



The abundance and distribution of
British Greylag Geese in Orkney,
August 2016

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

Carl Mitchell ¹, Alan Leitch ² & Eric Meek ³

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¹ The Wildfowl & Wetlands Trust, Slimbridge, Gloucester, GL2 7BT

² The Willows, Finstown, Orkney KY17 2EJ

³ Dashwood, 66 Main Street, Alford, Aberdeenshire AB33 8AA

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Wildfowl & Wetlands Trust

Slimbridge

Gloucester

GL2 7BT

T 01453 891900

F 01453 890827

E monitoring@wwt.org.uk

Reg. Charity no. 1030884 England & Wales,
SC039410 Scotland

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Summary

1. A survey involving field counts of British Greylag Geese on the Orkney archipelago counted 24,250 birds in late August 2016, a 13.6% increase on the number counted there in August 2015. The mean density of geese on agricultural land was 0.63 birds ha⁻¹.
2. A sample of geese was aged and 25.6% were young. The mean brood size was 2.89 young per successful pair. If the proportion of young is indicative of the whole population in Orkney then there were potentially 2,148 successful breeding pairs of Greylag Geese in Orkney in summer 2016.
3. Greylag Geese were found primarily on improved grass fields (73.1% 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, 5.7% of the geese were in arable fields, of which the vast majority were on harvested stubbles, with 0.1% recorded on un-harvested standing crops.
4. Between ~20,000 and ~24,250 Greylag Geese have been counted in Orkney during late August from 2012 to 2016, suggesting that the rapid increase 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. Possible explanations for the modest discrepancy between the expected population level in summer 2016, estimated by SNH, and the number counted are given. These include:
 - i. The August 2016 census may have slightly over-estimated the number of birds present;
 - ii. The estimate of the percentage young in Greylag Goose flocks in August 2016 may have under-estimated breeding success;
 - iii. Of the 8,266 Greylag Geese reported shot between October 2015 and the end of the hunting season (Jan/Feb 2016), the bag may have comprised a lower 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).
6. 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 an added complication in a management process that is seeking to reduce the size of the British Greylag Goose population in Orkney. However, there is no way of distinguishing between the two populations during the winter months, even in the hand. Determining stable isotope ratios in feathers collected from shot birds may shed light on the actual proportions of residents and migrants in the bag and work is ongoing this season to investigate this.

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. In order to manage British Greylag Geese in Scotland, regular assessments of their abundance, productivity and distribution are required. This is particularly pertinent in Orkney where the Scottish Government and SNH have initiated a pilot adaptive harvest management process 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.

For a summary to the historical status of British Greylag Geese in Scotland and the provenance of the geese in Orkney, see pp. 2-3 in Mitchell *et al.* (2015).

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.

Subsequently, four other late summer archipelago-wide surveys have been carried out prior to this summer's survey. A survey in late August 2012 estimated 21,367 Greylag Geese (Mitchell *et al.* 2012), the 2013 survey estimated 20,242 geese (Brides *et al.* 2013), the 2014 survey estimated 22,911 geese (Mitchell *et al.* 2014) and the 2015 survey estimated 21,354 geese (Mitchell *et al.* 2015).

Methods

Field counts

Following the methods employed in 2012 (see Mitchell *et al.* 2012), Greylag Geese were counted in Orkney during late August 2016, 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 2012-2015 late August surveys, suggested 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 2016 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 2016, 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). First winter Greylag Geese (left) 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. Adults (right) 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.



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

Brood sizes of successful pairs were also recorded. Young geese hatched in the spring remain with their 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 between 25-28 August and involved c. 23.5 person days of time (see Appendix 1). All areas checked during the annual winter counts were checked during the August 2016 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 24,250 Greylag Geese were counted in 281 flocks (median flock size 42 birds, range 1 to 782), with the largest numbers found on Mainland and Stronsay (Table 1, Figure 2). Mainland accounted for the majority of the total number of geese counted (44.4%, 10,766 geese). The density of Greylag Geese per hectare ranged from 0 ha⁻¹ on several islands to 1.01 ha⁻¹ on Stronsay, with an overall density of 0.24 ha⁻¹ for the whole archipelago (Table 1).

Table 1. The abundance and distribution (by major island) of Greylag Geese in Orkney during 25-28 August 2016, 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 | 10,766 | 52,325 | 0.21 | 0.53 |
| Stronsay ⁵ | 3,477 | 3,430 | 1.01 | 1.62 |
| Sanday | 2,578 | 5,043 | 0.51 | 0.84 |
| South Ronaldsay | 2,021 | 4,980 | 0.41 | 0.78 |
| Shapinsay | 1,915 | 2,948 | 0.65 | 1.44 |
| Westray | 1,082 | 4,713 | 0.23 | 0.36 |
| Eday | 814 | 2,745 | 0.30 | 0.74 |
| Rousay/Eynhallow ⁷ | 568 | 4,935 | 0.12 | 0.49 |
| North Ronaldsay | 401 | 690 | 0.58 | 0.84 |
| Burray ⁸ | 352 | 1,098 | 0.32 | 0.73 |
| Flotta/Fara/Switha ⁹ | 142 | 1,212 | 0.12 | 0.97 |
| Papa Westray | 61 | 933 | 0.07 | 0.14 |
| Egilsay | 20 | 650 | 0.03 | 0.06 |
| Gairsay | 20 | 240 | 0.08 | 0.16 |
| Auskerry | 12 | 85 | 0.14 | 0.30 |
| Graemsay | 11 | 409 | 0.03 | 0.07 |
| Wyre | 10 | 311 | 0.03 | 0.08 |
| Hoy/South Walls ⁶ | 0 | 14,558 | 0.00 | 0.00 |
| Copinsay | 0 | 73 | 0.00 | 0.00 |
| Small Holms ¹⁰ | 0 | 265 | 0.00 | 0.00 |
| Swona | nc | 92 | | |
| Total | 24,250 | 101,663 | 0.24 | 0.63 |

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).

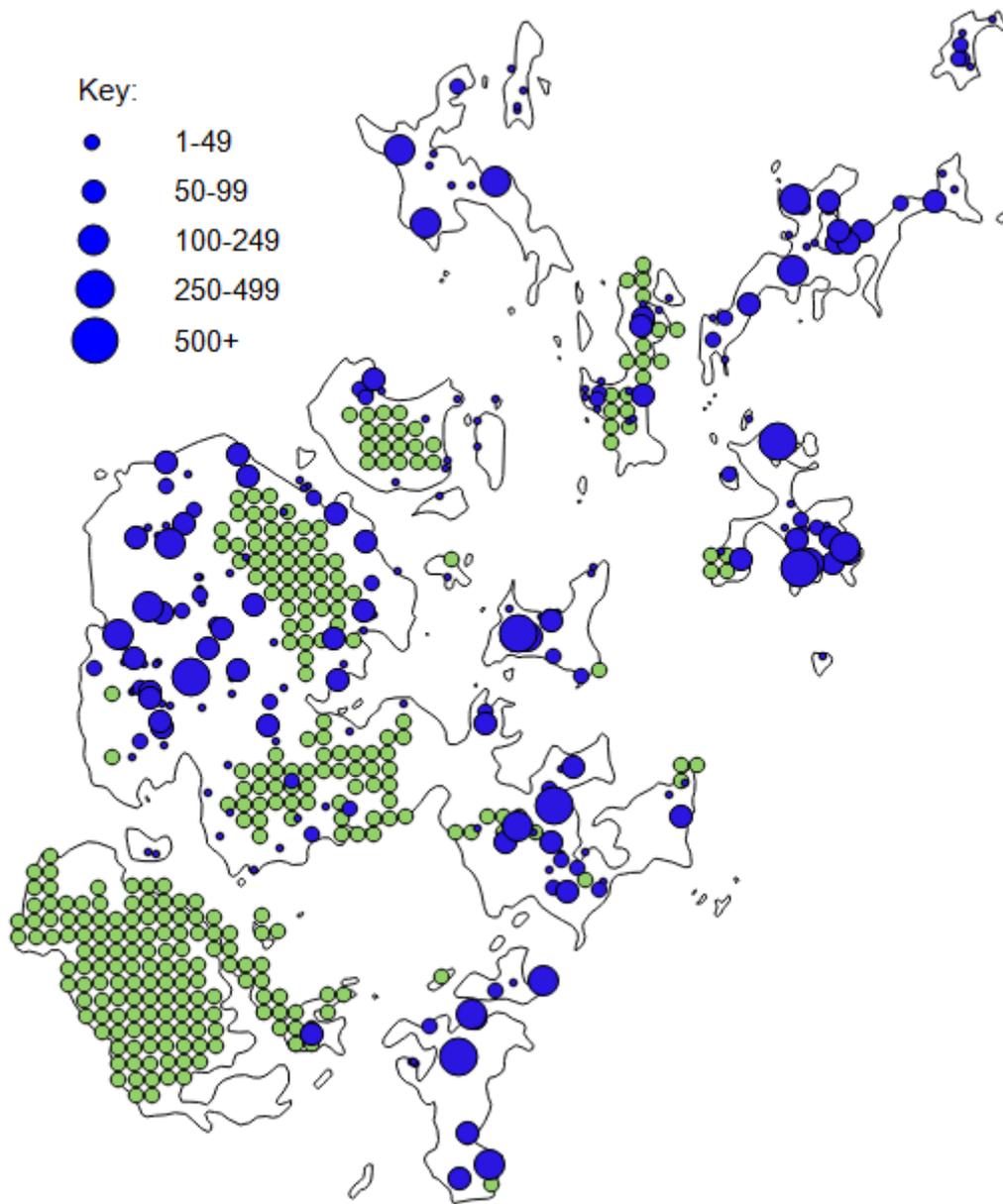


Figure 2. The distribution of Greylag Geese found during field surveys in late August 2016. Blue dots are proportional to flock size. One km squares dominated by moorland are shaded in green.

The 2016 estimate was 13.6% higher 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 ~24,250 birds (Figure 3, see Discussion).

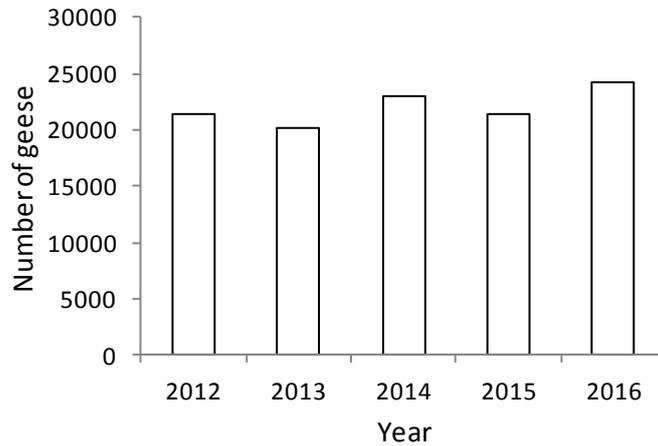
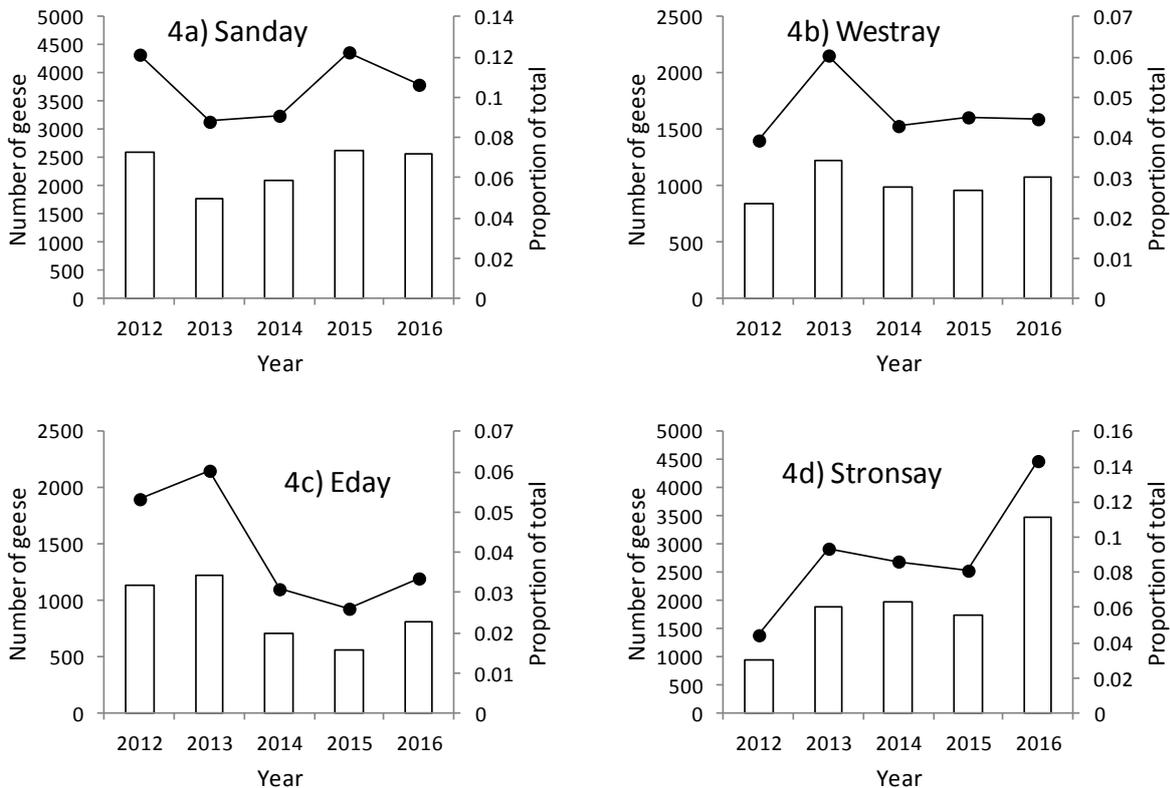
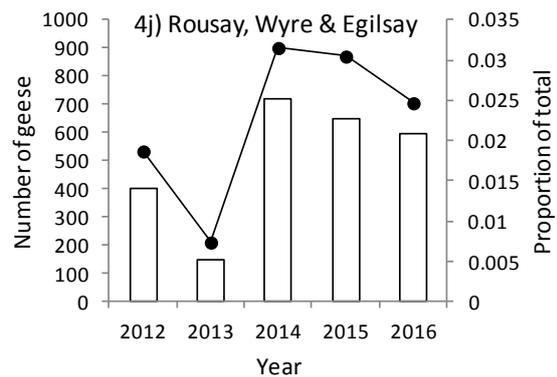
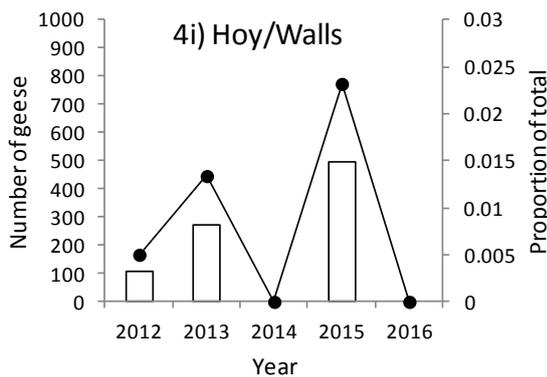
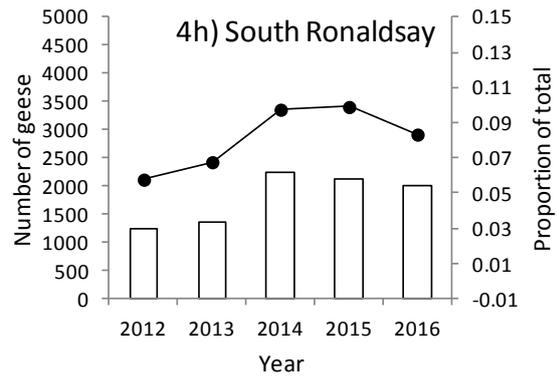
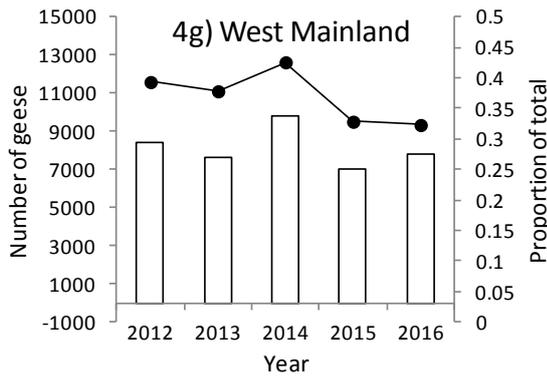
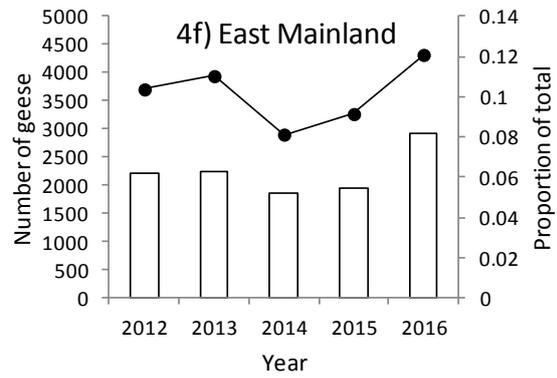
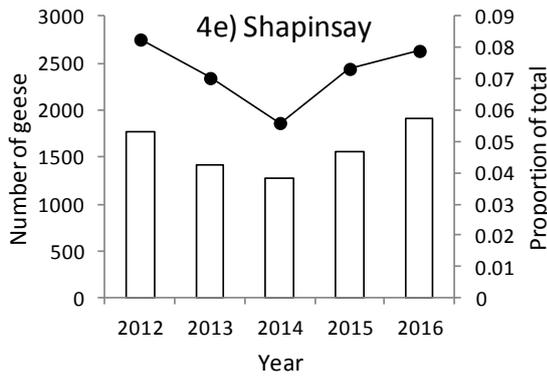


Figure 3. The number of Greylag Geese found during field surveys in Orkney in late August 2012 to 2016.

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 several small islands to 1.62 ha⁻¹ on Stronsay, with an overall density of 0.63 ha⁻¹ for the whole archipelago (Table 1).

Based on the counts from the five 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-4j Changes in the distribution of Greylag Geese counted during field surveys on ten of the largest islands in Orkney in late August 2012 to 2016. Figures are expressed as the total number of birds counted (columns) and the proportion of the total counted in Orkney each year (line).

Relative to the total number of geese counted, numbers have increased on Stronsay and Rousay and decreased on Eday. Most other areas reflect the stability of the overall population.

Flock size was highly skewed; of the 281 flocks recorded, 161 (62.4%) were of 50 birds or fewer (Figure 5). However, 33 flocks (11.7%) contained over 200 birds, the largest flocks being of 610 (East Mainland), 670 (Stronsay) and 782 birds (Harray).

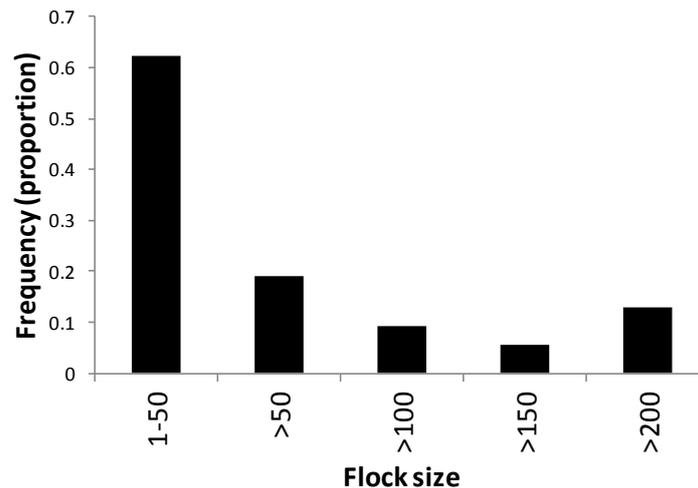


Figure 5. Frequency distribution of flock size of Greylag Geese encountered during field surveys in Orkney in late August 2016.

Habitat preferences of Greylag Geese

For the majority of Greylag Goose records (97.2%) habitat information was also recorded. Greylag Geese encountered on the sea (42 birds), open freshwater or saline/brackish waterbodies, loch edges and on mud (5,400 birds) and any geese counted in flight (338 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 arable land 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 2016 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 2016 | Percentage of geese counted in habitat class | Jacobs Index ¹ |
|-------------------------------------|-----------------------|---------------------------|--------------------------|---|--|---------------------------|
| Arable ² | 3 | 2,589 | 2.7 | 1,006 | 5.7 | 0.37 |
| Improved grass | 4 | 35,969 | 37.1 | 12,999 | 73.1 | 0.64 |
| Semi-natural grassland | 5,6,7,8,9 | 29,029 | 29.9 | 3,004 | 16.9 | -0.35 |
| Moorland (mountain, heath, and bog) | 10,11,12,13,14 | 23,462 | 24.2 | 582 | 3.3 | -0.81 |
| All other habitats | 1,2,15-23 | 5,886 | 6.1 | 201 | 1.1 | -0.73 |
| Total | | 96,935³ | 100.0 | 17,792⁴ | 100.0 | |

Notes:

¹ Jacobs (1974).

² 994 geese were recorded on post harvest arable stubble fields and 12 geese were recorded on un-harvested arable crops

³ Total excludes areas of freshwater (LCM 2007 code 16) and saltwater (LCM 2007 code 17).

⁴ Total excludes birds counted on the sea (n = 42), waterbodies (n = 5,400) and in flight (n = 338).

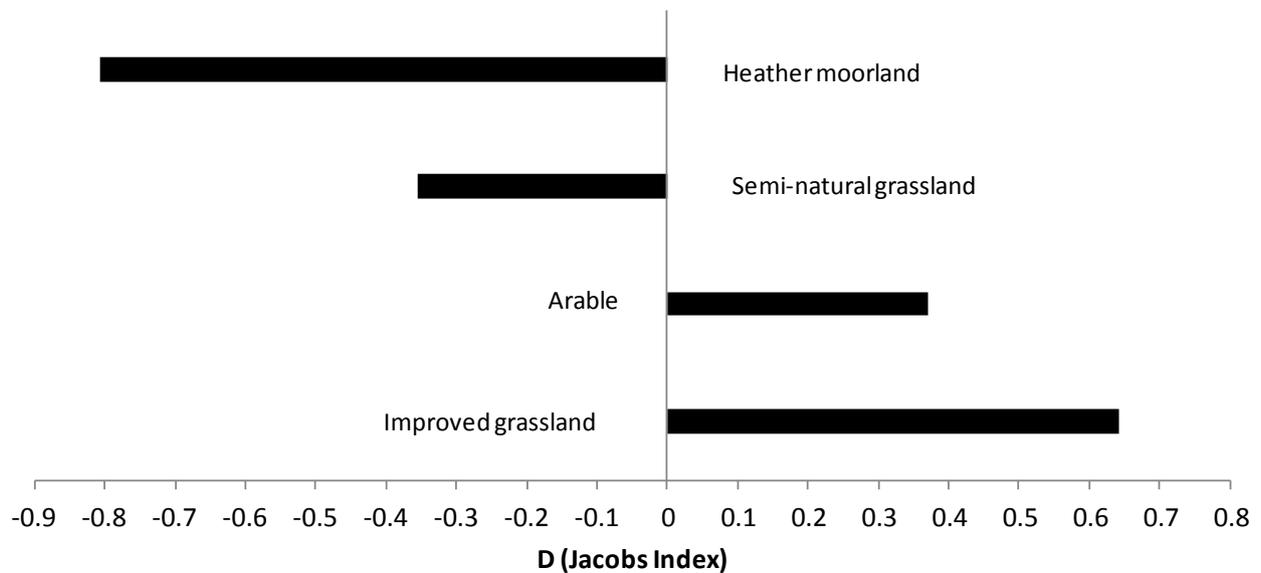


Figure 6. Terrestrial habitat preferences of Greylag Geese in August 2016 expressed by Jacobs Index (D). The index ranges from -1 (complete avoidance) to +1 (exclusive use).

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 1,006 geese (5.7% of the birds for which habitat data were collected) were recorded on arable land; 12 birds (0.1%) on un-harvested standing crop and 994 birds (5.6%) on arable stubbles. The late August count took place a week or more before the main arable harvest, after which time the arable stubbles are a favoured feeding habitat for the geese (pers. obs.).

Age counts

A sample of 1,011 geese was aged on Mainland, Stronsay and Rousay, of which 259 (25.6%) were first-winter birds (young of the year). The sample represented 4.1% of the 2016 Orkney population. The mean brood size was 2.89 young per successful pair (n=29).

If the proportion of young birds recorded was indicative of the whole population in Orkney, then approximately 6,208 birds were young ($24,250 \times 0.256$). The mean brood size was 2.89 young, suggesting that, as an approximation, there were potentially 2,148 successful pairs of Greylag Geese in Orkney in summer 2016. Using these approximations, the estimated number of successful pairs has been between 1,600 and 2,200 during 2012 to 2016 (Figure 7).

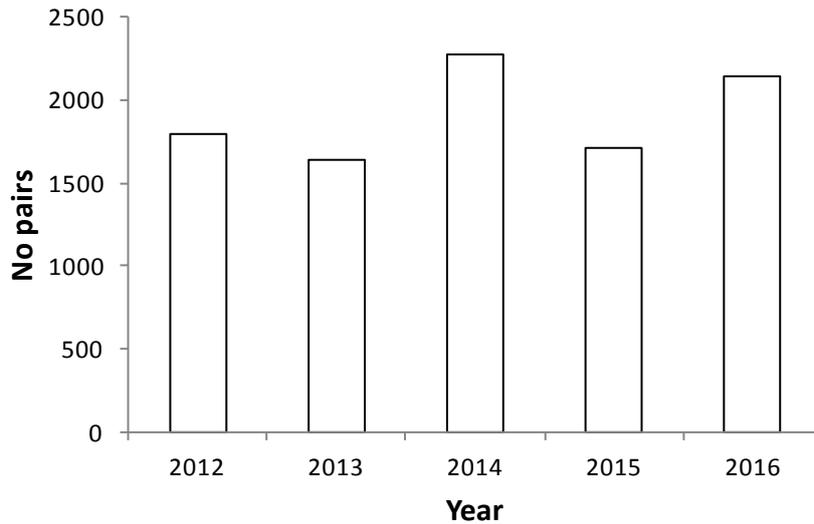


Figure 7. Estimated number of successful pairs of Greylag Geese in Orkney in late August 2012 to 2016 (see text for calculation).

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 from 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 were deserted. The proportion of clutches that were 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 2,148 successful pairs in 2016. 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.

Distribution of Greylag Geese during 2012 to 2016

Using the sum of the number of Greylag Geese counted in each 1km square during the late August counts from 2012 to 2016, Greylag Geese appear to be widely distributed throughout the archipelago (Figure 8) and are particularly associated with managed grasslands at that time of year. In all five years, Greylag Geese were recorded in 524 1km squares (total counts ranged from 1 to 1,174 geese). However, of the 1,517 1km squares within Orkney, 50% of the geese were recorded in just 58 (3.8%) 1km squares and 16 (1.0%) 1km squares held 20% of the total number of geese counted.

In addition, Greylag Geese were not recorded in all 524 1km squares in all years. Geese were recorded in 295 (56.3%) 1km squares in just one year, 121 (23.1%) in two years, 66 (12.6%) in the three years, 26 (5.0) in four years and only 16 (3.1%) 1km squares held Greylag Geese in all five years. When compared to all 1,517 1km squares within Orkney, only 1.1% held Greylag Geese in all five years.

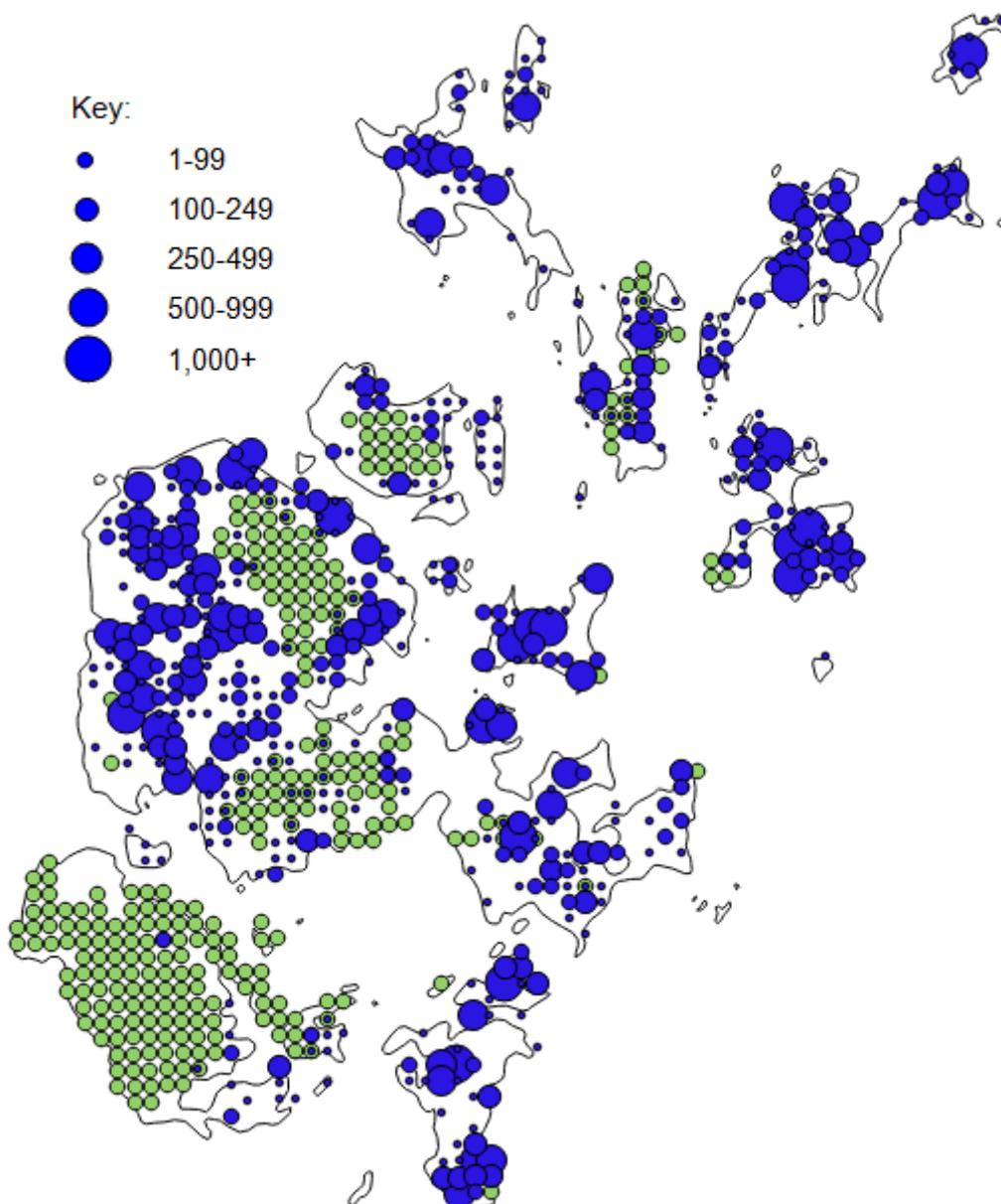


Figure 8. The distribution of Greylag Geese found during field surveys in late August 2012-2016. Blue dots are proportional to flock size and are based on the mean number of geese counted in 1km squares. One km squares dominated by moorland are shaded in green.

This can be demonstrated at a finer scale (flocks are recorded at 100m resolution). Using counts from 2012-2016, the distribution of the recorded flocks on Shapinsay show that the geese are highly localised, using a relatively small number of fields, often close to safe roosts (Figure 9). The vast majority of fields were not used by Greylag Geese in late August.

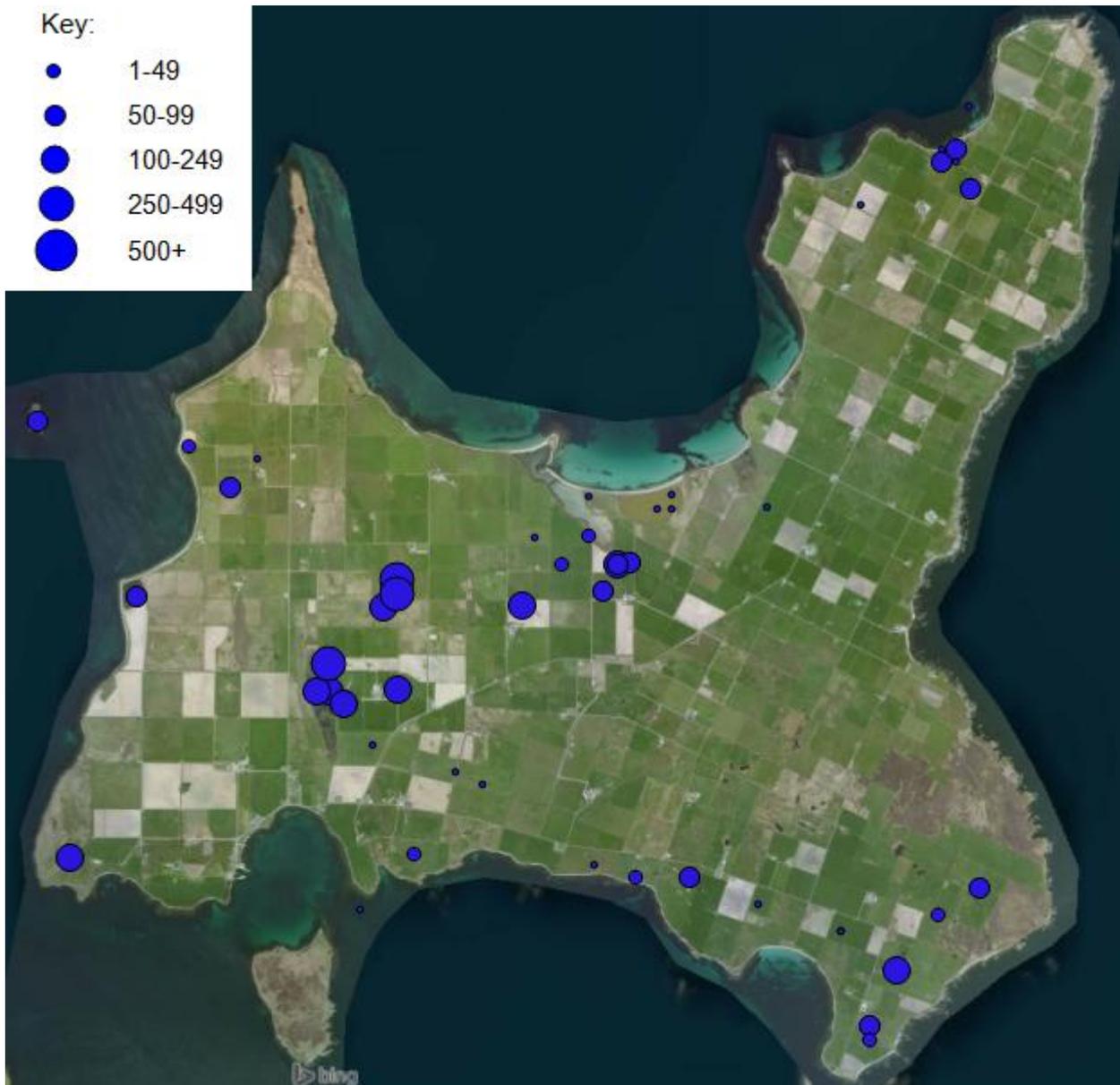


Figure 9. The distribution of Greylag Geese found during field surveys in late August 2012-2016 on Shapinsay. Blue dots are proportional to flock size and are based on all counts recorded (at 100m scale).

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.

The late August counts in 2013, 2014, 2015 and 2016 were 20,242, 22,911, 21,354 and 24,250 birds, respectively. The results of the surveys from 2012 to 2016 are well below the projected rate of increase, based on the estimated rate up to summer 2012 (Figure 10), and numbers therefore appear to have stabilised.

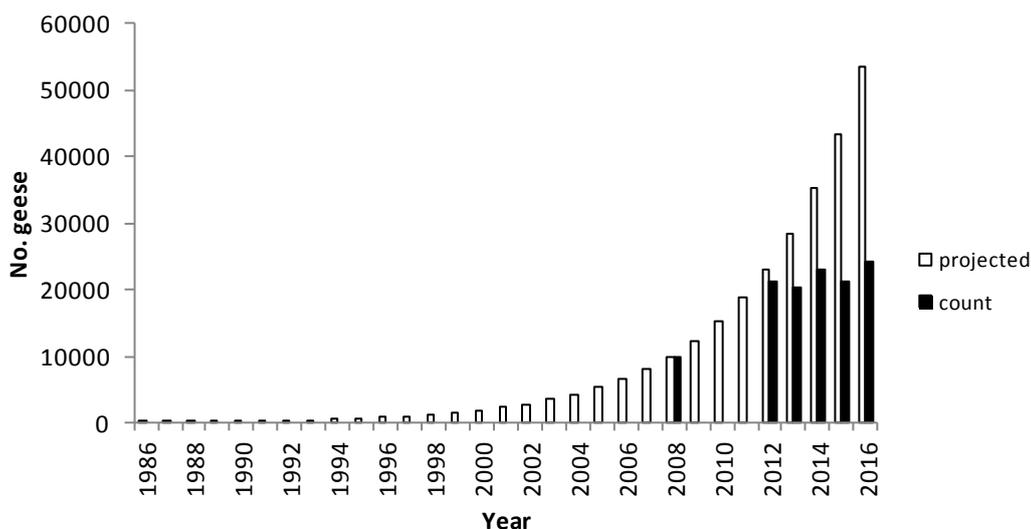


Figure 10. The projected number of Greylag Geese in Orkney, based on an estimated rate of increase of *c.* 19% per annum, compared to the number counted in 2008 and 2012 to 2016.

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 2015/16 (from SNH annual reports). Years run 1 April until 31 March.

| Population | Bag type | 2012/13 | 2013/14 | 2014/15 | 2015/16 |
|--|---|--------------|--------------|--------------|----------------------------|
| British Greylag Geese | Under licence (May to end August) | 89 | 258 | 37 | 290 |
| | By pilot project (Aug/Sept) | 2,532 | 1,648 | 1,615 | 705 |
| | Recreational hunting (Sept) | 570 | 900 | 1,047 | 1,207 |
| Total | | 3,191 | 2,806 | 2,699 | 2,202 |
| British and Iceland Greylag Geese combined | Recreational hunting (Oct to end of shooting season in January) | 6,600 | 8,262 | 9,550 | 8,266 |
| | Under licence (Feb to April) | 209 | 364 | 245 | (269) ¹ |
| Total | | 6,809 | 8,626 | 9,795 | (8,535)¹ |

Note 1: the bag return for licences February to mid-April 2016 were not all available and will be reported in the Orkney Resident Greylag Goose Adaptive Management Pilot - Annual Report for the 2016 Season. The bag return to date (16 December 2016) was 269 birds (SNH data) giving a total of 8,535 birds shot in all, although this number is likely to increase.

A proportion of the total number of geese reported as being shot from October 2015 through to the end of the hunting season in early 2016 (at least 8,266 birds, 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.* (2015), SNH estimated that the British Greylag Goose population was likely to be 16,188 birds at the start of the 2016 breeding season (Churchill & Skene 2016).

The number of young British Greylag Geese produced in summer 2016 was estimated as 6,208 (see above). It might have been expected therefore that the August 2016 count would have been approximately 22,396 geese (16,188 estimated by SNH + 6,208 young), but this is 1,854 birds lower than the 24,250 counted; a difference of 7.6%. However, not all the bag data were available from SNH at the time of writing on the number of birds shot under licence between February and April 2016 (of which a proportion would be British Greylag Geese).

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

- 1) The count of Greylag Geese in Orkney in August 2016 may have slightly over-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 2016 may have under-estimated breeding success. This is possible, since the sample of birds aged ($n=1,011$) only represented c. 4.1% of the population. The majority of the Greylag Geese on Orkney were not checked and the reproductive success could vary spatially. In August 2016, the age counts were only recorded from flocks on Mainland, Rousay and Stronsay. The proportion of young in these areas may have been lower than on other islands in the archipelago due to differences in productivity rates between islands.
- 3) Of the 8,266 Greylag Geese shot between October 2015 and the end of the hunting season, and those shot under licence between February and April, the bag may have comprised a lower than estimated proportion of British Greylag Geese. This is possible, since those implementing the adaptive management pilot have no way of determining the provenance of the birds shot at this time of year. A higher than estimated proportion of British Greylag Geese in the bag (SNH use count ratios to estimate the proportion shot) would have led to a higher number of British birds surviving the winter, thus the SNH estimate of 16,188 birds at the start of the breeding season could have been too low.
- 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 higher than expected number of Greylag Geese counted in Orkney relative to the SNH estimate of 16,188 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 an added complication in a management process that is seeking to reduce the size of the British Greylag Goose population in Orkney. However, as highlighted earlier there is no way of distinguishing between the two populations during the winter months, even in the hand. Determining stable isotope ratios in feathers collected from shot birds may shed light on the actual proportions of residents and migrants in the bag and SNH has commissioned work this season to investigate this.

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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Appendices

Appendix 1. Person-days needed to count Greylag Geese in Orkney during 25-28 August 2016.

| 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.