either adult or gosling using plumage characteristics (Figure 1). Adults were characterised by broad, blunt ended, pale tipped coverts on the upper wing, broad feathers on the flank and an ivory coloured tip to the bill. First winter Greylag Geese were characterised by narrower, rounded wing coverts lacking the broad pale parallel lines of the adult, a more mottled belly and flanks and, often, a black nail on the bill tip.



Figure 1. Photograph of adult (left) and first winter (right) Greylag Geese showing plumage features that determine age in late summer.

Brood sizes of successful pairs were also recorded. Young geese hatched in the spring remain with successful parents for most of the first winter. Families can be identified on behaviour; two (or rarely one) adult geese are accompanied by first-winter birds, the unit often walking and feeding together.

Results

Field counts

Whole archipelago counts were completed on 27 August to 1 September and involved c. 23.5 person days of time (see Appendix 1). All areas checked during the annual winter counts were checked during this August count. Coverage was considered good and no counters reported that they felt that they had missed birds. Count conditions were favourable with fair weather and long day length throughout the survey period.

A total of 21,354 Greylag Geese were counted in 258 flocks (median flock size 38 birds, range 1 to 605), with the largest numbers found on Mainland, Sanday and South Ronaldsay (Table 1, Figure 2). Mainland accounted for the majority of the total number of geese counted (42%, 8,964 geese). The density of Greylag Geese per hectare ranged from 0 ha⁻¹ on several islands to 0.79 ha⁻¹ on North Ronaldsay, with an overall density of 0.21 ha⁻¹ for the whole archipelago (Table 1).

Table 1. The abundance and distribution (by major island) of Greylag Geese in Orkney during 27 August to 1 September 2015, with estimated densities overall and on agricultural land.

Area ¹	Count	Area (ha) ²	Density (geese ha ⁻¹)	Density (geese ha ⁻¹) on agricultural land ³
Mainland ⁴	8,964	52,325	0.17	0.44
Sanday	2,613	5,043	0.52	0.86
South Ronaldsay	2,113	4,980	0.42	0.81
Stronsay ⁵	1,732	3,430	0.50	0.81
Shapinsay	1,563	2,948	0.53	1.17
Westray	962	4,713	0.20	0.32
Eday	566	2,745	0.21	0.52
North Ronaldsay	546	690	0.79	1.15
Papa Westray	501	933	0.54	1.16
Hoy/South Walls ⁶	495	14,558	0.03	0.39
Rousay/Eynhallow ⁷	447	4,935	0.09	0.38
Burray ⁸	466	1,098	0.42	0.97
Egilsay	176	650	0.27	0.56
Graemsay	105	409	0.26	0.68
Gairsay	47	240	0.20	0.38
Wyre	27	311	0.09	0.21
Auskerry	25	85	0.29	0.62
Flotta/Fara/Switha ⁹	6	1,212	0.01	0.04
Copinsay	0	73	0	0.00
Small Holms ¹⁰	nc ¹¹	265	-	-
Swona	Nc	92	-	-
Total	21,354	101,663	0.21	0.55

Notes:

¹ Islands not checked for geese include Cava (107ha). See also Appendix 2 for extent of coverage.

² Source: http://en.wikipedia.org/wiki/List_of_islands_of_Scotland. Estimates based on Ordnance Survey maps and General Register Office for Scotland statistics. Accessed on 31/10/12.

³ Improved grassland (LCM 2007 code 4) and arable land (LCM 2007 code 3) combined.

⁴ Includes West Mainland, East Mainland and Deerness.

⁵ Includes Stronsay (3,275ha), Papa Stronsay (74ha), Linga Holm (57ha) and Holm of Hulp (24ha).

⁶ Includes Hoy (13,458ha) and South Walls (1,100ha).

⁷ Includes Rousay (4,860ha) and Eynhallow (75ha).

⁸ Includes Burray (903ha), Hunda (100ha), Glims Holm (55ha) and Lamb Holm (40ha).

⁹ Includes Flotta (876ha), Fara (295ha) and Switha (41ha).

¹⁰ Includes Faray (180ha), Holm of Faray (29ha), Muckle Green Holm (28ha), Sweyn Holm (18ha), Rusk Holm (6ha) and Little Green Holm (4ha).

¹¹ nc = not counted by landing, but checked from the ferry and no geese were seen.

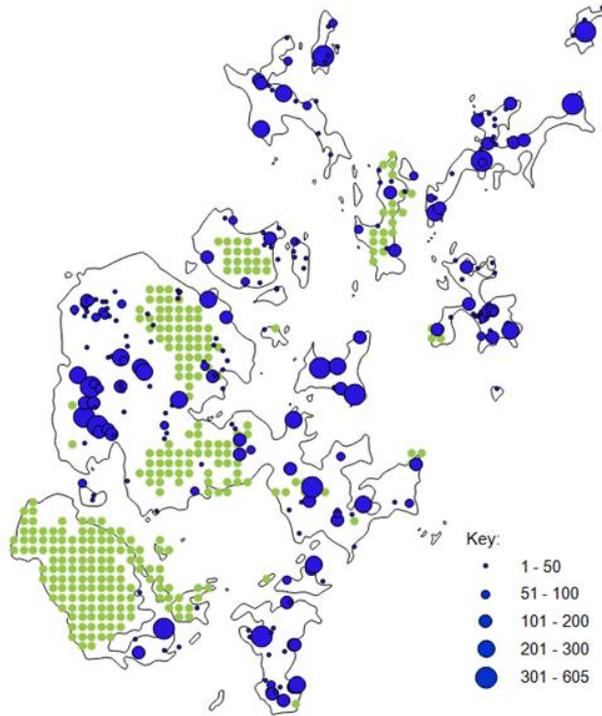


Figure 2. The distribution of Greylag Geese found during field surveys in late August 2015. Blue dots are proportional to flock size. One km squares dominated by moorland are shaded in green.

The 2015 estimate was 6.8% lower than the estimate from the previous year although, since August 2012, the total number of geese in Orkney has remained relatively stable at between ~20,000 and ~23,000 birds (Figure 3).

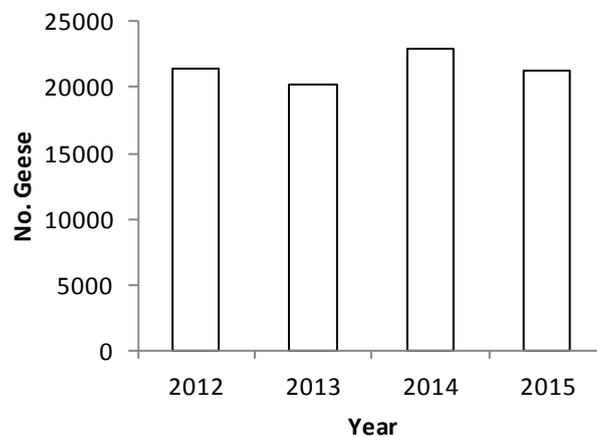
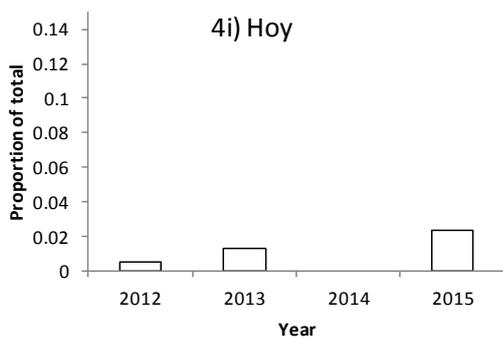
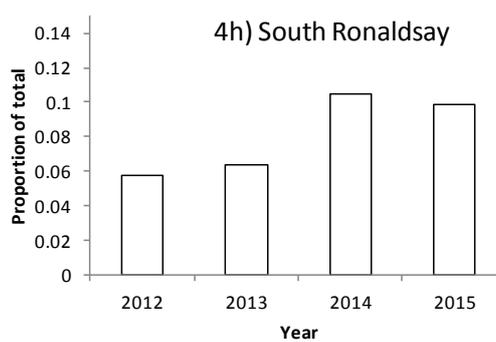
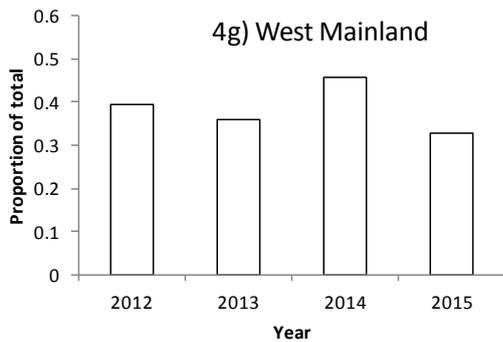
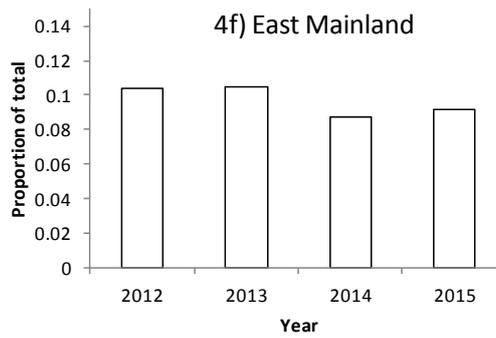
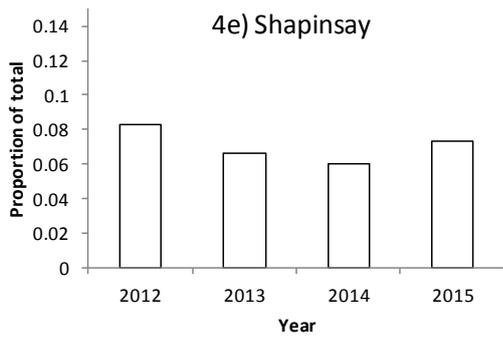
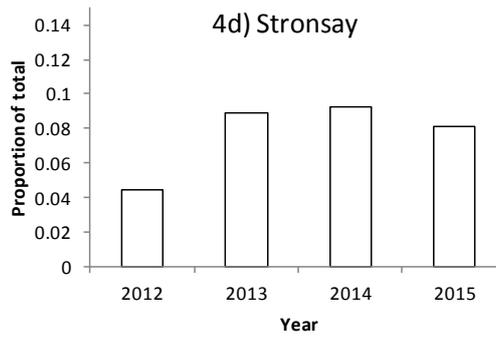
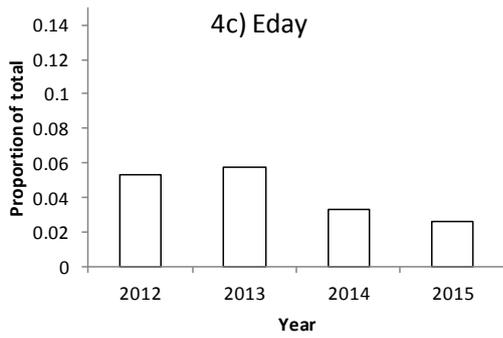
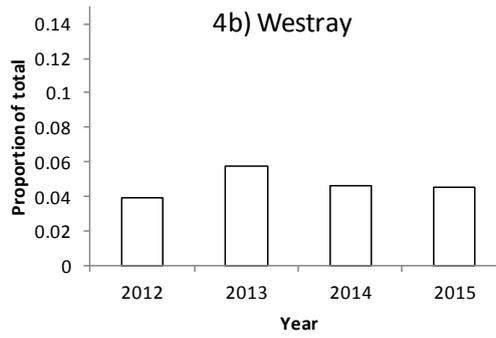
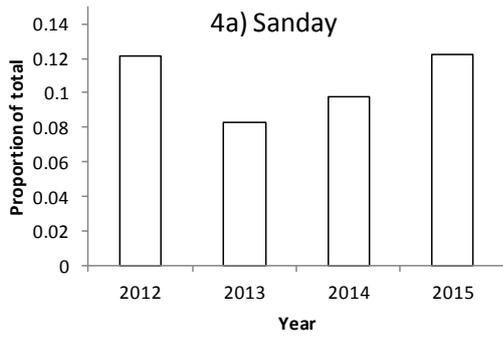


Figure 3. The number of Greylag Geese found during field surveys in Orkney in late August 2012 to 2015.

Some of the habitat in Orkney is moorland (Figure 2) which, although providing a suitable habitat for breeding Greylag Geese, holds few birds outwith the breeding period when the geese prefer to utilise agricultural land. Comparing the counts of geese to the availability of agricultural land (the area of improved grassland and arable land combined), the density of Greylag Geese per hectare ranged from 0 ha⁻¹ on Copinsay to 1.17 ha⁻¹ on Shapinsay, with an overall density of 0.55 ha⁻¹ for the whole archipelago (Table 1).

Based on the counts from the four late summer surveys, there have been some changes in the distribution of Greylag Geese on the main islands in Orkney (Figures 4a to 4i).



Figures 4a-4i. Changes in the distribution of Greylag Geese counted during field surveys on nine of the largest islands in Orkney in late August 2012 to 2015. Figures are expressed as the proportion of the total counted in Orkney each year. Note that the y-axis scales are set to the same scale apart from West Mainland.

Relative to the total number of geese counted, numbers have increased on South Ronaldsay and Hoy and decreased on Eday and East Mainland.

Flock size was highly skewed; of the 258 flocks recorded, 149 (57.8%) were of fewer than 50 birds (Figure 5). However, 27 flocks (10.5%) contained over 200 birds, the largest flocks being of 555 (West Mainland), 570 (Sanday) and 605 birds (Shapinsay).

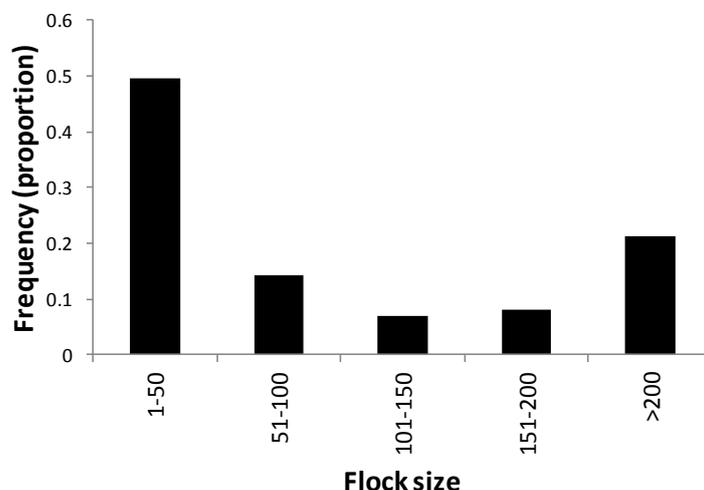


Figure 5. Frequency distribution of flock size of Greylag Geese encountered during field surveys in Orkney in late August 2015.

Habitat preferences of Greylag Geese

The majority of Greylag Goose records (86.8%) were accompanied by habitat information. Greylag Geese encountered on the sea, open freshwater or saline/brackish waterbodies (3,561 birds) and any geese counted in flight (525 birds) were excluded from this analysis, since geese were only encountered there loafing or after being disturbed from feeding areas. Records of geese in the remaining habitats revealed a strong preference for improved grassland and avoidance of semi-natural grass fields and heather moorland, relative to the habitat available (Table 2, Figure 6).

Table 2. The location of flocks of Greylag Geese encountered during late August 2015 in relation to various habitat classes (excludes freshwater and saltwater habitats). See also Appendix 2.

LCM 2007 habitat class	LCM 2007 habitat code	Area (ha) in Orkney	Percentage of total area	No. geese counted in habitat class in August 2015	Percentage of geese counted in habitat class	Jacobs Index ¹
Arable	3	2,589	2.7	397	2.8	0.02
Improved grass	4	35,969	37.1	10,191	72.9	0.64
Semi-natural grassland	5,6,7,8,9	29,029	29.9	2,941	21.1	-0.23
Moorland (mountain, heath, and bog)	10,11,12,13,14	23,462	24.2	387	2.8	-0.83
All other habitats	1,2,15-23	5,886	6.1	52	0.4	-0.88
Total		96,935 ²	100.0	13,968 ³	100.0	

Notes:

¹ Jacobs (1974).

² Total excludes areas of freshwater (LCM 2007 code 16) and saltwater (LCM 2007 code 17).

³ Total excludes birds counted on waterbodies (n = 3,561) and in flight (n = 525).

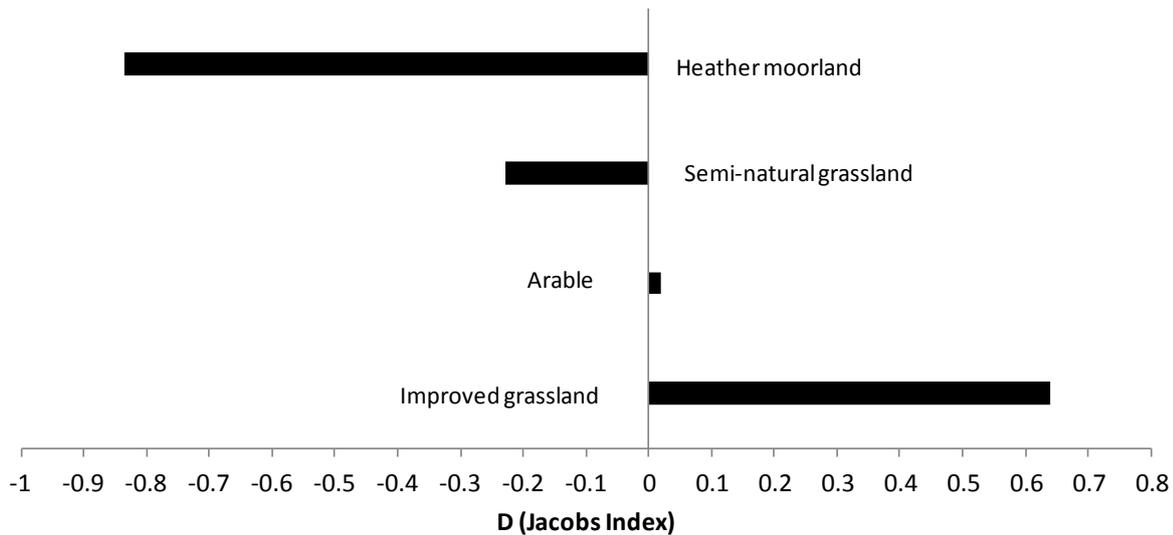


Figure 6. Terrestrial habitat preferences of Greylag Geese in August 2015 expressed by Jacobs Index (D). The index ranges from -1 (complete avoidance) to +1 (exclusive use).

However, even when Greylag Geese were found in moorland habitats, the geese tended to feed in small patches of semi-natural grass within the heather (pers. obs.).

A total of 397 geese (2.8% of the birds for which habitat data were collected) were recorded on arable land; 117 birds (0.8%) on un-harvested standing crop and 280 birds (2.0%) on arable stubbles.

Age counts

A sample of 1,085 geese was aged on Mainland, Hoy and Westray of which 293 (27.0%) were first-winter birds (young of the year). The sample represented 5.1% of the Orkney population. The mean brood size was 3.38 young per successful pair. In contrast to 2012, no flocks that were aged contained no young (see Mitchell *et al.* 2012).

If the proportion of young birds recorded was indicative of the whole population in Orkney, then approximately 5,766 birds were young ($21,354 \times 0.27$). The mean brood size was 3.38 young, suggesting that, as an approximation, there were potentially 1,706 successful pairs of Greylag Geese in Orkney in summer 2015. Using these approximations, the estimated number of successful pairs has been between 1,600 and 2,200 during 2012 to 2015 (Figure 7).

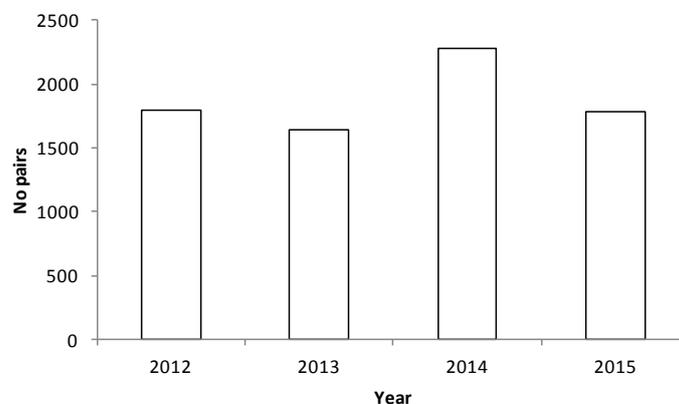


Figure 7. Estimated number of successful pairs of Greylag Geese in Orkney in late August 2012 to 2015.

However, the above calculation does not include pairs of geese that failed to breed. In a study of Greylag Geese breeding on South Uist in the Outer Hebrides, it was found that the proportion of

failed nests (pairs) varied between 30 to 50% annually (Newton & Kerbes 1974). The main factor reducing the production of fledged young on South Uist was the complete loss of clutches, some of which were taken by predators (notably Hooded Crows *Corvus cornix*) and others deserted. The proportion of clutches successful each year was associated with the timing of nesting. The earlier the population as a whole bred, the greater the proportion of clutches that hatched, and the greater the number of young fledged per nesting pair (Newton & Kerbes 1974).

The total number of breeding Greylag Geese in Orkney is therefore likely to be higher than the estimated 1,706 successful pairs. Annual differences in the timing of breeding and annual variation in the effects of predation make it difficult to draw conclusions about any trend in the number of pairs.

Discussion

The survey in late August 2012 provided the first archipelago-wide assessment of the abundance and distribution of Greylag Geese in Orkney during the late summer. The total number of geese counted (21,367) was more than twice the number estimated in Orkney in July 2008, when Mitchell *et al.* (2010a) reported an estimate of 10,000 birds (range 9,000 to 11,000). Such an increase in numbers would have therefore involved an estimated annual rate of increase of *c.* 19% per annum.

In late August 2013, 20,242 Greylag Geese were counted, in late August 2014 the count was 22,911 birds and in late August 2015, the count was 21,354 birds. The results of the surveys from 2012 to 2015 are well below the projected rate of increase at the estimated rate up to summer 2012 (Figure 8) and numbers therefore appear to have stabilised.

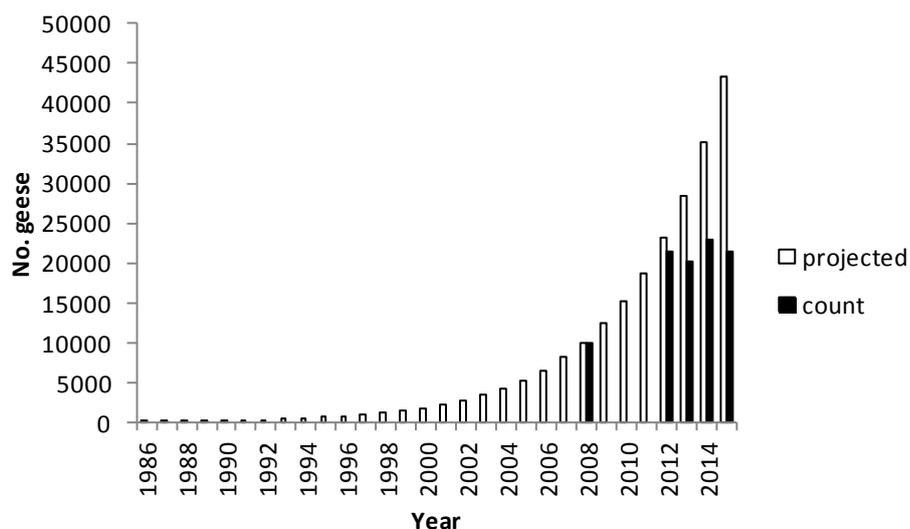


Figure 8. The projected number of Greylag Geese in Orkney, based on an estimated rate of increase of *c.* 19% per annum compared to the number counted in 2008 and 2012 to 2015.

The numbers of Greylag Geese reported to have been shot in Orkney since spring 2012 are shown in Table 3.

Table 3. Summary of reported bag returns of Greylag Geese shot in Orkney 2012/13 to 2014/15 (from SNH annual reports). Years run 1 April until 31 March.

Population	Bag type	2012/13	2013/14	2014/15
British Greylag Geese	Under licence (May to end August)	89	258	37
	By pilot project (Aug)	445	473	862
	By pilot project (Sept)	2,087	1,175	753
	Recreational hunting (Sept)	570	900	1,047
Total		3,191	2,806	2,699
British and Iceland Greylag Geese combined	Recreational hunting (Oct to end of shooting season)	6,600	8,262	9,550
	Under licence (Feb to April)	209	364	(218) ¹
Total		6,809	8,626	²

Note 1: the bag return for licences Feb to mid-April 2015 are not all available and will be reported in the Orkney Resident Greylag Goose Adaptive Management Pilot - Annual Report for 2015 Season. As of 30 Nov 2015, 218 birds were reported shot during this period.

Note 2: the total bag return for October 2014 to mid-April 2015 are not all available and will be reported in the Orkney Resident Greylag Goose Adaptive Management Pilot - Annual Report for 2015 Season.

A proportion of the total number of geese reported as being shot from October 2014 through to the end of the hunting season in early 2015 (at least 9,550, Table 3) would have been summering British Greylag Geese. However this proportion, and hence the number of British geese shot, is

unknown since there is no way of distinguishing between the two populations during the winter months, even in the hand.

SNH estimated this proportion by using the ratio of the number of British geese counted in the summer (less birds shot between counts) to the number of British and Iceland geese counted in November. Using these estimates, together with bag data from Table 3 and abundance and productivity data from Mitchell *et al.* (2014), SNH used a simple spreadsheet schema, and estimated that the British Greylag Goose population was likely to be 17,245 birds at the start of the 2015 breeding season (Churchill & Skene 2015).

The number of young British Greylag Geese produced in summer 2015 was estimated as 5,766 (see above). It might have been expected therefore that the 2015 August count would have been approximately 23,011 geese (17,245 estimated by SNH + 5,766 young), or 1,657 birds higher than the 21,354 counted. However, not all the bag data were available from SNH at the time of writing on the number of birds shot under license between February and April (of which a proportion would be British Greylag Geese). Up to 30 November 2015, 218 birds had been reported shot and a percentage of these would have been British Greylag Geese. Nor were there complete bag data available on the number of geese shot under the pilot project in August 2015, before the survey was carried out. Up to 30 November 2015, 252 had been reported shot. The incomplete bag data at the time of writing this report, makes it difficult to determine the magnitude of the difference between the expected number of geese and the number counted in August 2015. However, given that many hundreds of British Greylag Geese were shot between February and the time of August count, the difference will be less than the 1,657 birds calculated above.

There are several explanations for this modest difference. These include:

- 1) The count of Greylag Geese in Orkney in August 2015 may have slightly under-estimated the number of birds present. As explained in Mitchell *et al.* 2014, when counting a flock of birds, both stochastic and systematic errors are likely to occur. Errors in estimating single flock sizes are possible. Count accuracy of $\pm 10\%$ was reported for flocks of ducks (Matthews 1960). The risk of missing flocks of geese altogether is probably greater. However, because of their large body size, preference for open habitat and gregarious behaviour, count accuracy of goose flocks ought to be high.
- 2) The estimate of the proportion of young in Greylag Goose flocks in August 2014 may have over-estimated breeding success. This is possible since the sample of birds aged ($n=1,085$) only represented c. 5.1% of the population. The majority of the Greylag Geese on Orkney were not checked and the reproductive success could vary spatially. In August 2015, the age counts were only recorded from flocks on Mainland, Hoy and Westray. The proportion of young in these areas may have been higher than on other islands in the archipelago due to differences in productivity rates between islands.
- 3) Of the 9,550 Greylag Geese shot between October 2014 and the end of the hunting season, and those shot under licence between February and April, the bag may have comprised a higher than expected proportion of British Greylag Geese. This is possible, since the adaptive management pilot has no control over the provenance of the birds shot at this time of year. A higher than expected proportion of British Greylag Geese in the bag (SNH use count ratios to estimate the proportion shot) would have led to a lower number of British birds surviving the winter, thus the SNH estimate of 17,245 birds at the start of the breeding season could have been too high.
- 4) There may have been inaccuracies in the reported bag either during the pilot scheme and/or during the open season. The reporting of bag data during the open season, and outwith the pilot, is voluntary. It is possible that the number of geese reported as being shot (at any time) was too low, although the reasons for such a discrepancy remain unclear.

5) The SNH schema is relatively crude and other factors not included in the model may affect population projections. For example, the age/sex ratios of shot birds are assumed to be in proportion to the population; immigration or emigration of geese to and from Orkney is not considered.

It is possible that small inaccuracies in any, or all, of the above values (abundance, annual breeding success and bag data) and/or the crudeness of the SNH schema, could contribute to the lower than expected number of Greylag Geese counted in Orkney relative to the SNH estimate of 17,245 birds at the start of the breeding season.

A known constraint of the adaptive management pilot is estimating the number of British Greylag Geese shot when both the Iceland and British Greylag Goose populations are together. Having no control over which population of Greylag Goose is shot once the Iceland migrants arrive in Orkney from October onwards is clearly a weakness in a management process that is seeking to reduce the size of the British Greylag Goose population in Orkney. Determining stable isotope ratios in feathers collected from shot birds may shed light on the actual proportions of residents and migrants in the bag.

In order to better explain the abundance of British Greylag Geese in Orkney, an attempt could be made to collate all existing demographic data on breeding pairs (e.g. Meek 2008), annual assessments of productivity and survival rates based on recent ringing and use these to model rates of increase.

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References

- Booth, C., M. Cuthbert & P. Reynolds. 1984. *The Birds of Orkney*. The Orkney Press, Kirkwall.
- Brides, K., A.J. Leitch & E. Meek. 2013. *The abundance and distribution of British Greylag Geese on Orkney, August 2013*. Wildfowl & Wetlands Trust Report, Slimbridge. 16pp.
- Churchill, G. & Skene, C. 2015. *Orkney resident Greylag Goose Adaptive Management Pilot 2012-2017. Annual Report for 2014 season*. Scottish Natural Heritage Report, 38pp
- Holloway, S. 1996. *The Historical Atlas of Breeding Birds in Britain and Ireland 1875-1900*. Poyser, London.
- Jacobs, J. 1974. Quantitative measurement of food selection. *Oecologia* 14: 413–417.
- Matthews, G.V.T. 1960. An examination of basic data from wildfowl counts. Proc XII Int. Orn. Cong., Helsinki 1558: 483-491.
- Meek, E. 2008. Greylag Geese in Orkney. *Orkney Bird Report, 2007*.
- Mitchell, C., L. Griffin, M. Trinder, J. Newth & C. Urquhart. 2010a. The status and distribution of summering Greylag Geese in Scotland, 2008/09. *Bird Study* 58: 338-348.
- Mitchell, C., L. Griffin, M. Trinder & J. Newth. 2010b. *The population size of breeding Greylag Geese Anser anser in Scotland in 2008/09*. Wildfowl & Wetlands Trust Report. 70pp.
- Mitchell, C., A.J. Leitch, K. Brides & E. Meek. 2012. *The abundance and distribution of British Greylag Geese on Orkney, August 2012*. Wildfowl & Wetlands Trust Report, Slimbridge. 33pp.
- Mitchell, C., A.J. Leitch & E. Meek. 2014. *The abundance and distribution of British Greylag Geese on Orkney, August 2014*. Wildfowl & Wetlands Trust Report, Slimbridge. 21pp.
- Newton, I. & R.H. Kerbes. 1974. Breeding of greylag geese in the Outer Hebrides, Scotland. *Journal of Animal Ecology* 43: 771-783.

Appendices

Appendix 1. Person-days needed to count Greylag Geese in Orkney during 27 August to 1 September 2015.

Area	Person-days	Transport needed
Mainland (East Mainland, West Mainland and Deerness)	8	5-8 cars ¹
Sanday	2	Ferry plus car
Shapinsay	1	1 car
South Ronaldsay	1	1 car
Eday	1	1 car
Stronsay	2	Ferry plus car
Westray	1	1 car
Burray	0.5	1 car
Rousay	0.5	Ferry plus car
North Ronaldsay	1	1 car
Papa Westray	0.5	1 car
Hoy	1	1 car
Small Holms	nc ²	
Flotta	0.5	Ferry
Gairsay	0.5	Counted by local resident
Auskerry	0.5	Counted by local resident
Egilsay	0.5	1 bike
Wyre	0.5	Ferry plus 1 car
Copinsay	0.5	
Swona	nc	
Graemsay	1	Ferry
Total	23.5	

Notes:

¹ – Five cars are needed if Mainland is counted over two days; eight cars are needed if counted on one day.

² – not counted by landing, but checked from ferry and no geese were seen. Can be counted by two people using a RIB.

Appendix 2. The land area and calculated area of selected habitat types in Orkney.

Area	Total area (ha)	Area arable (ha) ₁	Area improved grass (ha)	Total area 'agricultural' land ²
Mainland (includes West Mainland, East mainland, Deerness, Holm of Grimbister and Damsay).	52,325	1,799	18,560	20,358
Sanday	5,043	82	2,980	3,062
Shapinsay (including Helliar Holm and Grass Holm)	2,948	107	1,227	1,334
South Ronaldsay	4,980	91	2,512	2,603
Eday (including Faray, Holm of Faray and Calf of Eday)	2,745	38	1,060	1,098
Stronsay (including Papa Stronsay, Holm of Huip and Linga Holm)	3,430	96	2,052	2,148
Westray	4,713	191	2,793	2,984
Burray (including Lamb Holm, Glimps Holm and Hunda)	1,098	27	456	483
Rousay (including Eynhallow and Holm of Scockness)	4,935	27	1,138	1,165
North Ronaldsay	690	68	410	478
Papa Westray (including Holm of Papa)	933	5	427	432
Hoy (including Rysa Little)	14,558	30	1,233	1,263
Small Holms (including Faray, Sweyn Holm)	265	0	163	163
Flotta ³	1,212	4	143	147
Gairsay	240	0	124	124
Auskerry	85	0	41	41
Egilsay	650	2	312	314
Wyre	311	17	113	130
Copinsay	73	1	46	47
Swona	92	0	30	30
Graemsay	409	4	150	154
Total	101,663	2,589	35,969	38,558

Notes:

¹ – Values calculated from LCM 2007 data (figures have been rounded up to nearest hectare).

² – Agricultural land defined as arable and improved grassland combined.

³ – East side of Fara, south side of Flotta and north side of Switha were all checked from Flotta, but no birds were recorded.