Svalbard Barnacle Goose distribution around the Solway Firth 2019-2020: Flock counts from the Solway Goose Management Scheme area

WWT Conservation Programmes Report

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Contents

Executive Summary

A total of 13 counts were carried out in winter 2019-2020 within the Solway Barnacle Goose Management Scheme area. Due to the government imposed travel ban under the COVID-19 restrictions, the SNH Scheme counts and the JNCC census counts of the Svalbard Barnacle Goose *Branta leucopsis* were abandoned from 20 March 2020 onwards. Thus in a change to the tender specification this report draws on the results of seven JNCC census counts and six SNH Scheme counts including four JNCC counts in the October period instead of two to provide as much count data as possible for the Scheme area. The travel restrictions imposed in March 2020 meant that only one count (instead of two) was available for March and none (instead of two) for April.

For the SNH Scheme counts, the times of day, the days of the week and the starting points at which the counts were conducted were varied as much as possible to avoid bias in terms of when a section was surveyed. With the coordinated JNCC census counts this was not possible as the volunteer count network is only typically available at a certain time and on a certain day and so all survey sections tend to be counted on a Wednesday from 10:00–12:00. For the SNH counts, flock size assessments were made for all goose and swan species encountered, with flocks assigned to fields by code. Instances of direct disturbance clearly aimed at the geese and of conversations with farmers were also noted. Again for the JNCC counts, except where they were conducted by WWT, these extra data were not consistently noted across the count sectors, with barnacle goose flock counts being the focus of those surveys. Data collected under the JNCC contract on brood size and productivity estimates for this population are also presented.

The adopted total for the Barnacle Goose population wintering on the Solway Firth was 36,000 geese (the mean of the maximum count of 37,360 and one other count within 10% of this, rounded up to the nearest 100), a decline of over 4,400 since 2018 and 6,600 since 2017, suggesting a two year decline in total population numbers. The only caveat with regard to this adopted population total is that although it is derived in part from a full census count carried out across all count sections of the Solway under good stable count conditions, there are not as many full census counts overall for winter 2019-2020 to choose from. Normally there are about six to eight full counts available for deriving an adopted total, but this year there were only two because a key bridge was washed away at Brow Well, at the eastern end of the Caerlaverock reserve, preventing access to a count section including Ruthwell, Cummertrees and Gretna until December, and because the March, April and May counts could not be conducted due to the COVID-19 restrictions.

This continued decrease in the population present on the Solway could have been due to continued increased mortality of older birds relative to recruitment in an ageing population as reproductive success has been below average for seven out of the last ten years in the period from 2010-2019, and was significantly lower in 2019. This explanation is however confounded to an extent by the increasing use of the east coast Budle Bay area, Northumberland, by an increasing number of birds that evidence suggests (ring sightings and timing of arrival, plus the use of that area by a GPS tracked bird that was wintering on the Solway but moved to Budle Bay at the end of January 2020 before returning to the Solway again in mid-March 2020) are mostly from the Svalbard population. This increasing tendency for short-stopping in that area makes the population counts on the Solway increasingly difficult to interpret in isolation. As such, even when the full flyway population of the Solway Firth plus the Budle Bay group are considered together the population has declined in both of the last two years; an issue of great concern for the conservation of this Protected species.

Count conditions on the Solway were very challenging in 2019-2020 initially due to the loss of a key bridge to flooding for the October to December period preventing access to some key eastern count areas and then because of the COVID-19 restrictions imposed from March. The winter up until the end of the count period in March had been very mild with only very occasional frosts and no laying snow of any significant depth or duration on the coastal marshes and fields of the Solway. As such, as far as could be ascertained the geese made little use of areas outside their usual range and were thus well covered by the counter network when and where that was possible. The mean brood size was 1.6 goslings per family (range 1-4 goslings; 121 families sampled) – which is lower than the current ten year mean of 1.9 (S.E. ± 0.1), with an average productivity of 5.2% (range 0.7-14.6% young; 14 flocks and 10,111 birds sampled) - which is lower than the current ten year mean of 8.1% (S.E. ± 1.2). This compares to 1.7 goslings per family and 6.3% young for the previous winter.

1 Introduction

The Solway Firth is an internationally important site for a number of wetland bird species being a key site for the wintering Svalbard Barnacle Goose *Branta leucopsis* population. By mid-winter, ~97% of this flyway population utilise five main sites around the Solway, with three of those being on the north side of the Firth, including Caerlaverock, Kirkconnell (Nith) and Southwick (since 2016, ~3-5% now stopover in the Budle Bay area, Northumberland, in the period from October-March to an increasing extent). This century with the growth of the population to over 40,000 birds (though this has recently declined), the distribution has spread west towards the Outer Solway with geese now visiting the areas around Colvend, Auchencairn and Rascarrel in most winters, with significant flocks at Wigtown typically from late February to early April.

The Cumbrian saltmarshes, and some inland fields, west of Rockcliffe Marsh also accommodate a larger number of this increased goose population for a longer duration. On Rockcliffe Marsh itself, gatherings of up to 30,000 barnacle geese have been recorded in late April/early May immediately prior to the spring departure north. Parts of this flock can utilise nearby fields and saltmarsh in the Gretna, Redkirk and Baurch area on the Scottish side of the Solway.

During the winter, on the Scottish side of the Solway, the geese mainly feed within managed reserves or within the Solway Barnacle Goose Management Scheme area, often choosing stubbles in early autumn and improved pastures and saltmarsh throughout the rest of the winter. SNH has run this management incentive scheme on the Solway since 1995 in order to integrate farming and goose grazing needs on areas of improved agricultural land. On land entered into the Scheme, tiered payments are made to help cover the extra costs of managing the land for Barnacle Geese. Fields are classified as 'Feeding', 'Buffer' (which receive a tiered payment) or 'Scaring' (non-payment) zones depending in large part on the typical level of winter goose use. Controlled scaring is encouraged in the non-payment zone during the winter to try to keep the geese within the feeding or buffer zones. Scaring is also permitted throughout April within the Scheme area, as due to budgetary constraints imposed since 2012 (though reinstated briefly in 2013), fields within the Scheme area no longer receive goose management payments for April.

Since about 2010, there has been an increasing tendency for large numbers of Barnacle Geese to remain at the autumn staging site around Budle Bay/Lindisfarne, Northumberland, until later in the winter or into the following spring depending on the east coast weather. Based on ring sightings, data from GPS tagged birds and the timing of the initial increase in numbers at the site during the traditional migratory period in late September/early October it is assumed that the majority of these birds are of Svalbard origin.

1.1 Objective

The overall objective of the survey is to assess the distribution and abundance of the Svalbard Barnacle Goose and other goose and swan species on the fields and saltmarsh of the north side of the Solway Firth in relation to the Solway Barnacle Goose Management Scheme area.

2 Methods

2.1 Management Scheme counts

Six "SNH Route Counts" within the Goose Scheme area were carried out in addition to seven "JNCC Census Counts" on an approximately 14-day cycle between 2 October 2019 and 6 March 2020, the counting period being cut short because of the government-imposed travel restrictions observed by WWT from 20 March 2020 (**Table 1**). The reduced number of counts available meant that two earlier JNCC counts from 2 October and 9 October have been included to provide extra information about goose use of the Scheme area. For the SNH route counts, the starting points were varied as much as possible to prevent counting any area at the same time of day, with count days spread evenly throughout the week including weekends. For the JNCC census counts, the use of volunteers meant that count sections were surveyed between 10:00-12:00, typically on Wednesdays.

Table 1 – Summary of the sources of count data provided each month.

Count source	October	November	December	January	February	March	April	Total
JNCC counts	4	1	1	0	1	0 (COVID)	0 (COVID)	7
SNH counts	0	1	1	2	1	1	0 (COVID)	6

During SNH route counts, geese and swans in larger flocks were counted in tens on a tally counter, while those in smaller flocks of <100 were counted individually; all flocks being mapped and coded according to the SNH convention on the field maps provided. Each day was broken down into four counting periods to cover the four main count areas (**Table 2**), starting at first light with allowance made for weather conditions, e.g. geese tend to be slow to move off the roost during periods of frost such as those geese flighting off the Blackshaw Bank roost to utilise fields up the River Nith at Greenmerse and Kirkconnell. The time of observer arrival at each count section was recorded. Where significant numbers of geese moved during a count, the field the geese moved from and to was recorded with a "Comment" added within the Excel spreadsheet provided. Observations of leucistic geese and other goose species of note have also been added.

Table 2 – Count sections covered within the counting periods.

Count Period 1	Count Period 2	Count Period 3	Count Period 4
Caerlaverock	Gretna	Nith	Southwick
Southwick	Nith	Caerlaverock	Gretna
Nith	Caerlaverock	Gretna	Southwick
Gretna	Caerlaverock	Nith	Southwick

The SNH count route covered areas to the east as far as Gretna and to the west as far as Mersehead, with JNCC counts extending as far west as Wigtown on the Scottish side of the Solway (**Figure 1**). Use of any fields out with the SNH Goose Management Scheme area was noted during the census counts.

Areas where there are difficulties observing the fields from the road are well known as are the high vantage points which can be utilised to count them from. Otherwise approach on foot was adopted with prior permission being sought for access. During the SNH route counts and the JNCC census count routes covered by WWT staff, the presence and nature of any disturbance to the geese, intentional or otherwise, was noted using the SNH field code system provided. Impromptu discussion with any landowners during the surveys was welcomed and a record of each conversation regarding the geese along with those had during arranged visits or calls to farmers were logged. Care was taken in relation to biosecurity and disease prevention, and where access to fields was required there was compliance with any precautions required by the landowners, with gates being left as they were found.

As with last winter it soon became clear that the Priestside/Hurkledale area was being used quite often by the Barnacle Geese whereas the section to the northeast of Ward Law covering the Quay Hill was rarely being used and was therefore not surveyed on a regular basis although it was covered during the census counts. In some previous years the Priestside/Hurkledale section has been dropped due to a lack of goose use but this winter it was again surveyed. During the co-ordinated counts of the Solway, Barnacle Geese were rarely recorded in the Auchencairn/Rascarrel area in mid-winter and from February onwards numbers of Barnacle Geese began using the Wigtown area in larger numbers but this could not be economically covered via the SNH route count budget.

Figure 1. The Inner Solway Firth showing the main areas surveyed during the SNH Solway Goose Management Scheme counts (black polygons – except Boreland of Colvend area which although surveyed in previous winters was replaced in winter 2017-2018 by a small area around Redkirk/Baurch near Gretna). Site names are referred to in the text and also cover those areas surveyed during the coordinated JNCC census counts. For mapping clarity, Wigtown Bay and RSPB Crook of Baldoon are not shown as they are 20km to the west of Borgue.

2.2 Coordinated Svalbard Barnacle Goose total population counts

Each winter WWT has conducted total population counts of the Svalbard Barnacle Geese present on the Solway from arrival to departure. This involves a network of staff and volunteers counting the geese in survey sections within a one- to two-hour time-period at the same time on the same day, typically 10:00-12:00 on Wednesdays. There are weekly counts during the arrival period in October and during the departure period in April/May, with monthly counts from November to March (except January) depending on the weather.

2.3 Brood sizes and juvenile productivity of the Svalbard Barnacle Goose

Each winter WWT carefully assesses the brood sizes and juvenile productivity of a large proportion of the Barnacle Geese from as many sites as possible around the Solway. The dates, land use types, and flock sizes used for sampling are varied as much as possible to avoid any bias in the average estimate obtained. Also the sampling units within the flocks are varied as much as possible if whole flock estimates cannot be made as families with young tend to associate at the edges of a flock, particularly at the front. All observations were carried out by an experienced observer.

2.4 High tide heights, times and dates

Table 3. Dates and times of high tides (≥ 9.5m as summarised from Laver's '*Liverpool and Irish Sea Tide Table 2019 & 2020*') for the period during which geese were present in the Barnacle Goose Management Scheme area.

Month	Period 1: From date/time	Period 1: To date/time	Period 1: tidal height range (m)	Period 2: From date/time	Period 2: To date/time	Period 2: tidal height range (m)
September	22:03 27/09/19	01:39 03/10/19	9.5 - 10.3	-		
October	21:42 26/10/19	12:53 31/10/19	9.5 - 10.1	-		
November	22:06 25/11/19	11:53 28/11/19	9.6 - 9.7	-		
December	-			-		
January	12:03 12/01/20	13:34 14/01/20	9.5 - 9.6	-		
February	23:30 09/02/20	14:03 13/02/20	9.5 - 10.0	-		
March	10:48 09/03/20	13:41 13/03/20	9.6 - 10.2	-		
April	10:24 07/04/20	13:18 11/04/20	9.7 - 10.0	-		

Figure 2. Mean goose use (total geese/number of goose count days) per hectare in winter 2019/20 (shaded symbols) compared to the previous five-year period from 2014/15 to 2018/19 (shaded fields plus SNH field codes) for the Priestside to Longbridgemuir area.

Figure 3. Mean goose use (total geese/number of goose count days) per hectare in winter 2019/20 (shaded symbols) compared to the previous five-year period from 2014/15 to 2018/19 (shaded fields plus SNH field codes) for the Glencaple to Ladyhall area.

3 Results

3.1 Barnacle Goose counts within the Management Scheme area

A field code system has been used by SNH to cover all of the fields within the Management Scheme area typically used by the geese (**Figures 2-5**), with new codes and field boundaries digitised for the Redkirk to Gretna area added to the SNH count route in October 2017. These are the codes also used in the results tables (**Tables 4 - 9**). Over the past decade, where geese were recorded in an uncoded field, the coding was extended in a logical and consecutive manner. The first five figures covering the Goose Management Scheme area are ordered in a sequence from east (Priestside area; **Figure 2**) to west (Mersehead area; **Figure 5**), with the final figure showing the new field surveillance area near Gretna and the border with England (**Figure 6**). The field and marsh compartments have been shaded from light to dark blue/purple depending on the average number of geese encountered on the count days over the previous five year period and the size of the field (as measured in the GIS). Those fields without shading but with a SNH code have never had Barnacle Geese observed in them during the Scheme counts carried out in the previous five year period. Other fields shown on the BING imagery are not part of the Barnacle Goose Scheme survey area.

Field use in winter 2019-2020, up until early March 2020 (due to COVID-19 restrictions) was fairly similar to that recorded in the previous five winters with core use being focussed on the Caerlaverock area at the WWT reserve, with especially heavy use of Newfield, Midtown and Newmains and in the Southerness area on the fields at Cowcorse and West Preston Farms (those fields not managed by RSPB); some details in each area include:

- Even with the counting access restrictions (collapsed Brow Well bridge to December and COVID-19 from mid-March) there was probably heavier use of the Nethertown Farm area near Priestside e.g. fields PR55, 58 and 59 with some Hurkledale fields continuing to get fairly heavy use. Thwaite seemed to have less geese but this will have been affected by the early and late season restrictions on counter access to that area (**Figure 2**);

- There was very light use of the Powhillon and Stanhope fields although a small flock of geese was often present on the flooded stubble at SC20. The Nether Locharwoods and Mid-Locharwoods fields seemed to have fairly normal numbers of geese though the lack of road use and thus disturbance by vehicles due to the bridge closure in the first half of winter may have caused the slightly increased use of fields north of the road such as A18 and A21; no barnacle goose use of any note was recorded for fields at Upper Locharwoods and closer to Bankend (**Figure 2**);

- In the Newmians area there was perhaps a tendency for the geese to use fields further north such as C33, 37 and 40 with spill over onto others nearby, balanced by lighter use of fields further south such as C28, 30 and 31. The Midtown fields were similarly well used to normal with some fields holding more geese than usual and others less, the rush cutting continuing to maintain goose numbers on fields C21/22 and S67a (**Figure 3**). Newfield had typically high numbers of geese across all fields on that holding except C06 (wet rush pasture). At Eastpark Farm the WWT reserve probably accommodated slightly higher numbers of geese than usual albeit the rush-dominated pasture of field C16 was again unused;

- There were fairly typical levels of barnacle goose use in the Lands, Hollands and Shearington areas though field S60/64 had increased use. At Lantonside, field use along the shore road was low but on the hillside fields of Ward Law usage was perhaps higher than normal (**Figure 3**);

- Up the River Nith towards Dumfries fields of the Netherwood Mains, Islesteps, Flats of Cargen and Greenmerse areas showed no particular pattern of sustained higher or lower goose use although some fields in low lying areas of Greenmerse farm did have big goose flocks especially into March (**Figure 4**);

- The Prestonmill to Mersehead area of the coast has probably seen some of the bigger shifts in goose use with a tendency for large flocks of up to 7,000 forming on fields nearer Newmains Farm and Southerness such as N37, 46 and 47 and continued heavy use of fields at Cowcorse Farm and nearer the

road at West Preston while the fields managed by RSPB at West Preston and Mersehead have either declined in use or continue to hold lower numbers of geese. This is presumably due to the fields being agriculturally improved on the Newmains holding through drainage and reseeding while those acquired by RSPB e.g. at West Preston have become rush dominated (**Figure 5**). In the Southwick area goose use seemed fairly typical though fields such as M03 were heavily used in some periods;

- In the Gretna area it is difficult to draw conclusions due to the lack of counts possible this season. However when counts were possible there were few geese seen. Counts tend to increase on those fields later in the season, especially in May when large numbers of geese can flight over from Rockcliffe Marsh if food there is depleted by the spring departure build up in numbers or by high tides (**Figure 6**).

Overall, it is difficult to interpret the patterns seen this winter compared to the previous five year period simply because the mean values for 2019-2020 cannot include late March and April counts, a time at which the geese often move onto the saltmarshes to feed, and therefore the saltmarsh areas will mostly show lower use values in the 2019-2020 compared to normal. Also some field areas are used more than others in late March and April.

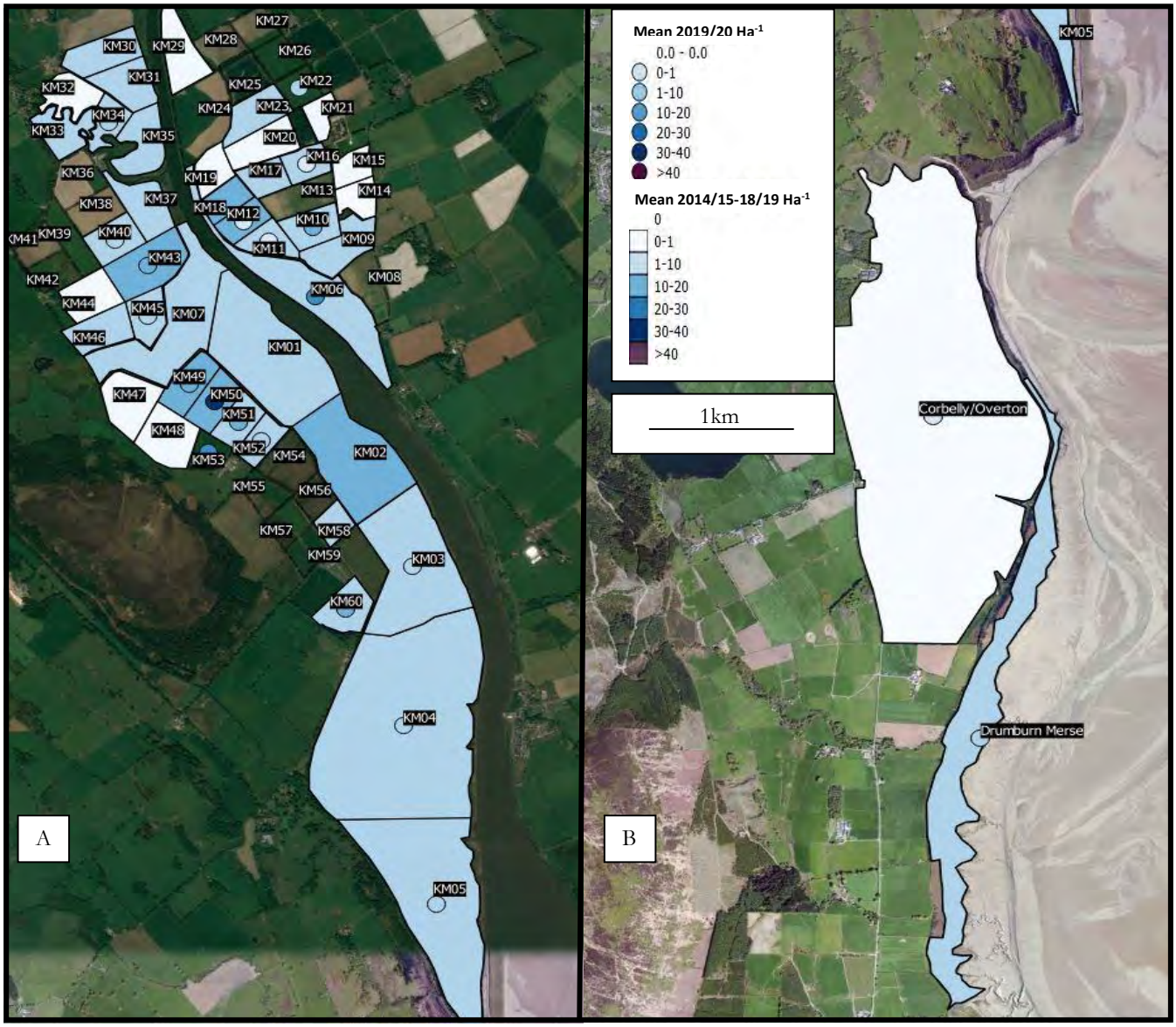

Figure 4. Mean goose use (total geese/number of goose count days) per hectare in winter 2019/20 (shaded symbols) compared to the previous five-year period from 2014/15 to 2018/19 (shaded fields plus SNH field codes) for the Kirkconnell and River Nith (A) south to the Corbelly/Overton and Drumburn Merse area (B).

Figure 5. Mean goose use (total geese/number of goose count days) per hectare in winter 2019/20 (shaded symbols) compared to the previous five-year period from 2014/15 to 2018/19 (shaded fields plus SNH field codes) for the Carsethorn to Southwick area.

Figure 6. Mean goose use (total geese/number of goose count days) per hectare in winter 2019/20 (shaded symbols) for the Redkirk to Gretna area, which although not part of the Goose Management Scheme area, was added to the SNH count surveillance route in October 2017 (hence the previous five-year data are not available for this area).

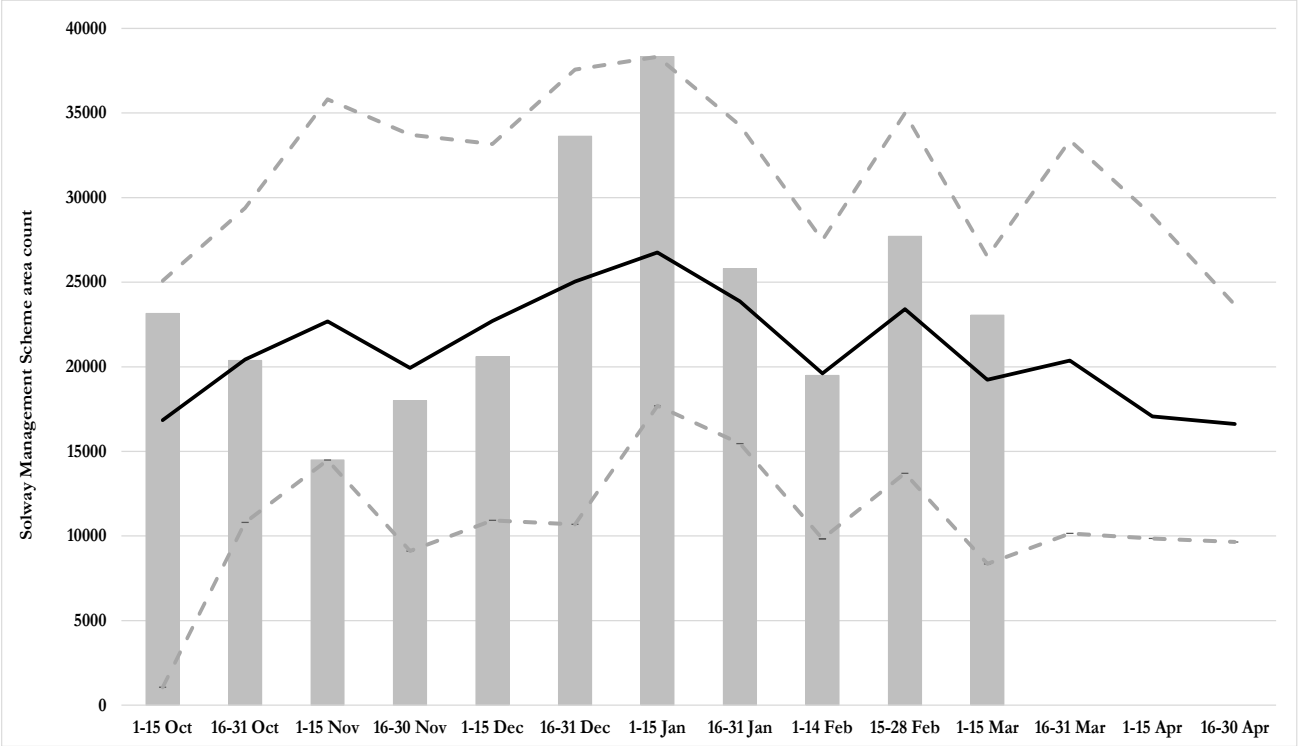

Figure 7. Svalbard Barnacle Goose 2019/20 half-month flock count totals (grey bars) within the SNH Solway Goose Management Scheme area compared to the mean (solid black line), minimum and maximum (dashed grey lines) counts for the period from 2008/09 to 2019/20 within the same area.

Some goose count totals for the Scheme area are greater than others because double counting of flocks that move between fields often occurs over the course of a route count. The methodology of the SNH route counts does not seek to remove this bias as the aim is to record the numbers of geese using individual fields. In contrast, the co-ordinated count methodology of the JNCC census at a set time of day within a *ca.*1.5 hour period aims to remove this bias. Fluctuations in goose numbers within the Scheme area also occur due to the effect of high tides (see **Table 3**) combined with weather conditions which can push geese off low lying saltmarsh areas on the south side of the Solway, and due to geese dispersing mid-winter after peak arrival to foraging areas outside the Scheme area (**Figure 7**).

The mean number of geese recorded during the route counts was 23,700 for the period from early October to early March (25,055 for October to April in 2018-2019) ranging from a minimum of 14,495 on 13 November 2019 (14,858 in 2018-2019) up to a maximum of 38,330 on 12 January 2020 (37,567 in 2018-2019). Due to the COVID-19 restrictions in place from March 2020 it was not possible to monitor departure from the different Solway sites via the April and May counts that are usually conducted. Overall within the Scheme area there tends to be a decline in goose use as food resources within the area are depleted by the end of January. This trend was less apparent this winter probably due to the milder winter conditions allowing for grass growth throughout the period, although heavy rains in January and February reduced the area of pasture in lower lying flooded areas. Winter 2019-2020, like the previous winter, was fairly benign with only 21 nights (data to 30 April 2020) on which ground frosts (minimum temperature less than -1°C recorded at the WWT Caerlaverock weather station) were likely; the first not being recorded until 13 November 2019.

Flock sizes and field distribution of Barnacle Geese within the Management Scheme area are given in **Table 4**. Coded fields with zero counts have not been shown although these data are provided in the accompanying Excel file.

Table 4. Svalbard Barnacle Goose flock sizes recorded during the Management Scheme route counts.

Field code	02/10/19	09/10/19	23/10/19	30/10/19	13/11/19	26/11/19	04/12/19	28/12/19	12/01/20	27/01/20	05/02/20	20/02/20	06/03/20	Total
A02										2				2
A18					245		360		390					995
A21						112								112
C01			1850		1	2		720	80	34		640	1	3328
C02			1930	85		95	450	870	5	15		440		3890
C03		760	85	22		15			45		45	6		978
C04/05			5	35					140	160	280	770		1390
C06										4				4
C07					160				750					910
C08					790		170		140		85		9	1194
C09		240		1090	430	20	70	270	150	15	60			2345
C10/11		3570		1550		210	1340			120				6790
C12			1270			50			1320	390	50			3080
C13	5300	400	300					1420	90	70				7580
C14		240						45	70	710				1065
C15			650				2000	1100				1500		5250
C19a		28		380	5	610		62			190		130	1405
C19b	210	580	310				340	270	400			40		2150
C19c									150	150	80	460		840
C20				520	610		180				460	36		1806
C21/22			4					4	20	81		230		339
C23a								1350		260			1270	2880
C23b									660	540				1200
C24										85				85
C27	1400													1400
C28			830				700							1530
C29	830		85	160			550	310		580				2515
C30	2000	280							900					3180
C32	500			600										1100
C33	1650			650			650		580	390	280			4200
C34									80			45		125
C35			6									450		456
C36			210	1						12				223
C37				2100						180	40			2320
C38				800										800
C39						830								830
C40	700	22												722
C42									220					220
C44										9				9
C51/S71			110			1400	20	16		40	240	430	580	2836
C52	1050	1085	410	960	950		300	292	20	1060	700	100		6927
Corbelly/Overton							500	1000	100					1600
Drumburn Merse						960		150				363	130	1603
G29							1400							1400
JP09										140				140
JP18						280		190						470
JP22											300			300
JP28						250								250
JP29									590					590
JP30												180		180
JP47			39											39
JP48										15				15
JP49												280	1100	1380
KM03											90	1800	480	2370
KM04					580					180	240		4200	5200
KM05										20	1800			1820
KM06		1600	5400			2090								9090
KM10		1700												1700
KM11								33	8					41
KM12									45					45

KM16			70											70
KM22									340					340
KM34										110				110
KM40		250												250
KM43									2700	430				3130
KM45		450												450
KM49								1340					80	1420
KM50	520							420	720	650			800	3110
KM51								510					300	810
KM52													100	100
KM53										1600				1600
KM60					120				380			850		1350
L30				1020										1020
L38								590						590
L43					60		20		300					380
LB07									1800					1800
LB08											350			350
LB10										720				720
M01													1760	1760
M02												170		170
M03								850					1760	2610
M05								850	420					1270
M07b									370					370
M07c								330						330
M10						40								40
M13a				1600		470	320			55				2445
M13b								310						310
M16				70	6		230		23					329
M18								220						220
M19				62				210	3			12	300	587
M20	645		110	504	20	230		840				58		2407
M21		13		92				3						108
M22				201	32								140	373
M23	400						150						170	720
M24	14			19		160								193
M25					15				45	45				105
M26	515		360		62	70						140		1147
M27	200	169	290	32			390	240	95	35				1451
M28							4					7		11
M29		163	420	664		310	180	550	105	165		12	6	2575
M30			570				300							870
M31					190	40	915	1320	690	520		32	260	3967
M32	720			50		850		340		240	1500			3700
M33				164		690		70			300	345	960	2529
M36/37/38/39			90	350	1410		7			115				1972
M45a					1400									1400
N08										16				16
N13												1190		1190
N17				94										94
N35												1750		1750
N37								4000						4000
N39		220					710							930
N46						980		4000					980	5960
N47					310				4600					4910
N48								170	320					490
N49							710							710
N51						720								720
N52					180				510					690
N53					730									730
N57					2320									2320
P09/12													2200	2200
P15			760								1500			2260
P16												440		440
P19							630		2450			2200		5280

P20												760		760
P21/22			3290	550				41				70	1080	5031
P23			330	550					6870		3750	760		12260
P24							260		350			4300		4910
P25			1120				952	80	490	1250		950		4842
P26			1120											1120
P30		260												260
P33		515		135						260				910
P34					315	620						320		1255
P35	2500	830						320				30		3680
P36	400					550					650	8	160	1768
P37a									180		30		410	620
P38						10					100			110
P39					350									350
P40		700			400			40		330				1470
P41a	500	700										470		1670
P41b	1500	800							40	1570		80	65	4055
P42a											250			250
P43b				600					640					1240
P44									190			25		215
P45a	500	255												755
P45b	450													450
P45c										70		17		87
P45d		1350						80	390	1440				3260
P46										1260				1260
P47	350	1350								680				2380
PR30												21	350	371
PR36												3		3
PR53							2							2
PR55							1850							1850
PR56							300							300
PR57							6							6
PR58							1750							1750
PR59												1300		1300
PR68b								290	400	1610	70			2370
PR69									1450					1450
PR70												800		800
PR76											2800			2800
RK14										60				60
S17/18a										95	6			101
S18b/24												5		5
S21										110				110
S25	700				400						14			1114
S26						1100								1100
S33a													380	380
S38												3		3
S39												960	380	1340
S40/42									1800					1800
S41/43									420					420
S44/46					280					340	440			1060
S45/47					170									170
S52											10			10
S54/55								3200		520				3720
S56/57	10				1800				490			130		2430
S58										117				117
S59									118	65				183
S60/64		180	75			1020		25		800	560			2660
S65					4				310					314
S66	40	2120							25	4	65	60		2314
S67		25												25
S67a			60				30		15	220				325
S68			77				1850	520	270			27		2744
S69				1250								100		1350

S70											140	1400		1540
SC05								1100						1100
SC06						480								480
SC08								1080	290					1370
SC10						2000								2000
SC20								3	18	55		45		121
SC22/23										3160				3160
SC25									750				1250	2000
SC34								380						380
SC35								1200						1200
SC45	1450	350	1200	350	150						2010	80	1250	6840
W05						730								730
W06										1800				1800
W39/43										18				18
W52	30													30
Total	25084	21205	23436	17310	14495	17994	20596	33624	38330	25797	19485	27700	23041	308097

3.2 Pink-footed Goose counts for the Management Scheme area

Pink-footed Goose *Anser brachyrhynchus* counts are very variable as the extent to which geese remain in the area tends to be very weather and crop dependent. Typical peak times include the autumn as geese arrive back from Iceland into the UK and nearly 5,000 were recorded across the Scheme area at the start of October 2019 (**Table 5**). Peaks also tend to occur from February to April as birds from further south in the UK move north on migration. Pink-footed geese were seen in the traditional wintering areas between Carsethorn and Powillimount, Kirkconnell Merse, Priestside and Hurkledale, with occasional flocks elsewhere at Lands, Shearington, Bankend and the Locharwoods area.

Table 5. Pink-footed Goose flock sizes recorded during the Management Scheme route counts.

Field code	02/10/19	09/10/19	23/10/19	30/10/19	13/11/19	26/11/19	04/12/19	28/02/19	12/01/20	27/01/20	05/02/20	20/02/20	06/03/20	Total
A02				80	60									140
C23a													50	50
C25/26	200													200
C37				2										2
C40	400	30												430
C42									350					350
C44	25													25
D59										500				500
Drumburn Merse												340		340
G06										220				220
JP09								35		570				605
JP18						210								210
JP22											350			350
JP28						2000								2000
JP29									120					120
JP48										70				70
JP49												15	360	375
KM03												50	40	90
KM04	30									50			120	200
KM05										25				25
KM10							30		130					160
KM16			70					8						78
KM20								70						70
KM22									800					800
KM34										60				60
KM36										85		35		120
KM37										80				80
KM38					50		10	25						85
KM43											260	5		265
KM46												60		60
KM49													320	320
KM50	50												40	90
LB08											1000			1000

LB10										800				800
N08										180				180
N10										60				60
N13												490		490
P15	1540													1540
PR24											350			350
PR30											22	30	700	752
PR68a												110		110
PR68b								120			70			190
PR70										90				90
PR76										5	300			305
RK10												500		500
RK14										160				160
RK17													620	620
RK26											120			120
S21										140				140
S25			1											1
S33a													40	40
S38												2		2
S39												140		140
S44/46									45					45
S45/47	40													40
S52											350			350
SC16											3			3
W05						40								40
W06										650				650
W28	1900													1900
W39/43										960				960
W52	600						160	520						1280
Total	4785	30	71	82	110	2250	200	778	1445	4705	2825	1777	2290	21348

3.3 Greylag Goose counts for the Management Scheme area

Reduced numbers of Greylag Geese *Anser anser* were recorded within the Scheme area, most records occurring on the ponds and fields at WWT Caerlaverock (**Table 6**). Post-moult flocks usually build up in this area during late summer, with numbers declining from a few hundred to less than ten over the course of the winter. Even though numbers were small, the pattern this winter was fairly typical with a number of birds remaining at the WWT Caerlaverock swan feeds until January with numbers then dropping off rapidly to zero.

Table 6. Greylag Goose flock sizes recorded during the Management Scheme route counts.

Field code	02/10/19	09/10/19	23/10/19	30/10/19	13/11/19	26/11/19	04/12/19	28/12/19	12/01/20	27/01/20	05/02/20	20/02/20	06/03/20	Total
C17	10													10
C24									12			5		17
C40		50												50
S25	300													300
S45/47	30													30
Total	340	50	0	0	0	0	0	0	12	0	0	5	0	407

3.4 Canada Goose counts for the Management Scheme area

Small numbers of Canada Geese *Branta canadensis* were recorded within the Scheme area, most records occurring on the ponds and fields at WWT Caerlaverock (**Table 7**). As with the Greylag Geese with which they often associate in mixed flocks, post-moult flocks usually build up in this area during the late summer, with numbers declining from a few hundred to less than ten over the course of the winter.

Table 7. Canada Goose flock sizes recorded during the Management Scheme route counts.

Field code	02/10/19	09/10/19	23/10/19	30/10/19	13/11/19	26/11/19	04/12/19	28/12/19	12/01/20	27/01/20	05/02/20	20/02/20	06/03/20	Total
A02					6									6
C08								10						10
C17	40		10		10	20	50	80	80	105	25	25	2	447
C21/22									8					8
C40		130												130
S45/47	750													750
S56/57	80													80
Total	870	130	10	0	16	20	50	90	88	105	25	25	2	1431

3.5 Whooper Swan counts for the Management Scheme area

The Scheme area and fields at its fringe especially around WWT Caerlaverock, Kelton and Thwaite generally hold about 400 Whooper Swans *Cygnus cygnus* throughout the winter, with numbers increasing gradually up to the end of November and into December as the swans arrive from Iceland and decreasing rapidly during March as birds head north on migration. Some flocks occurring on fields outside the Scheme area are noted as comments on the Excel database but do not contribute to the totals given in **Table 8**. The swan numbers this winter followed the usual arrival and departure pattern with swans using the traditional feeding areas around Kelton, Caerlaverock, Thwaite and Ruthwell.

Table 8. Whooper Swan flock sizes recorded during the Management Scheme route counts.

Field code	02/10/19	09/10/19	23/10/19	30/10/19	13/11/19	26/11/19	04/12/19	28/12/19	12/01/20	27/01/20	05/02/20	20/02/20	06/03/20	Total
A02				346	85				50	9				490
A04/05			151										63	214
A20b							25	45	25	8			9	112
C08			1			2		53				30	52	138
C17	2		7		20	80	60	70	90	130	140	90	15	704
C24									8			10		18
C30													15	15
C40	12													12
KM06				4										4
KM08					60	70								130
KM10			40			95	100		55	16				306
KM13							30							30
KM18					30									30
KM38					40	2	30	2	39	20				133
KM51							30							30
L13											5	35		40
LB10										12				12
S33b											15			15
SC16					75									75
SC35								4						4
Total	14	0	199	350	310	249	275	174	267	195	160	165	154	2512

3.6 Mute Swan counts for the Management Scheme area

Mute Swans *Cygnus olor* mainly occur on the ponds at WWT Caerlaverock with scattered pairs elsewhere. This winter followed the usual pattern and after numbers built up at the Caerlaverock swan feeds to a peak in mid-winter, by early March the birds were dispersing to breeding territories elsewhere (**Table 9**).

Table 9. Mute Swan flock sizes recorded during the Management Scheme route counts.

Field code	02/10/19	09/10/19	23/10/19	30/10/19	13/11/19	26/11/19	04/12/19	28/12/19	12/01/20	27/01/20	05/02/20	20/02/20	06/03/20	Total
C10/11											2			2
C15													2	2
C16	2		2										2	6
C17	30		50		60	50	60	60	70	70	70	50	35	605
C52	10												2	12
M16													2	2
M30								2					2	4

RK17													2	2
S67a	1													1
SC06													2	2
SC16					3									3
SC45	9		6											15
Total	52	0	58	0	63	50	60	62	70	70	72	50	49	656

3.7 Deliberate disturbance to geese in the Management Scheme area

Disturbance activities (up to the end of the first week of March after which no further observations were possible due to the COVID-19 restrictions) thought to be directed towards geese were as follows (further details in Excel spreadsheet):

- From the start of January 2020 to March 2020, there were three blue barrels and a gas gun deployed on a hillside field at D09 northwest of Prestonmill; no barnacle geese were seen on this field and the devices were perhaps directed towards pigeons or pink-footed geese;
- From the end of January 2020 to March 2020, scarecrows with yellow jackets plus large white plastic water vats were deployed in fields N06, N14 and N15 at Newmains, Prestonmill probably in response to the presence of pink-footed geese and barnacle geese; these devices were not moved during the period of observations;
- Single sources of disturbance on six different fields due mainly to tractor or digger work or dog walkers will possibly have kept geese off of these fields and those in the surrounding area for the period during which they occurred; details are given in the Excel spreadsheet provided.

3.8 Count section dates and times of coverage

Table 10. Survey dates, times and types for the SNH Goose Management Scheme count sections.

Type	JNCC	JNCC	JNCC	JNCC	JNCC	SNH	JNCC	SNH	SNH	SNH	JNCC	SNH	SNH
Day	Wednesday	Wednesday	Wednesday	Wednesday	Wednesday	Tuesday	Wednesday	Saturday	Sunday	Monday	Wednesday	Thursday	Friday
Date	02/10/19	09/10/19	23/10/19	30/10/19	13/11/19	26/11/19	04/12/19	28/12/19	12/01/20	27/01/20	05/02/20	20/02/20	06/03/20
Thwaite	10:10	10:40	10:50	10:30	11:00	13:50	10:00	16:00	15:00	11:55	10:00	15:55	14:05
Nith	08:40	09:15	09:10	09:00	09:35	12:00	08:25	13:30	08:30	08:50	08:35	14:45	12:40
Southerness	10:30	11:00	11:30	11:45	11:15	09:30	10:45	09:15	12:00	15:30	11:30	12:30	09:00
Gretna	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	11:00	n.a.	15:45	12:45	11:15	16:35	15:00

There were seven Wednesday counts (due to the reliance on the early October JNCC counts because of later COVID-19 restrictions on the SNH count schedule after early March 2020) and one count on each of the other days of the week giving 13 counts in total (**Table 10**). Due to the collapse of the road bridge at Brow Well in the period from October to December 2019, it was not possible to cover the count section from Thwaite to Gretna.

3.9 Farmer liaisons regarding geese

As counts were conducted within the Scheme area, any significant conversations with the farmers about goose numbers were noted. Sometimes these were on days on which a count was not being conducted. Farmers were also contacted by phone during the January/February period to discuss goose issues once they had received the field count data from SNH. All conversations were about goose numbers and whether or not the counts being conducted gave a useful representation of what the farmers' impressions of field use was like; generally the farmers felt that the counts probably gave a reasonable representation of what was happening on their land although many also felt that the reduced frequency of counts did not give a good representation of goose use but understood the limitations of the methodology. Farmers engaging in conversations about geese were noted (**Table 11**).

Table 11. Records of conversations with farmers regarding goose activity in the Scheme area.

c.27/1/20 -3/2/20	Jim Kirkland said the geese were in big flocks in the usual places with nothing out of the ordinary; lots of use of fields out the back of the farm of late.
	Stuart Brown said there had been a lot of use of the pasture S61 south of Hollands farmhouse and he had pictures of them and would appreciate a trail camera overlooking that field and S58 & S59.
	Stephen Brown felt the counts had missed the heavy use of field C19c in October especially by big flocks of geese daily; thought that fields not under good managed grass should not get payments.
	Alastair Martin said fields south of road at Nether Locharwoods (L30-31?) had been well used by big flocks of geese and grass was now white-looking; no sheep for a while on L43 so where had all the grass gone?
	Alastair Wylie felt the counts had captured field use well this winter especially the use of 2nd year reseed down at Northpark C33 and even the Mossband fields where geese sometimes feeding at night around pools.
	Jack Graham wanted it noted that there had been big flocks of geese, perhaps as many as 10,000 making field C21 black, yet the survey has recorded hardly any geese on that field even though they are there every day. Also he wanted SNH to note that he has lost out on goose money for field S67a because of the disturbance caused by people using the footpath; this is scaring geese off the field as is the wildfowling closer to the hide and has reduced goose numbers compared to ten years ago so he should be compensated for this loss on income due to the effect of the path.
	Andrew Marshall felt there had been good use of fields SC08 and SC11 which corresponds to a degree to the counts so far; fields very wet and easily puddled.
	Doug Freeman said there had been a regular flock on the flooded stubble at SC20 and that these birds had sometimes been on the pasture between Stanhope and Brow Well (SC21). Nothing else to report but farm had been cut in half by the bridge collapse which made things tricky.
	John Jamieson was going to call me back if he had any issues he wanted to discuss.
	Stephen Murray said there had been heavy use of fields by the road like P23 and fields down by the barns like P25 where flocks almost daily. Recently had been some use north of road for fields like P09/12 but not field right by the wood (P13/18?). P31 pasture in golf course had been used but not the kale field P32. The counts had covered most field use reasonably well but there were some gaps that he guessed would be picked up in the second half of the season.
	James Worthington said geese had been on the winter cereal fields as evidenced by droppings and grazed leaves at H03/34, H04/33 and W02 and W03/04 etc. It's not clear if these are pink-footed geese, barnacles or both. He said the crop is now recovering after initial grazing period. Memorial deciduous trees being planted in half of field W05(?) pasture.
20/3/20	Mr Begg is not sure which fields he has in the Scheme but described heavy use of his lower fields like N37 earlier on and for his neighbour too down towards Southerness and then more latterly from mid-March when counts suspended he said the geese had been using the fields like N25-27 closer to the road. He said that usually the geese leave his land alone in March but this winter they had been back later on and he has had to push them away most mornings at about 07:00, but they head to West Preston without trouble. Mostly barnacles and not pink-footed geese. They have puddled the land and created pools and a pan in some field areas and he is going to need to plough those areas to break the pan.
	Ben Oliphant reckoned he had more geese about this winter due to longer grass growth with mild weather, with good use of fields both sides of the road and along forestry track especially at start of March.

3.10 Coordinated Svalbard Barnacle Goose population count totals

Table 12. Coordinated Svalbard Barnacle Goose population count totals for the Solway Estuary and Budle Bay.

Count section	02-Oct	09-Oct	23-Oct	30-Oct	13-Nov	04-Dec	05-Feb	Counts suspended after mid-March due to COVID-19 restrictions
Annan to Gretna	n.c.	n.c.	n.c.	n.c.	n.c.	150	0	
Ruthwell to Cummertrees	1450	350	1200	0	0	4158	3220	
Longbridgemuir	0	0	0	0	0	0	350	
Caerlaverock	13750	9530	8267	10553	5655	9030	5735	
Kirkconnell & Ward Law	1220	4000	5470	0	1100	3990	2150	
Mersehead to Airds Pt	8394	7325	8674	5737	7740	5758	8380	
Caulkerbush to Rascarrel	n.c.	n.c.	5	0	0	0	0	
Dundrennan to Wigtown	n.c.	n.c.	0	0	17	500	1450	
Rockcliffe Marsh	6000	4700	7200	4300	12000	4000	11670	
Burgh Marsh	0	0	0	0	0	0	0	
Bowness to Grune	800	1400	3700	2300	6500	3656	4405	
Solway total	31614	27305	34516	22890	33012	31242	37360	
Budle Bay	880	4000	2000	1600	1800	1800	2500	
Overall total	32494	31305	36516	24490	34812	33042	39860	

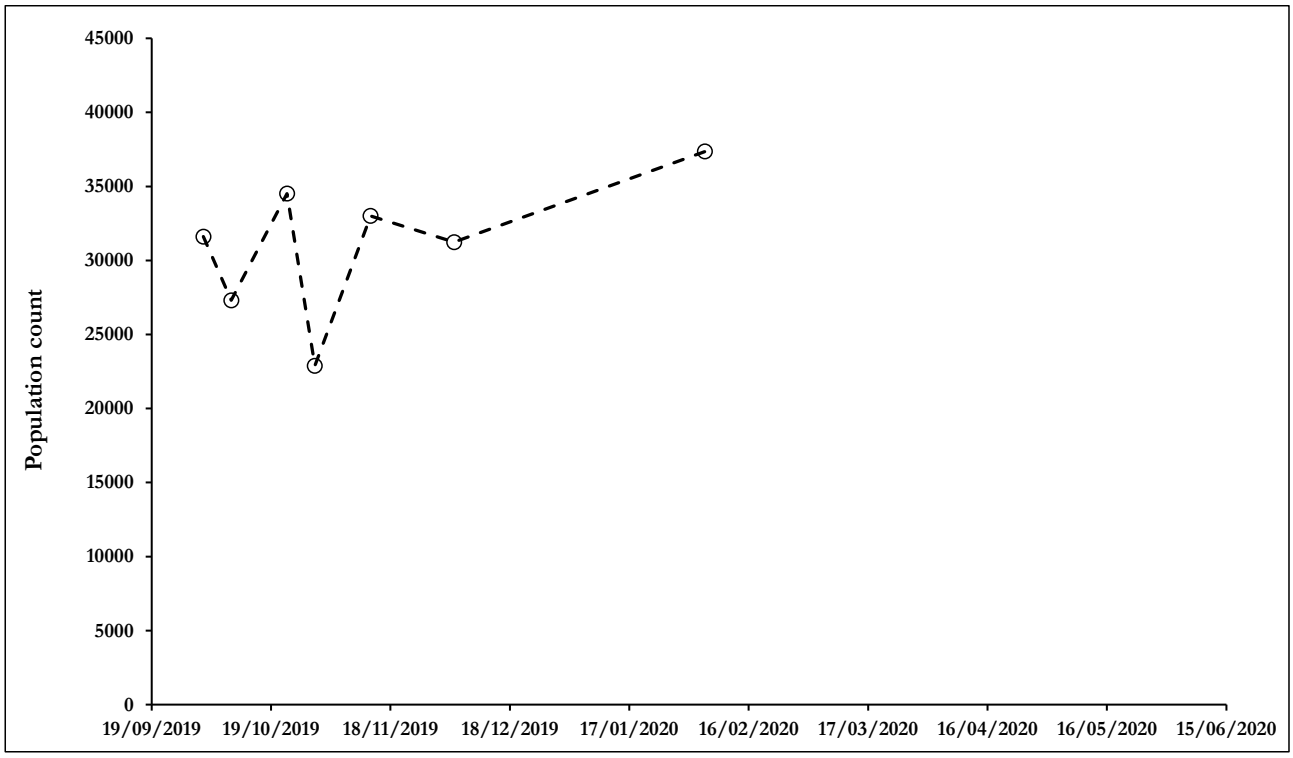

Figure 8. Total population of the Svalbard Barnacle Goose on the Inner Solway from October 2019 to February 2020 (with further JNCC census counts abandoned due to COVID-19 restrictions).

The first arrival of Barnacle Geese thought to be genuine migrants from Svalbard was a flock of 6 recorded on the saltmarsh at WWT Caerlaverock on 20 September 2019, with 940 on the saltmarsh by 24 September. It is known from past years that ringed birds from small feral flocks at Loch Leven and the Highland Wildlife Park can be present throughout the winter on the Solway and that birds over-summering in Cumbria can also be present. These birds, that can look like they are in moult and thus have a rather scruffy appearance, can turn up early to the Solway in small numbers and their numbers on the Solway throughout the winter probably total less than 500. As with 2018, goose numbers built up very rapidly on the Solway in 2019 with at least 31,600 present by 2 October, with 13,750 of those in the Caerlaverock area (**Table 12**; **Figure 8**). A further 3,000 geese had been recorded as part of further influxes to the Solway by 23 October 2019.

Census counts from 2 October to 13 November were hampered in one eastern section on the north side of the Solway from Brow Well to Gretna due to the collapse of a key road bridge after flood conditions. This meant that not only could the geese in the Thwaite, Ruthwell and Cummertrees areas not be counted, but also the northern part of Rockcliffe Marsh in Cumbria could not be covered. The situation returned to normal when the bridge was re-opened at the end of November and two census counts were then completed before the counts across all sections were suspended for the rest of the winter under the COVID-19 travel restrictions. The impression from the incomplete census counts was that there were less birds on the Solway than in winter 2018/19, especially as the count areas that could not be covered often do not contain a significant number of geese in the early part of the winter. This was confirmed when a full census count covering all sections was completed on 5 February 2020 when 37,360 geese were counted, the peak for the season.

Significant numbers of birds again staged/wintered on the east coast at Budle Bay, Northumberland with an estimated 4,000 there on 9 October 2019 (the same estimate as on 8 October 2018) dropping to a more sustained 1,800 to 2,000 for the rest of the winter until 5 February when 2,500 were counted; this increase from the 1,800 recorded on 4 December was thought to coincide with the timing of the movement of a GPS tagged bird from the Solway back to that area between 30 January and 1 February, suggesting a mid-winter influx to Budle Bay of birds moving north-east from the Solway. By 14 March numbers had dropped back to about 1,600 coinciding again with the movement of the tagged bird back to the Solway on 15 March, with only 250 geese being recorded in Budle Bay area on 18 March and none thereafter. The drop in numbers coupled with the movement of the tagged bird strongly inferred that the birds had moved to the Solway but with the suspension of counts in March this must remain speculation.

Due to count variation, with possible inaccuracies and the chance of double-counting, an adopted count total for the Solway population is derived by averaging those counts within 10% of the maximum recorded during the winter. In 2019/20, the counts of 37,360 on 5 February 2020 and 34,516 on 23 October 2019 fulfilled this criterion (albeit the count of 23 October did not cover all count sections) and were thus averaged to produce **an adopted Solway population total of 36,000 Svalbard Barnacle Geese** (rounded up to the nearest 100; c.f. 40,400 in 2018/19). Therefore in terms of peak counts or adopted counts there has been a decline in the population total on the Solway for the last two years. This conclusion remains unchanged if the Budle Bay counts are added to the Solway total for the last three years.

3.11 Brood size and juvenile productivity of the Svalbard Barnacle Goose

The juvenile productivity of the Svalbard Barnacle Goose observed in flocks sampled on the Inner Solway from October 2019 to November 2019 in the Redkirk, Caerlaverock, Kirkconnell and Southerness areas varied between 0.7% to 14.6% (**Table 13**; 0% to 11.2% in 2018-2019) with a mean of 5.2% young from 14 flocks with 10,111 geese sampled (6.3%; n = 19 flocks; 10,829 geese sampled in 2018-2019). Across the Caerlaverock and Southerness areas, the total number of broods sampled was 121, with a mean family size of 1.6 young, range 1-4 young (1.7 young; n = 151 broods; range 1-6 young in 2018-2019).

Table 13. Brood size and juvenile (juv) productivity for Svalbard Barnacle Geese on the Solway in winter 2019/20.

Date	Flock Size	Sample Size	Total Juvs	Field	Crop	Brood of 1	Brood of 2	Brood of 3	Brood of 4	Brood of 5	Brood of 6	Single Juvs	% juvs	Obs
10/10/2019	415	390	57	A5	pasture								14.6	LRG
24/10/2019	706	686	9	O5	pasture	5	2						1.3	LRG
24/10/2019	1090	1090	25	O3	pasture	10	6	1					2.3	LRG
24/10/2019	274	274	3	A5	pasture			1					1.1	LRG
24/10/2019	2300	375	4	A3b	pasture	2	1						1.1	LRG
24/10/2019	700	510	36	E1	stubble	11	5	5					7.1	LRG
29/10/2019	4600	1290	107	F6	pasture								8.3	LRG
30/10/2019	2800	1410	89	E6	pasture								6.3	LRG
30/10/2019	2400	1160	74	E1	stubble								6.4	LRG
31/10/2019	2020	1000	32	T10/11	pasture	12	1	2	1				3.2	LRG
31/10/2019	1400	880	59	S6/7	pasture	18	17	2					6.7	LRG
05/11/2019	286	286	2	A8	pasture		1						0.7	LRG
13/11/2019	240	240	23	H15	pasture	4	5	3					9.6	LRG
26/11/2019	720	520	8	X78	pasture	4	2						1.5	LRG
Total		10111	528											
Overall juv%			**5.22**			Brood size totals:								
						66	40	14	1	0	0	Total broods	121	
						Number of juveniles per brood size category:						Max %juvs	14.6	
						66	80	42	4	0	0	Total juvs	192	
												Mean brood	**1.59**	

3.12 Leucistic Barnacle Geese

A minimum of five or possibly six leucistic Barnacle Geese was recorded on 5 February 2020 (with five also recorded on 23 October), including two in the Newton Marsh area and three or possibly four at Rockcliffe.

3.13 Other geese

At least one blue phase Ross's Goose *Anser rossii* x Barnacle Goose hybrid was often present at Caerlaverock with the barnacle geese. In the second half of the winter a Cackling Canada Goose *Branta hutchinsii* was regularly seen in the Caerlaverock area.

3.14 Trail camera monitoring

From mid-November 2019 onwards six Acorn LTL 6310MC trail cameras with 32GB SD cards and rechargeable batteries were deployed on trees or fence posts, with landowner permissions, at five main locations within the Goose Management Scheme area (**Table 14**). The cameras were used in time lapse mode to take images every 20 minutes from dawn to dusk typically 06:00-20:00 GMT (14 hours in total) until retrieval in early May 2020 by which time the geese have typically left the Scheme area for Rockcliffe Marsh, Cumbria, prior to spring migration. In general, the images were unaffected by periods of poor weather except for some early morning mists and occasional rain on the camera lens. In some instances there were corrupted images but for all cases of poor image quality these totalled less than 1% of the total images collected by any camera. In most circumstances it was possible to discern goose flocks at all distances between the camera and field boundaries, though this no doubt depended on flock size to an extent and the terrain between the geese and the camera. The approximate surveillance polygons within which goose flocks could readily be detected are depicted in **Figure 9**. A subjective assessment was made of the approximate percentage field visibility as the edges of fields closer to the camera are out of the line of site of the "cone" shaped field of view (**Table 14**). Such a limitation to the view field was not thought to be a problem in assessing whether or not a field was used by geese as goose flocks tend to land near the centre of fields before spreading out to feed.

Table 14. Trail camera deployment locations (Figure 9), field areas surveyed and the survey periods covered.

Farm holding	Approximate percentage of field area visible	Deployment time & date	Retrieval time & date
Hollands	S58 ~55%	15:20 31/01/19	13:20 03/05/20
Hollands	S59 (northern segment used by geese) ~90%	15:50 31/01/19	13:40 03/05/20
Hollands	S61 ~75%	15:30 31/01/19	13:20 03/05/20
Hollands	S62 ~55%	13:20 30/12/19	13:00 03/05/20
Midtown	S67a (western upper improved part of field) ~85%	12:15 15/11/19	12:20 03/05/20
Midtown	S67a (eastern upper improved part of field) ~75%	13:40 30/12/19	12:20 03/05/20

Figure 9. The six trail camera positions (star symbols) on the five field compartments at Midtown and Hollands Farms and their approximate surveillance polygons. Cameras typically at ~1m height above ground on a post.

The pictures from the cameras were viewed on Windows PhotoViewer on a 27 inch desktop screen at the rate of about one picture per 2-3 seconds, each picture being scanned from side to side by the viewer (LG) for signs of goose flocks. It is quite likely that small flocks of less than 10-20 birds will be missed on occasion at increasing distances from the camera. A subjective assessment of the flock size, based on 20 years' experience of counting goose flocks, was made and noted on a spreadsheet along with the arrival and departure times of the geese to and from the field. These are probably minimum assessments of feeding times spent by the geese on the fields as sometimes a flock was seen to move into or out of the field of view of the camera and so it was not known if the flock had just arrived or just left the field. In some cases where a flock disappeared with a direction of travel into an area out of view, and then reappeared within the next hour from that direction, it was assumed that the flock had remained within the field during that whole time period. In the summary below it is presumed that the pictures taken every 20 minutes would have recorded any goose flocks using a field as goose flocks tend to use a field for 1-2 hours or more once settled (see below).

Each flock count recorded on the trail camera images was converted to "goose hours" (goosehrs) by multiplying the maximum estimated count recorded in a series of contiguous images by the period of time over which those images extended plus an allowance of 10 minutes either side of the first and last image for the flock to have been present but unobserved, for example 100 geese on a field for at least 40 minutes (present on two images) equates to 100*1.0 = 100 goosehrs which is deemed equivalent to 200 geese being present for 30 minutes or 100 geese for an hour. All 'goosehrs' totals for a field probably represent a minimum because birds may have used areas of the field that were not within view of the camera and occasionally flocks may have visited a field for less than 20 minutes. Each separate period of goose use of a field throughout a day was summed and divided by the number of observation days that the camera was operational for, in good visibility conditions, to give 'goosehrs/day'.

Feeding flocks of geese were recorded at five of the six trail camera locations. The trail camera observing the western upper section of improved grassland at S67a recorded no geese. This camera was running for 11 hours per day from 07:00-18:00 from 15 November 2019 to 3 May 2020 (**Table 14**) but no geese were recorded.

Only field S61, which was monitored 14 hours per day from 06:00-20:00 from 1 February to 3 May 2020, was used fairly heavily by geese throughout the period from the start of February to mid-March, but not thereafter during the key period of grass growth prior to stock turn-out, with nearly 20,000 goosehrs being recorded overall.

Fields S58, S59 and S62 had very sporadic use by flocks of up to ~600 geese, but typically much less than this, for short time periods and even though monitored for 14 hours per day from 06:00-20:00 from 1 February (1 January for field S62) to 3 May 2020, only ~2,000 goosehrs of use were recorded on each field. This is equivalent to a flock of 2,000 geese being present for one hour on a field during that whole monitoring period, i.e. extremely low goose use. The camera observing the eastern upper section of improved grassland at S67a recorded ~4,000 goosehrs of use during 14 hours of monitoring per day from 06:00-20:00 from 1 January to 3 May 2020, with only a flock of 4 and then 50 geese recorded for less than an hour on two days after 1 March, i.e. very low goose use overall and especially in the spring period of grass growth prior to stock turn-out.

The cameras at most locations recorded different sources of disturbance such as farming operations by tractors or diggers, dog walkers, horse riders or stock introduction to fields, and use of the fields by roe deer *Capreolus capreolus* (especially at S67a where two or three were present on most days).

Despite the impact of lockdown restrictions on movement imposed by the Scottish Government due to the COVID-19 pandemic in March 2020, an attempt was made to compare the data derived from the trail camera images with the count data collected during the SNH/JNCC surveys of the Goose Management Scheme area.

For calculating goose use from the SNH/JNCC route counts for comparison with the camera-derived goose use metric, three to eight coincidental ground counts from the November to May period were available. The field-specific number of days over which the observed counts were compared to the camera-derived metric of field use depended on the specific deployment date of the camera at each target field (**Table 14**). The ground counts of geese on target fields were transformed into 'goosehrs' by multiplying any flock counts by 1.7 hours, the average time a flock remained on a field as recorded by trail camera surveillance in the 2019/20 winter (N = 101 flock durations recorded by cameras across six field areas where 55% or more of the field area could be monitored; *cf.* 2.2 hours in 2018/19 winter for N = 715 flock durations recorded by the cameras across the 12 fields where 40% or more of the field area could be monitored). This metric was then divided by the number of SNH/JNCC counts carried out over the winter at that field during the period its camera was operational to derive 'goosehrs/day' (note that unlike the trail camera derived metric, fields were not revisited during a day on the SNH/JNCC surveys).

Table 15. Ground counts for fields with trail camera monitoring later in the season. Periods of overlap in monitoring are shown in grey; for field S67a the western upper improved part was monitored from 15 November and the eastern part from 30 December 2019. Where geese detected, peak counts recorded by the cameras during the 20 minute time lapse samples are given in italics with the approximate time periods the flocks were present.

Field code	02/10/19	09/10/19	23/10/19	30/10/19	13/11/19	26/11/19	04/12/19	28/12/19	12/01/20	27/01/20	05/02/20	20/02/20	06/03/20
S58	0	0	0	0	0	0	0	0	0	117	**0**	**0** ***(170 c.11:00-13:20)***	**0**
S59	0	0	0	0	0	0	0	0	118	65	**0**	**0**	**0**
S61	0	0	0	0	0	0	0	0	0	0	**0**	**0** ***(300 c.11:00-13:20)***	**0**
S62	0	0	0	0	0	0	0	0	**0**	**0**	**0**	**0**	**0**
S67a	0	0	60	0	0	**0**	**30**	**0**	**15**	**220** ***(30 c.09:00-15:00)***	**0**	**0**	**0**

The sample size for a comparison of goosehrs/day as recorded by the ground counts compared to the trail cameras across the five sample locations was too small and too skewed towards zero counts to allow for any meaningful comparison. This was due to the ground counts being stopped by the COVID-19 lock down. Instead, the limited number of days on which the five fields had monitoring periods that coincided are shown in **Table 15**. This table demonstrates that across the 22 "site days" on which both methods were operational (highlighted cells), there were only two instances, both on 20 February 2020, where images of geese on two fields (S58 & S61) were captured by the trail cameras but the ground counts recorded zero goose use. However, this was due to the ground counts being conducted in the Hollands and Midtown area at c.15:30 on that date (**Table 10**) by which time the trail camera images showed that the geese had left both of these fields.

Midtown field S67a is composed of two main compartments separated by a remnant fence/hedge line. It is mainly rush pasture dominated by *Juncus effusus* with some larger pools though there are two improved grassland areas covering ~15-20% of the northern raised areas of the eastern and western halves of this field. The trail cameras were set up to observe any geese using these small improved grassland areas as they cannot be observed fully from the WWT Farmhouse Tower and cannot be approached on foot from any direction without disturbing the geese on other Goose Scheme fields or the saltmarsh. The lower parts of the eastern and western halves of this field can be observed from the Tower and this accounts for the small flocks of 30 and 15 seen on 4 December 2019 and 12 January 2020 respectively that were not recorded within the field of view of the trail cameras, and also the larger total amount seen on 27 January 2020 compared to the small flock recorded by the trail camera (**Table 15**); overall there will likely have been closer to 220 (observable in Tower field of view) + 30 (in camera field of view) = 250 geese in the field that day. The final version of the Excel spreadsheet of summary counts supplied with this final report to SNH in fulfilment of this contract has the goose counts recorded on the trail camera for the eastern upper part of field S67a added to the ground count data for that time and day – with a comment added as to its source. Because of the time of day mismatch, the other trail camera counts for the two fields, S58 & S61, on 20 February 2020 will not be added to the Excel database as this would bias the ground count data in favour of those fields compared to other fields in the Scheme.

3.15 Acknowledgements

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