

**Svalbard Barnacle Goose distribution around the
Solway Firth 2022-2023: Flock counts from the
Solway Goose Management Scheme area**

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July 2023 - **DRAFT**

This publication should be cited as:

Griffin, L.R. 2023. Svalbard Barnacle Goose distribution around the Solway Firth 2022-2023: Flock counts from the Solway Goose Management Scheme area. Final Report to NS. Prepared by ECO-LG Ltd., Dumfries, Scotland. 34 pp.

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Executive Summary

A total of 17 counts of the Svalbard Barnacle Goose *Branta leucopsis* were carried out in winter 2022-2023 within the Solway Barnacle Goose Management Scheme area. Although the contract specification states 14 counts should be carried out, ten JNCC counts, and seven NS Scheme counts were completed in the period from October 2022 to April 2023. During the JNCC counts, a wider area across the Solway in Scotland and England, and including Budle Bay, Northumberland, is covered with the help of volunteers during a coordinated period.

For the NS Scheme counts, time of day, days of the week and starting points 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 NS counts, flock size assessments were made for all goose and swan species encountered, with flocks assigned to fields by code.

From December 2021, NatureScot changed the field code system to a new set of identifiers covering the original Scheme area surveyed since 1995 and new field areas extending east to Gretna – giving 2,672 field codes in total.

Instances of direct disturbance clearly aimed at the geese and conversations with land managers about geese were also noted. Again, for the JNCC counts, except where they were conducted by Larry Griffin of ECO-LG Ltd (ECO-LG), 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 ***breeding success of Svalbard Barnacle Geese*** sampled on the Solway Firth from October 2022 to December 2022 ranged from 3.6% to 53.8% with a ***mean of 18.4% young*** derived from 25 flocks and 11,261 geese sampled. Across a similar area, the total number of broods sampled was 271, with a ***mean family size of 2.4 young***, ranging from 1-5 young. Reproductive success was above the current ten year mean of $8.7\% \pm 1.6$ S.E., with a mean of 3.9% young the previous winter (and 1.6 goslings per family), and was the highest since 1995 (20.9%).

The ***peak count for the Svalbard Barnacle Goose flyway population including those wintering on the Solway Firth and at Budle Bay, Northumberland was 33,993*** on 22 February 2023 (including 33,992 on the Solway). This represents an increase of ~6,310 birds on the 27,683 recorded across the same flyway sites on 19 January 2022, but is still ~11,000 below the maximum flyway population count recorded for this flyway of 44,796 on 25 October 2017.

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, ~95% 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, and to an increasing extent, up to ~8% now stopover in the Budle Bay area, Northumberland, during the period from October-March). This century, with the growth of the Solway population to 43,000 birds, the distribution had spread west towards the Outer Solway with geese now visiting areas around Palnackie, Auchencairn and Rascarrel each winter, and significant flocks at Wigtown from mid-winter.

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, gatherings of up to 30,000 barnacle geese are common in late April/early May immediately prior to spring departure north. Parts of this flock can utilise nearby fields and saltmarsh in the Gretna/Redkirk/Baurch area on the Scottish side of the Solway well into May.

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. NatureScot has run this management 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' or 'Buffer' (which receive a tiered payment), or 'Scaring' (non-payment) zones depending in large part on the typical level of winter goose use. Controlled audio-visual scaring is encouraged in the non-payment zone during the winter to try to keep the geese within the feeding or buffer zones of the Scheme. Scaring is also permitted throughout April within the Scheme area, as due to budgetary constraints imposed since 2012, fields within the Scheme area no longer receive goose management payments for April.

1.1 Summary of contractual objectives

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. The survey objectives and project outputs were stipulated as follows (adapted for 2022-2023 based on conversations with Kate Campbell about draft report timing etc):

“...Counter is required to attend the local goose management group to discuss their results for the winter to date (February 2023).

A draft report will be provided by 31 March 2023. This will include tables showing all count information on a field-by-field basis for each count day (including zeros) from the season (including start and finish times, and times at key locations) with field codes being as provided by NatureScot, brief details of all farmer contacts (date, time, location, farmer name, issues raised by farmer) and details of any scaring/disturbance observed.

The final report detailing all work will be submitted by 31 July 2023.

Counter is required to attend summer meeting of local goose management group to discuss the results for the season (~June 2023).

The final report will include:

- ***Survey methodology;***
- ***Maps showing the field count codes and field boundaries (as provided by NatureScot);***
- ***Tables showing the number of barnacle geese in each field during each count (including zeros), records of any leucistic birds and the start and finish times and the times at key locations (in both paper copy and excel worksheet forms);***
- ***Tables showing details of the number of other large wildfowl present in each field during each count (although it is acknowledged that JNCC counts may not have that level of detail);***
- ***Details of any goose scaring techniques/disturbance recorded during the counts;***
- ***Tide tables for the period of the counts;***
- ***Details of trail camera observations with comparisons to the visual counts for the relevant fields...***

2 Methods

2.1 Management Scheme counts

Seven “NS Route Counts” within the Goose Scheme area were carried out in addition to ten “JNCC Census Counts” on an approximately 14-day cycle between 5 October 2022 and 26 April 2023 (**Table 1**). For the NS 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.

On 26 October 2022, two count sections were affected by counter health issues, and on 25 January 2023 one of those sections was again affected by the counter health issue.

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

Count source	October	November	December	January	February	March	April	Total
JNCC counts	3	1	1	1	1	1	2	10
NS counts	1	1	1	1	1	1	1	7

During NS 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 NS identifiers 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/fog such as those geese flying 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 were also added.

In a change to previous winters, goose use of the areas to the west of Mersehead/Southwick in the Auchencairn/Rascarrel and Wigtown areas meant that the NS route count methodology was extended to cover those areas albeit fields in those western sections had not been coded by NS. Any flocks of geese or swans recorded were assigned an OS grid reference or WGS84 Lat/Long and are noted at the end of each species’ count table below and in the Excel summary provided. Due to a lack of daylight hours and/or due to poor weather, these extra count sections were often covered at different dates/times than the traditional Scheme survey area; the summary of dates and times given in this report refer to this main survey area, though on the Excel provided, “Comments” have been added to give further details about the dates and times of surveys carried out in those extra areas.

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 NS route count thus covered areas to the east as far as Gretna and the west as far as Wigtown, with the JNCC counts covering the same area on the Scottish side of the Solway (**Figures 1 & 2**).

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 NS route counts and JNCC census counts covered by ECO-LG, the presence and nature of any disturbance to the geese, intentional or otherwise, was noted using the NS field code system provided. Impromptu discussions with any land managers 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.



Figure 1. The Inner Solway Firth showing the main areas surveyed during the NS Solway Goose Management Scheme counts. Site names are referred to in the text and also cover those areas surveyed during the coordinated JNCC census counts. Wigtown Bay/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

This winter, in fulfilment of the JNCC GSMP work plan, BTO contracted ECO-LG to conduct and coordinate the total population counts of the Svalbard Barnacle Geese present on the Solway from arrival to departure. This involves a network of staff (mostly RSPB) 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 October arrival period and during departure in April/May, with monthly counts from November to March depending on the weather.

2.3 Brood sizes and juvenile productivity of the Svalbard Barnacle Goose

This winter, in fulfilment of the JNCC GSMP work plan, BTO contracted ECO-LG to carefully assess 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. Some observations were also carried out by experienced volunteer observers.

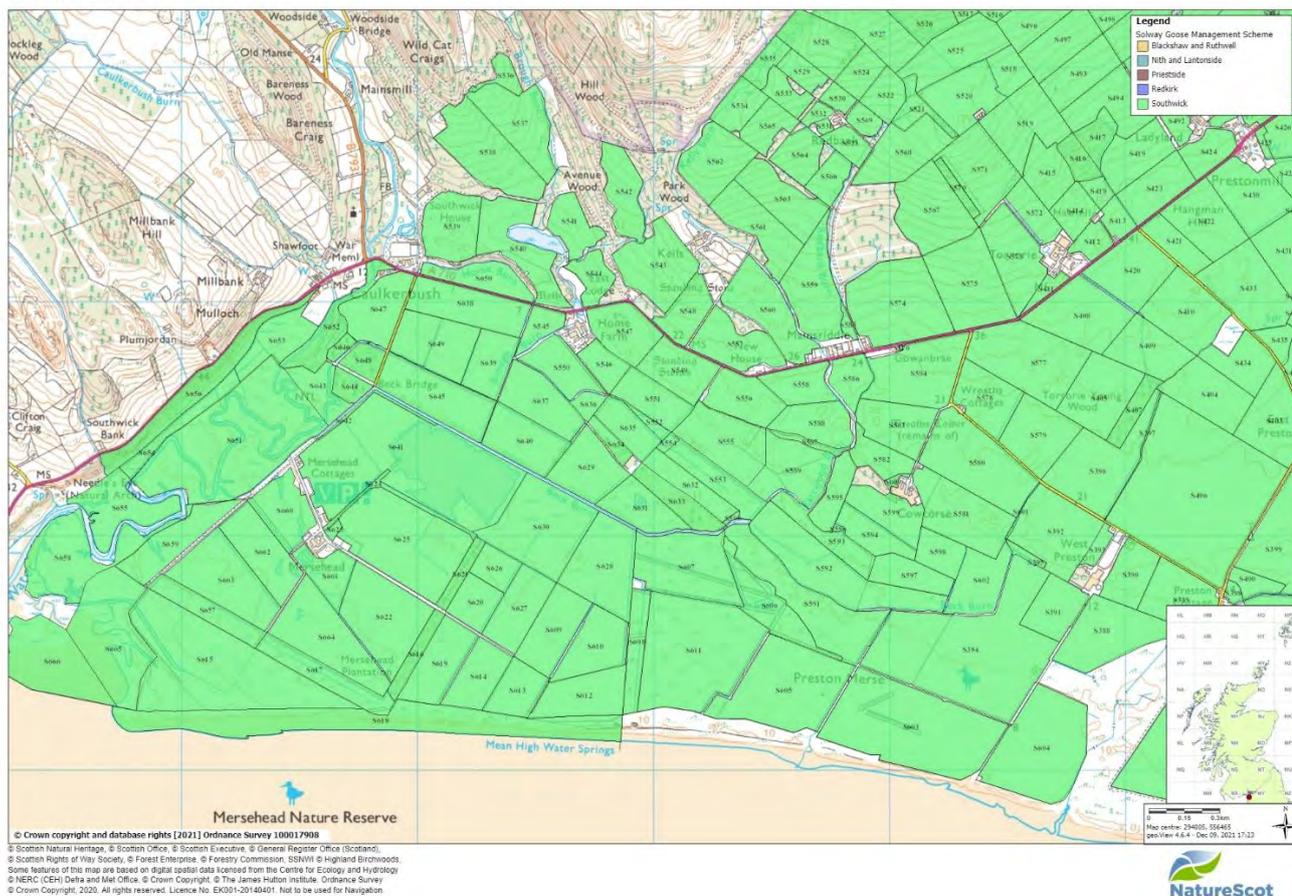
2.4 High tide heights, times and dates

Table 3. High tide dates/times (GMT; $\geq 9.5\text{m}$ as summarised from Laver's *'Liverpool and Irish Sea Tide Table 2022' & '2023'*) for the period during which geese were present in the Barnacle Goose Management Scheme area.

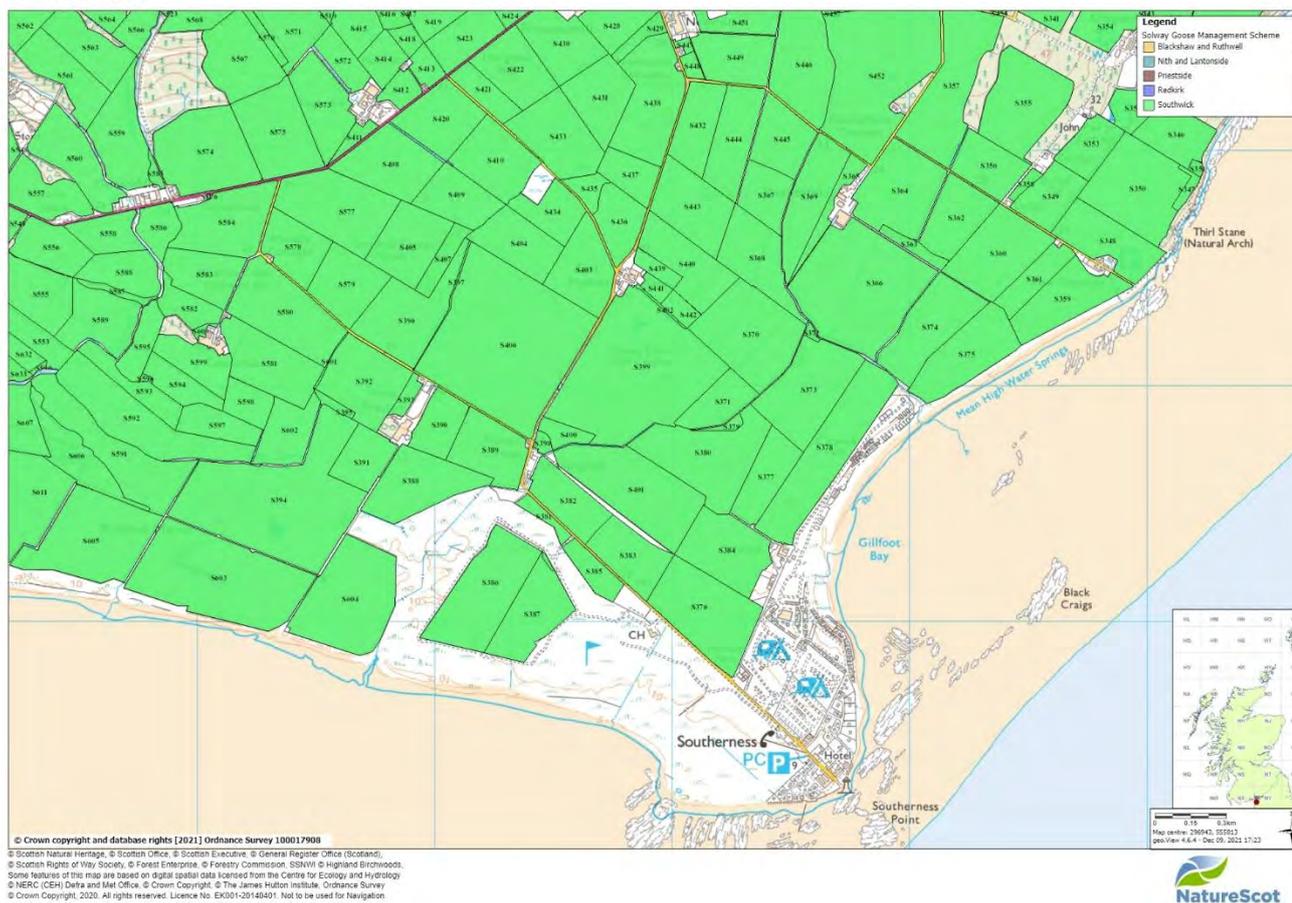
Month	Period 1: From date/time	Period 1: To date/time	Period 1: tidal height range (m)	Period 2: From date/time	Period 2: To date/time	Period 2: tidal height range (m)
October	22:49 09/10/22	00:02 12/10/22	9.5 – 9.8	22:59 25/10/22	12:34 28/10/22	9.5 – 9.6
November	10:54 24/11/22	12:21 26/11/22	9.5 – 9.6	-	-	-
December	11:24 24/12/22	13:55 27/12/22	9.5 – 9.7	-	-	-
January	11:18 22/01/23	14:25 26/01/23	9.5 – 10.0	-	-	-
February	11:08 20/02/23	13:57 24/02/23	9.5 – 10.2	-	-	-
March	10:49 21/03/23	13:27 25/03/23	9.5 – 10.1	-	-	-
April	10:25 19/04/23	12:23 22/04/23	9.5 – 9.8	-	-	-

Figure 2. Field code boundary maps – from west to east - newly created by NatureScot in December 2021 covering a total of 2,672 fields in total and as used in the species’ tables in this report and accompanying Excel file.

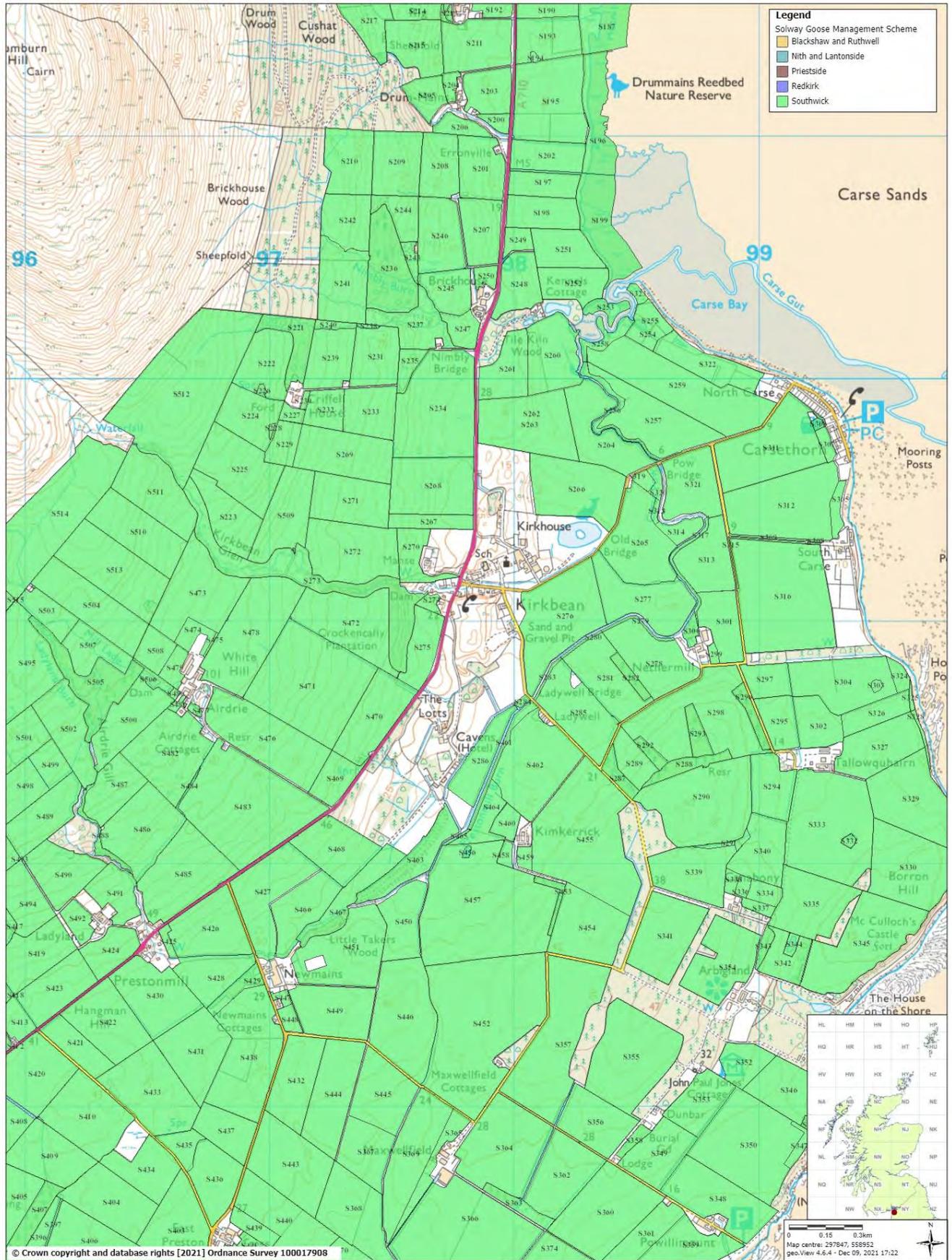
Southwick - Part 5



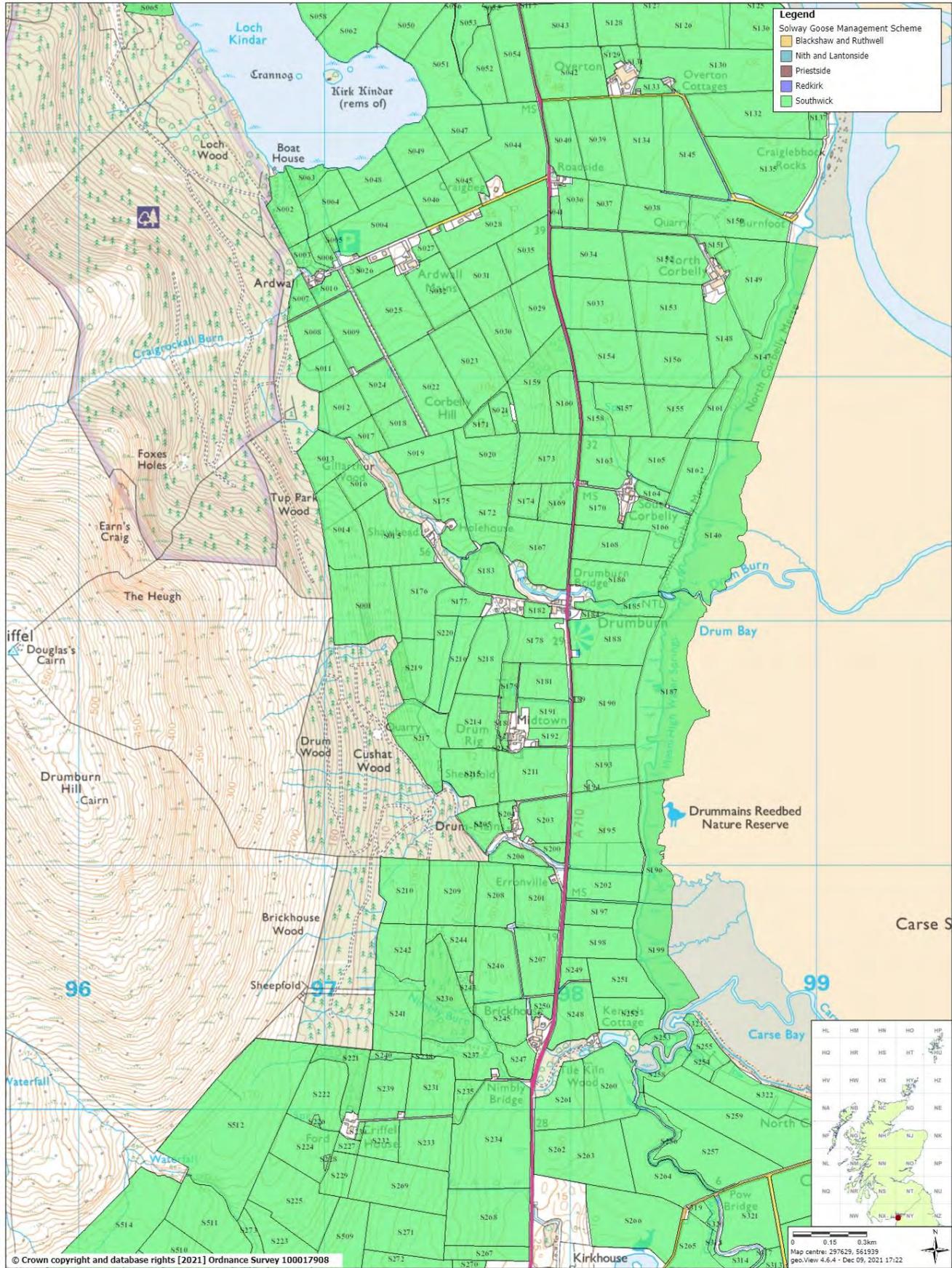
Southwick - Part 3



Southwick - Part 3



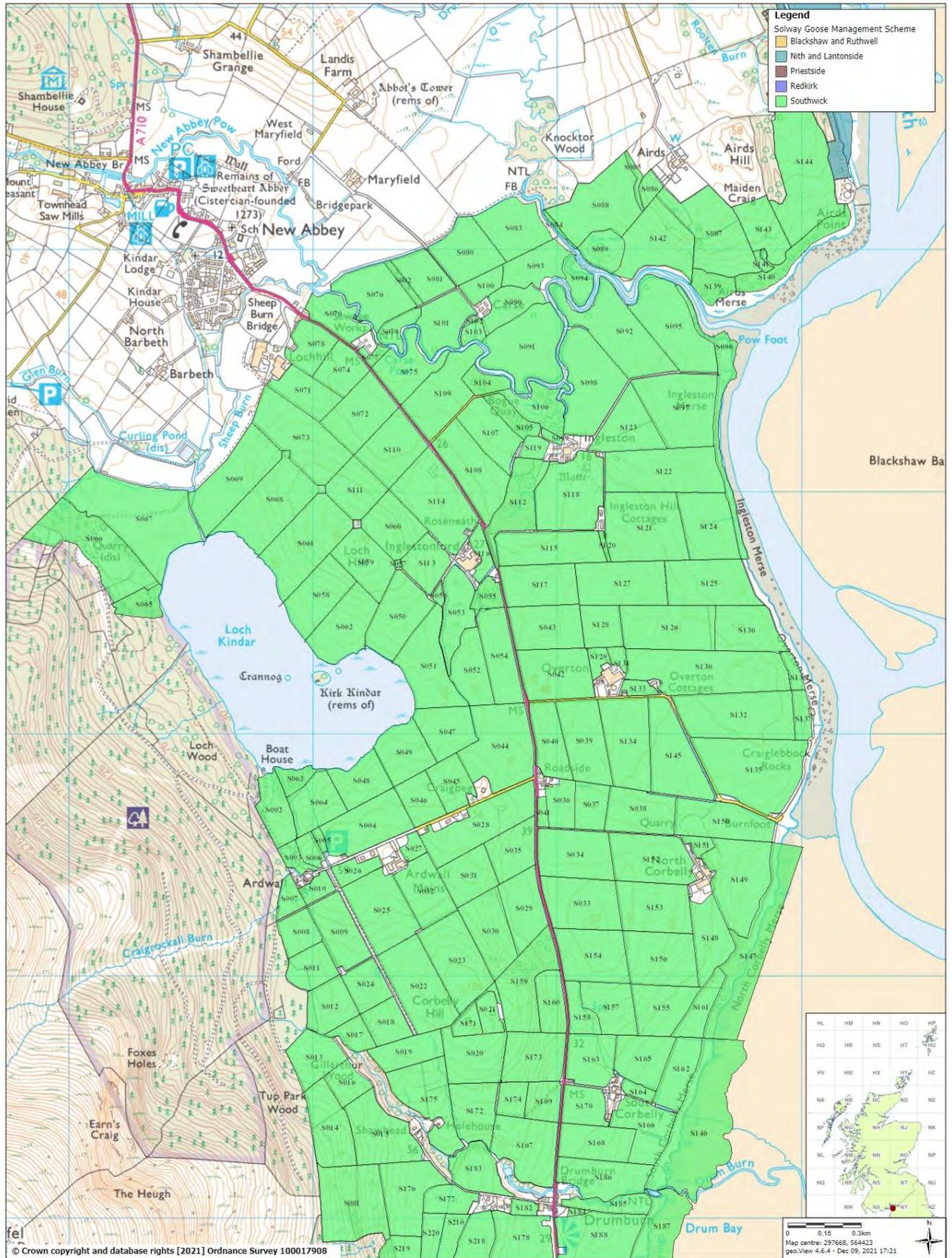
Southwick - Part 2



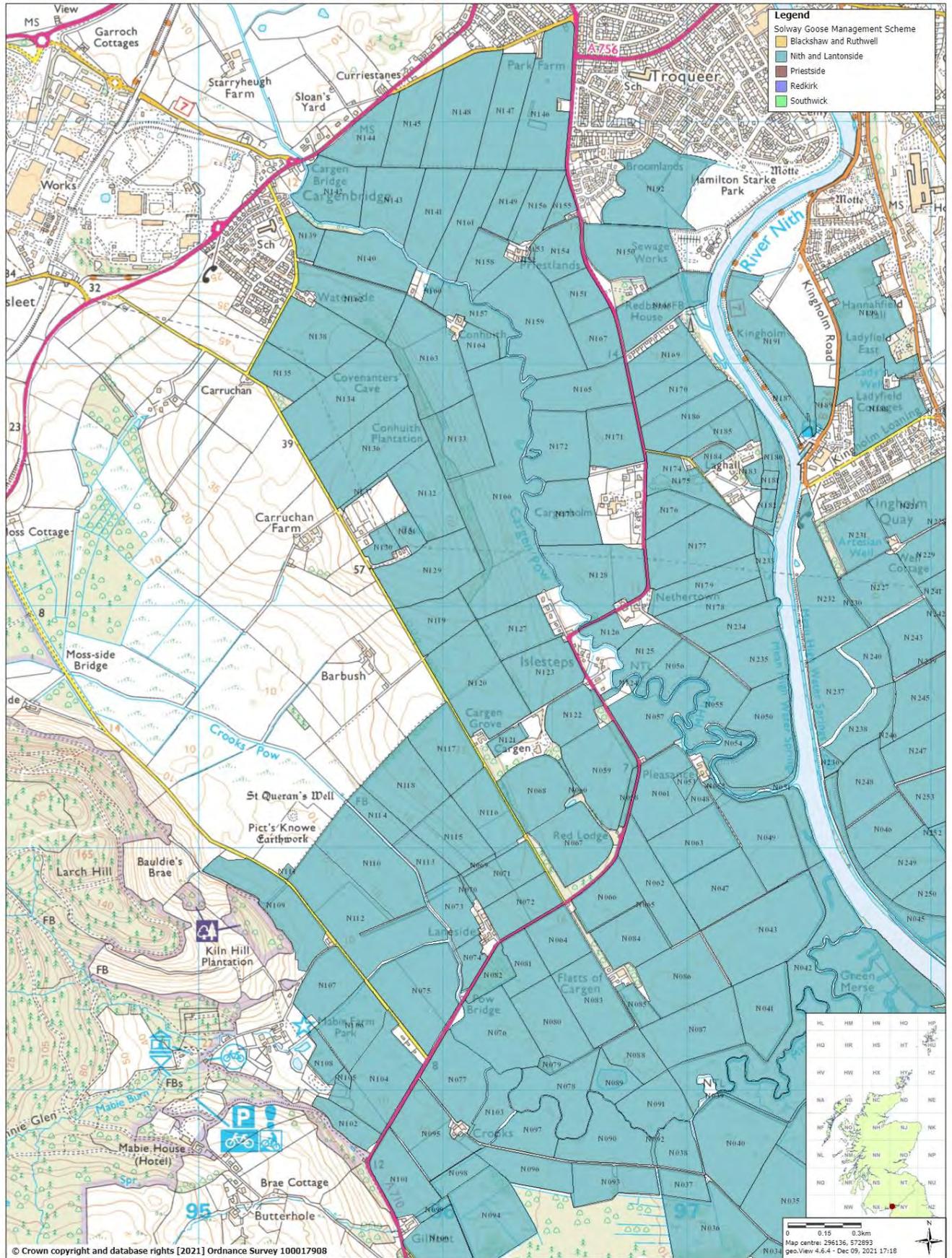
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Southwick - Part 1



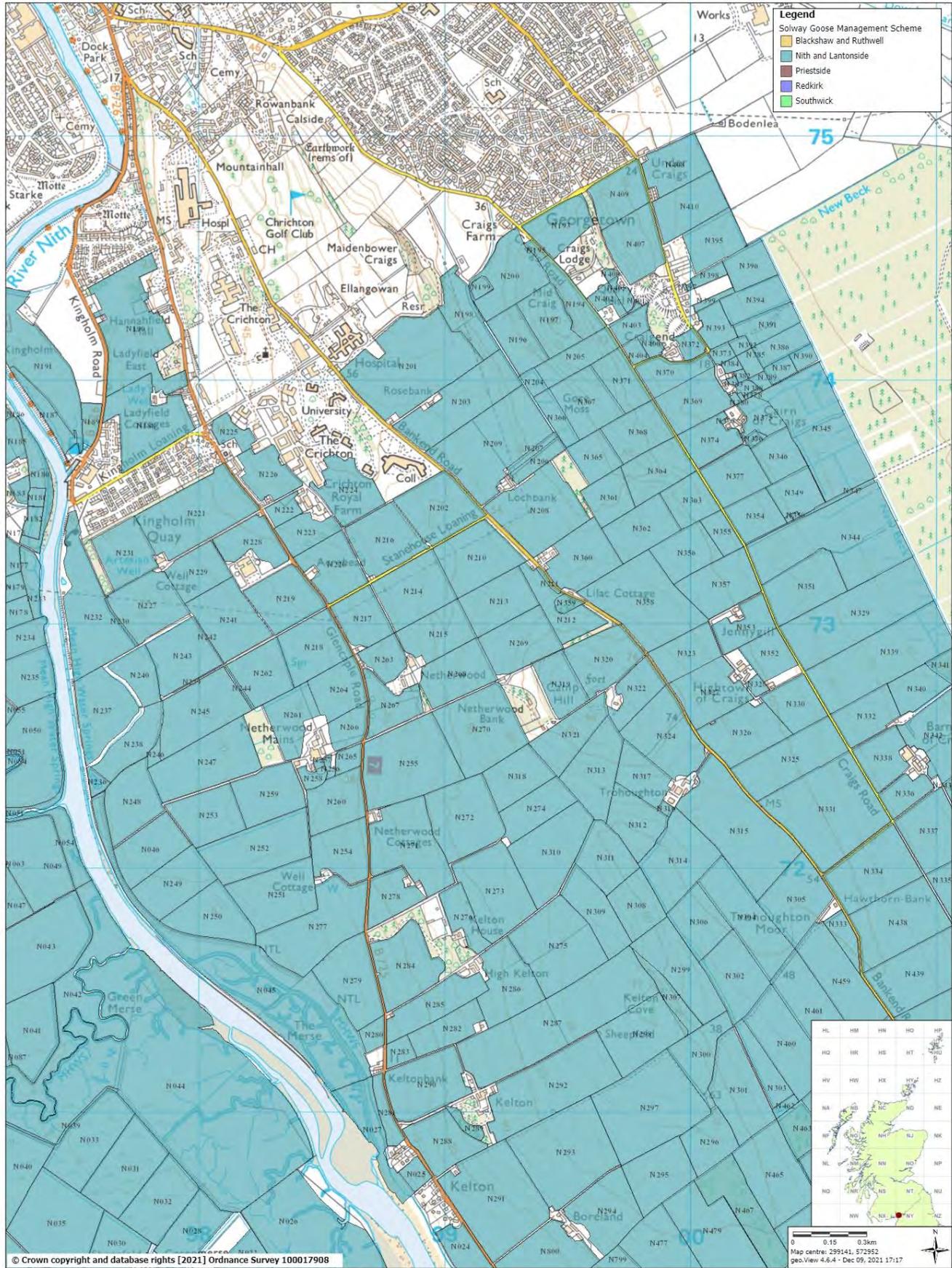
Nith and Lantonside - Part 4



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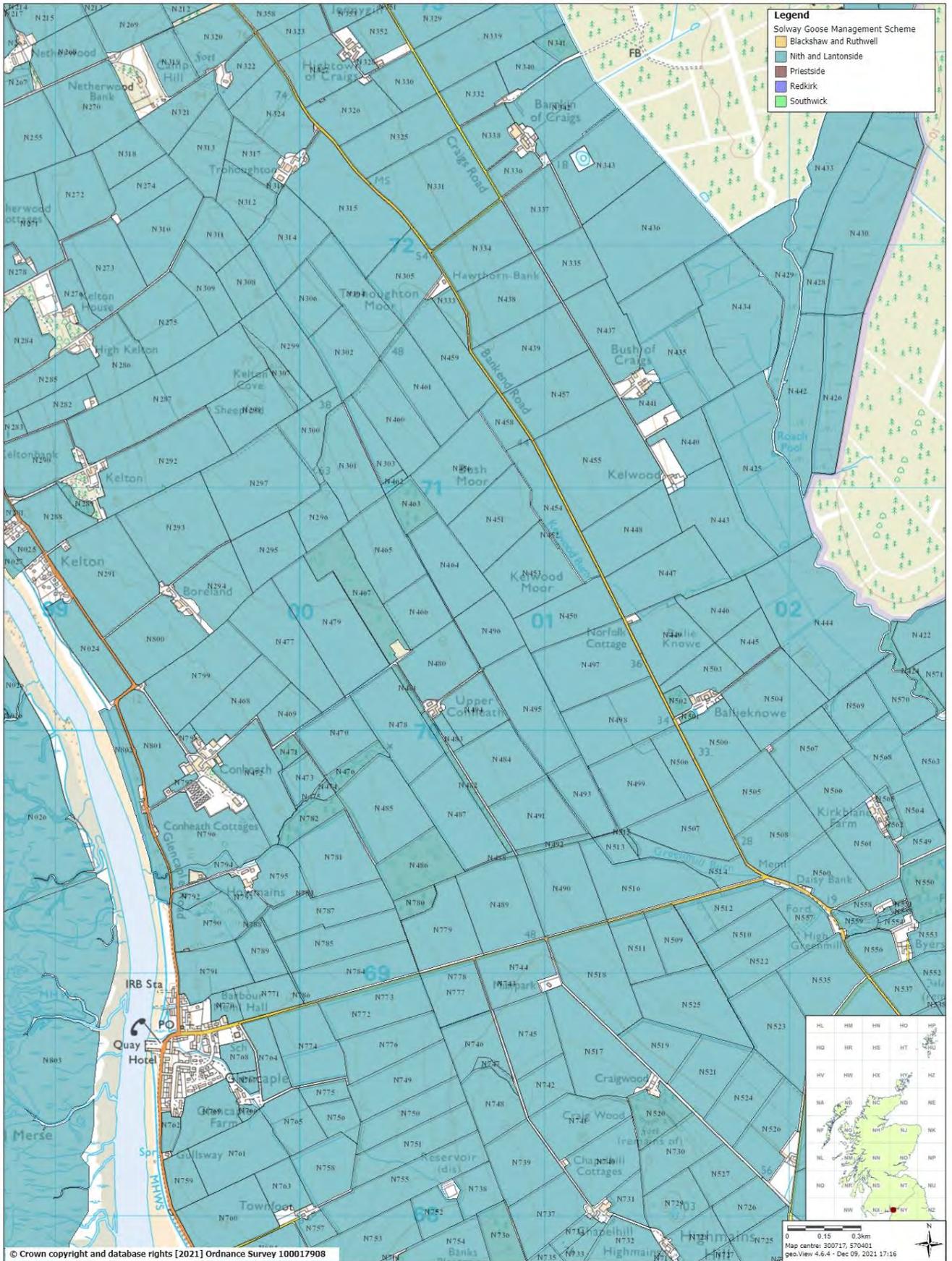
Nith and Lantonside - Part 3



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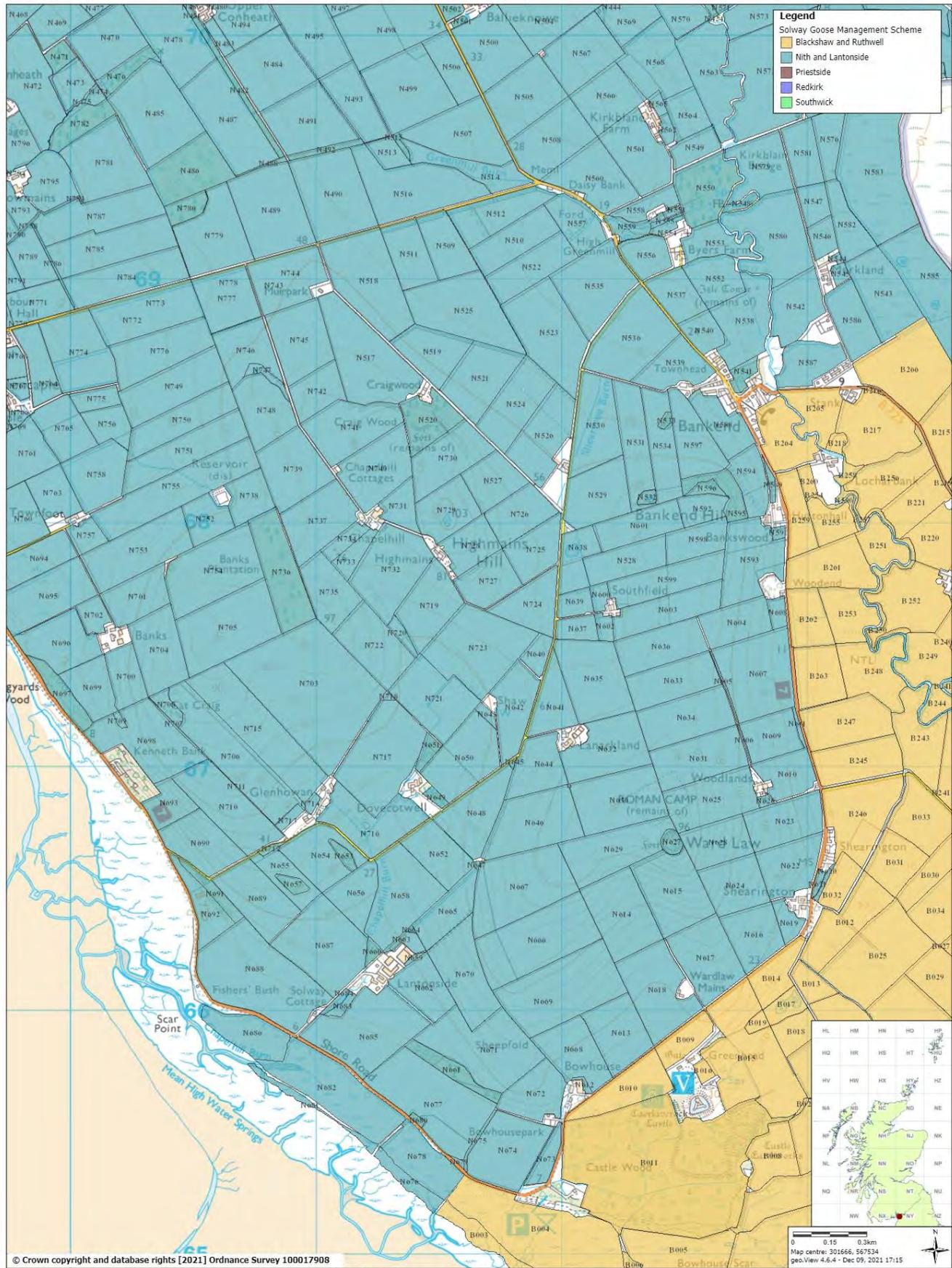
Nith and Lantonside - Part 2



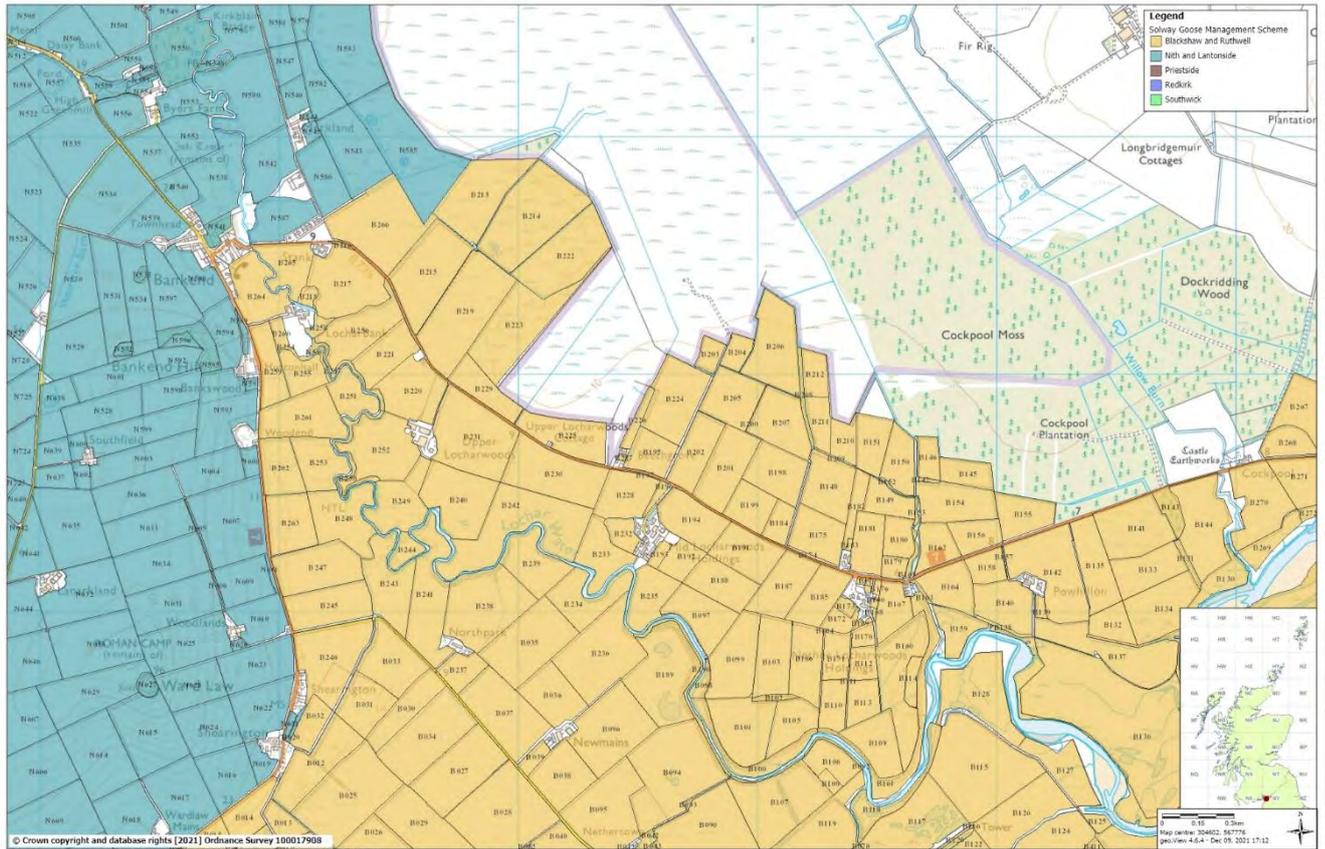
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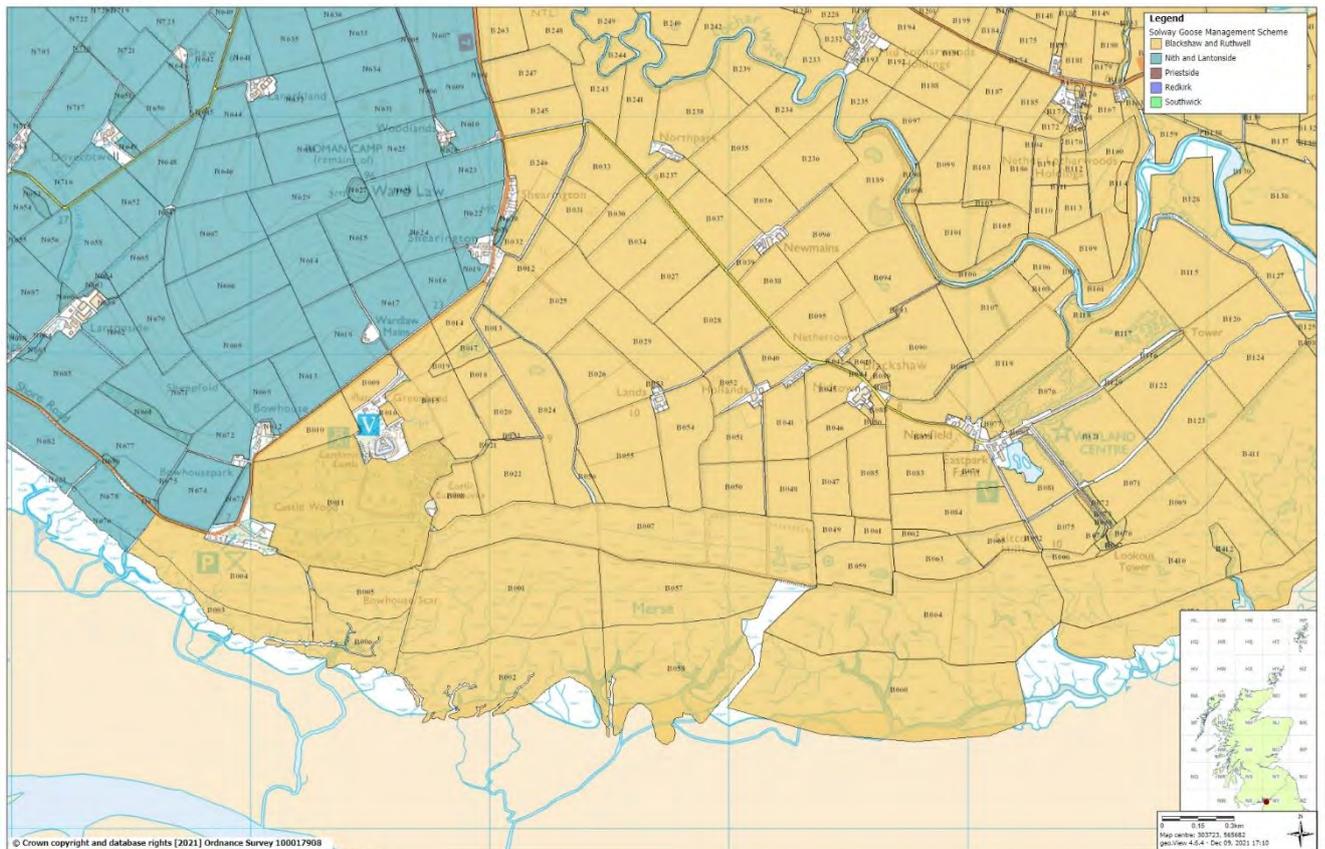
Nith and Lantonside - Part 1



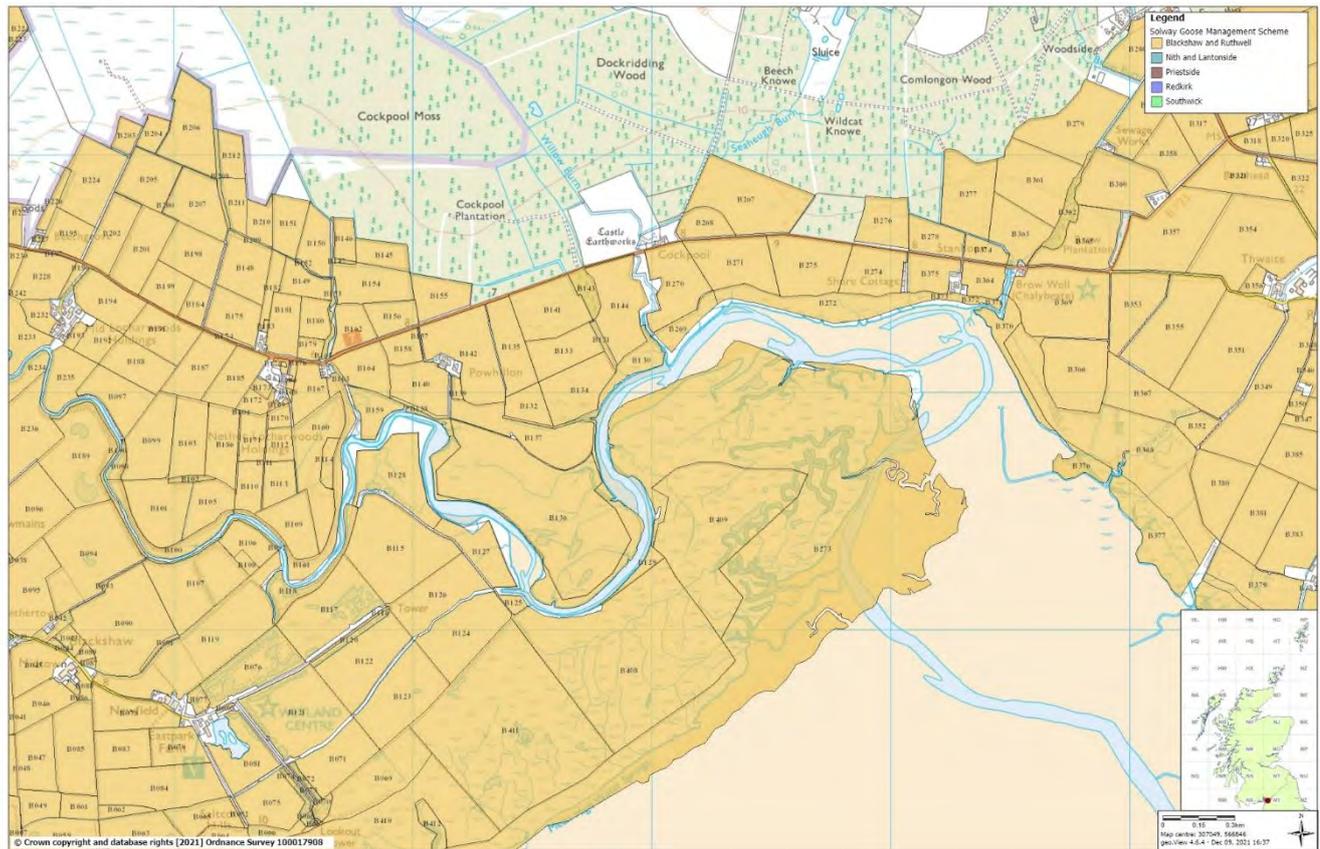
Blackshaw and Ruthwell Part 4



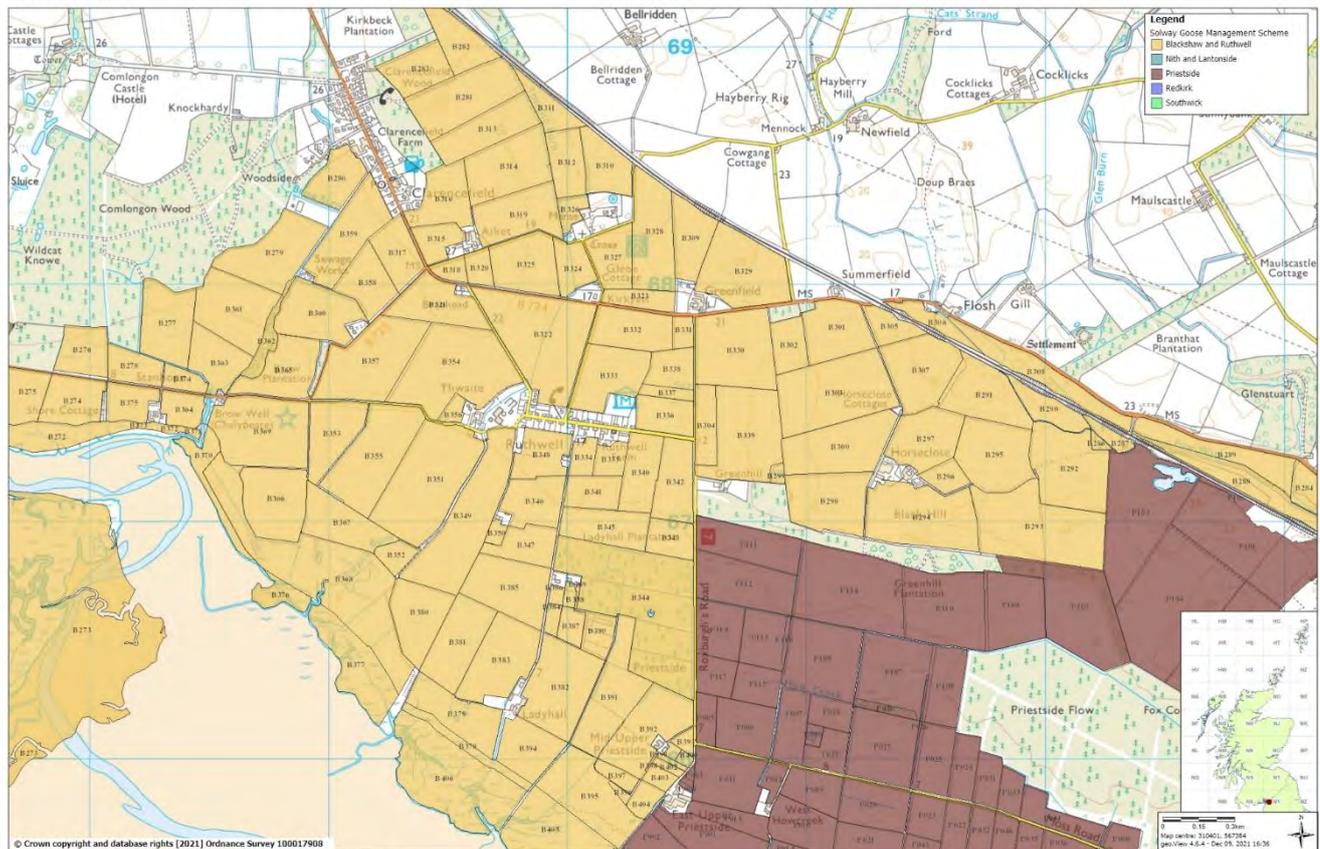
Blackshaw and Ruthwell Part 3



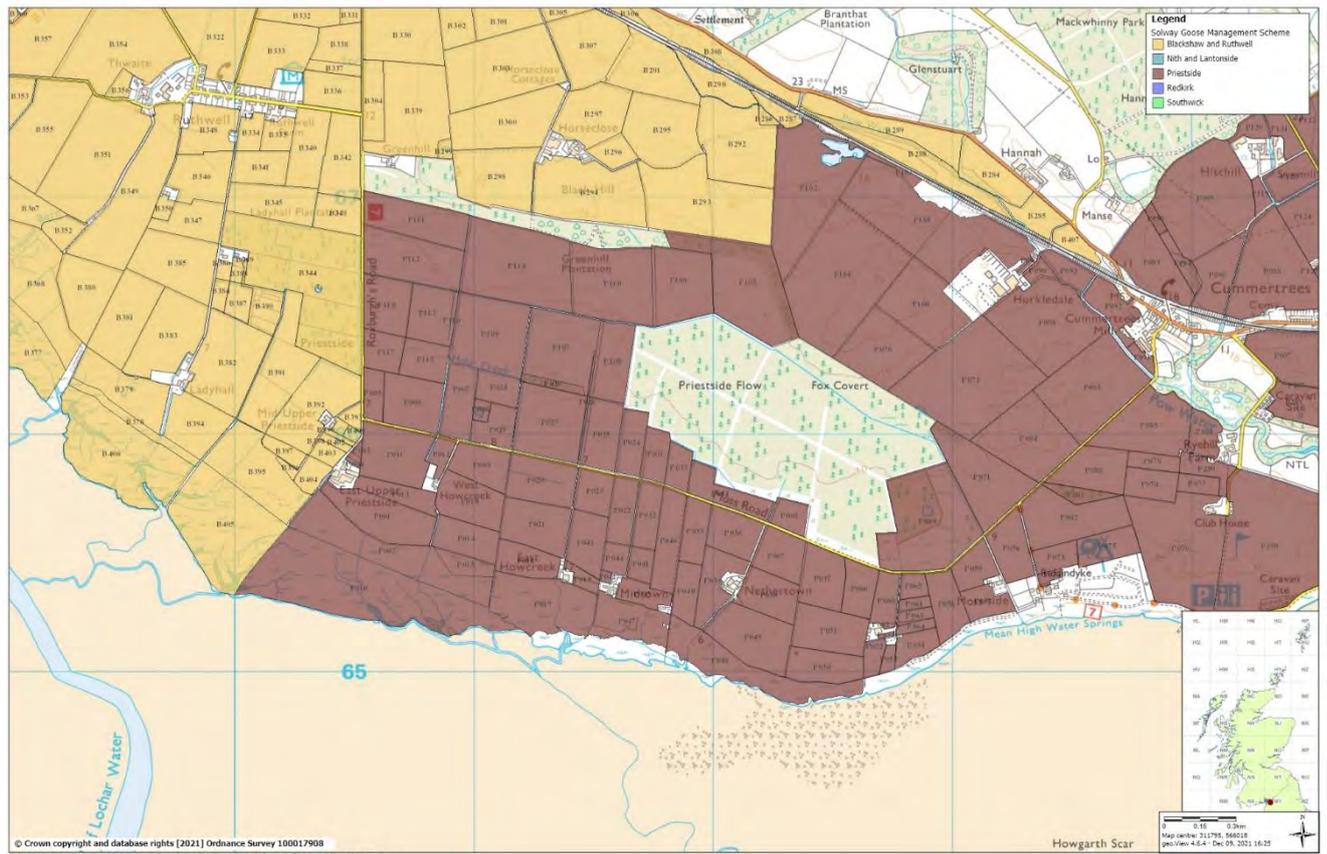
Blackshaw and Ruthwell Part 2



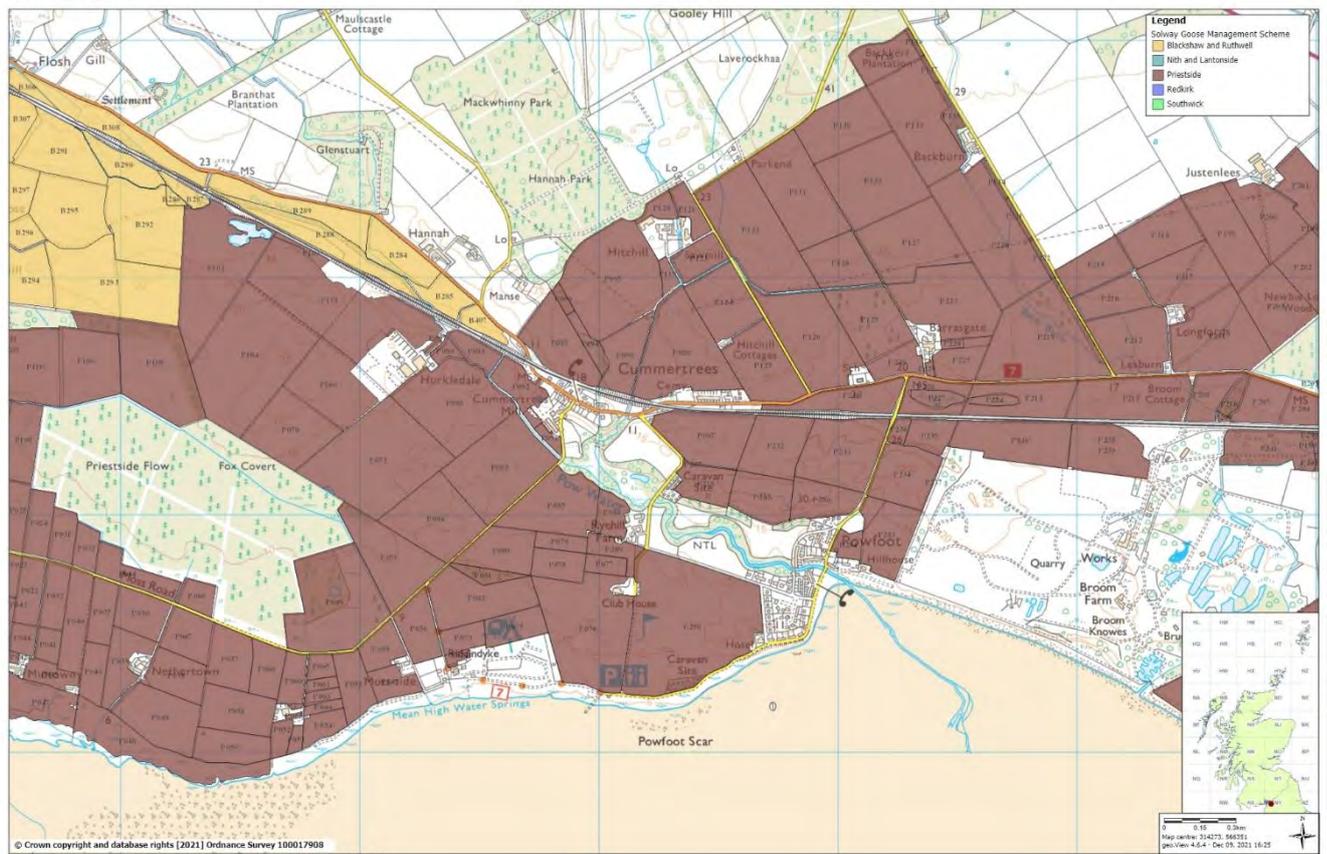
Blackshaw and Ruthwell Part 1



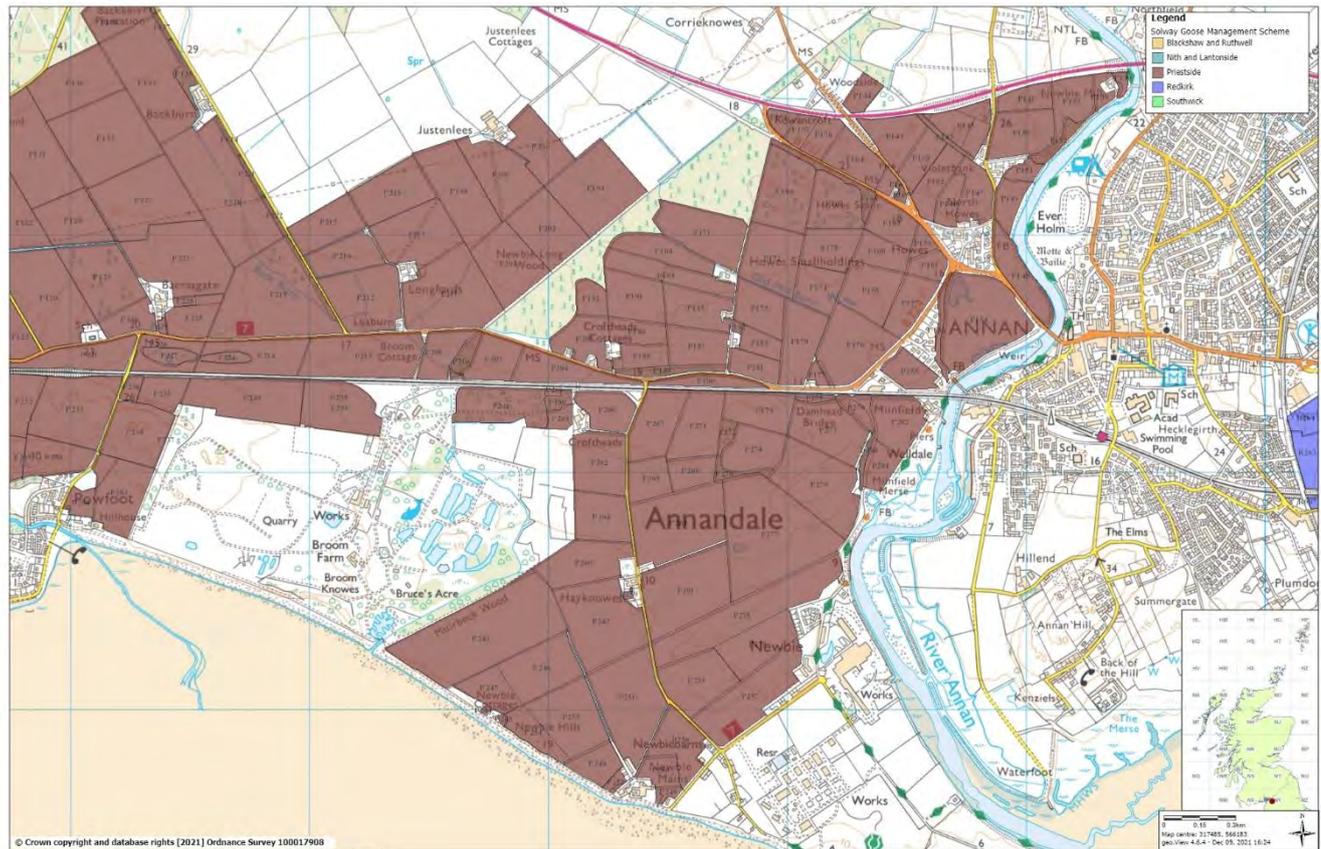
Priestside Part 3



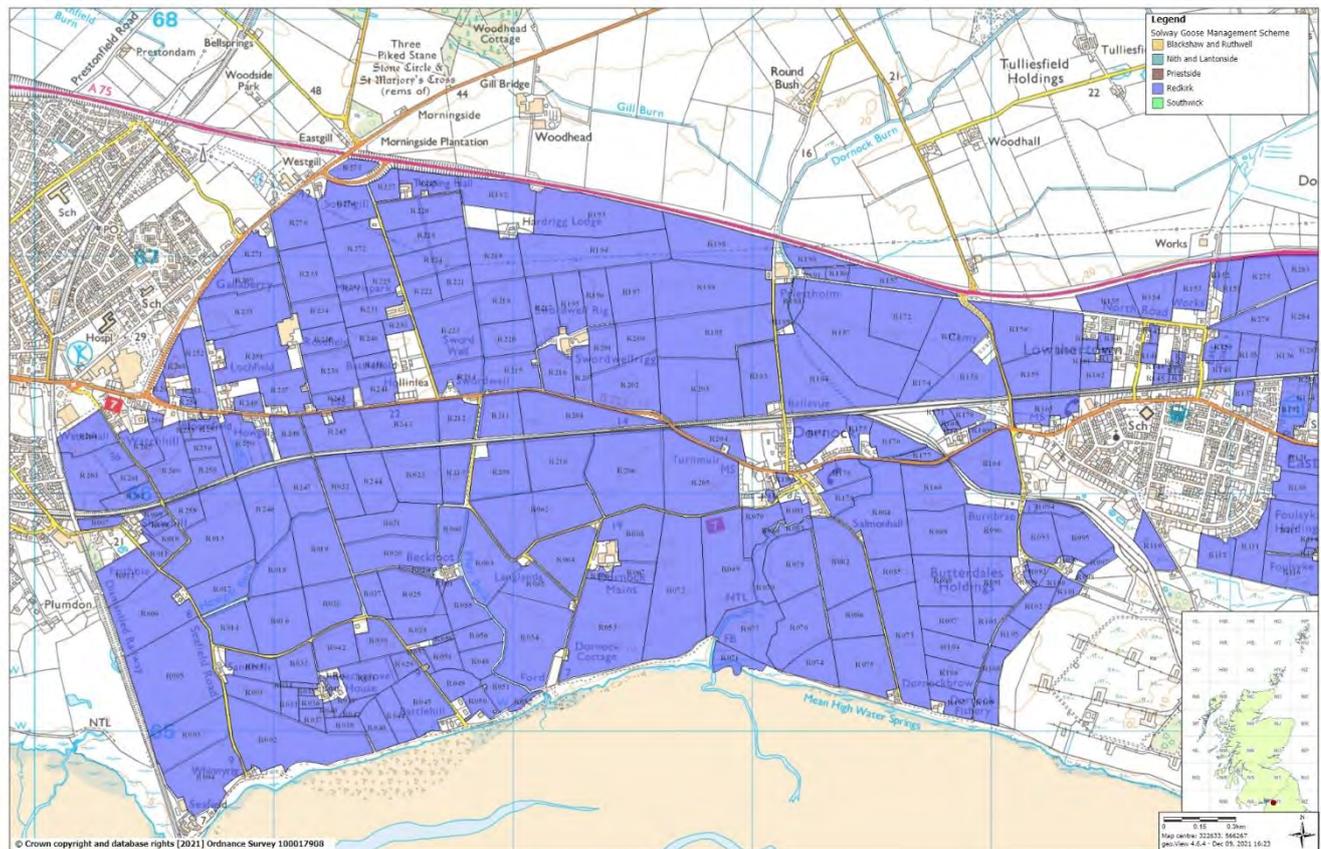
Priestside Part 2



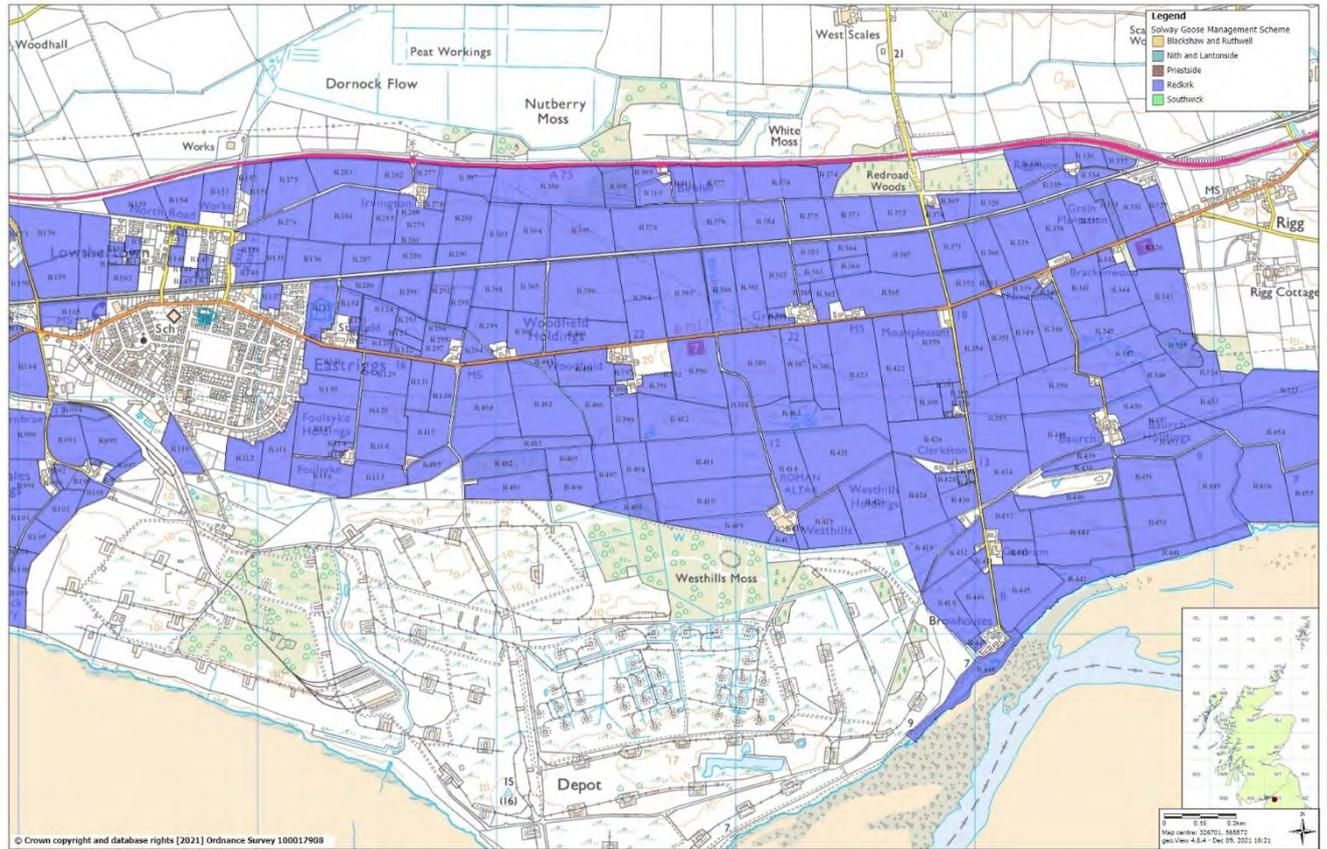
Priestside Part 1



Redkirk Part 3



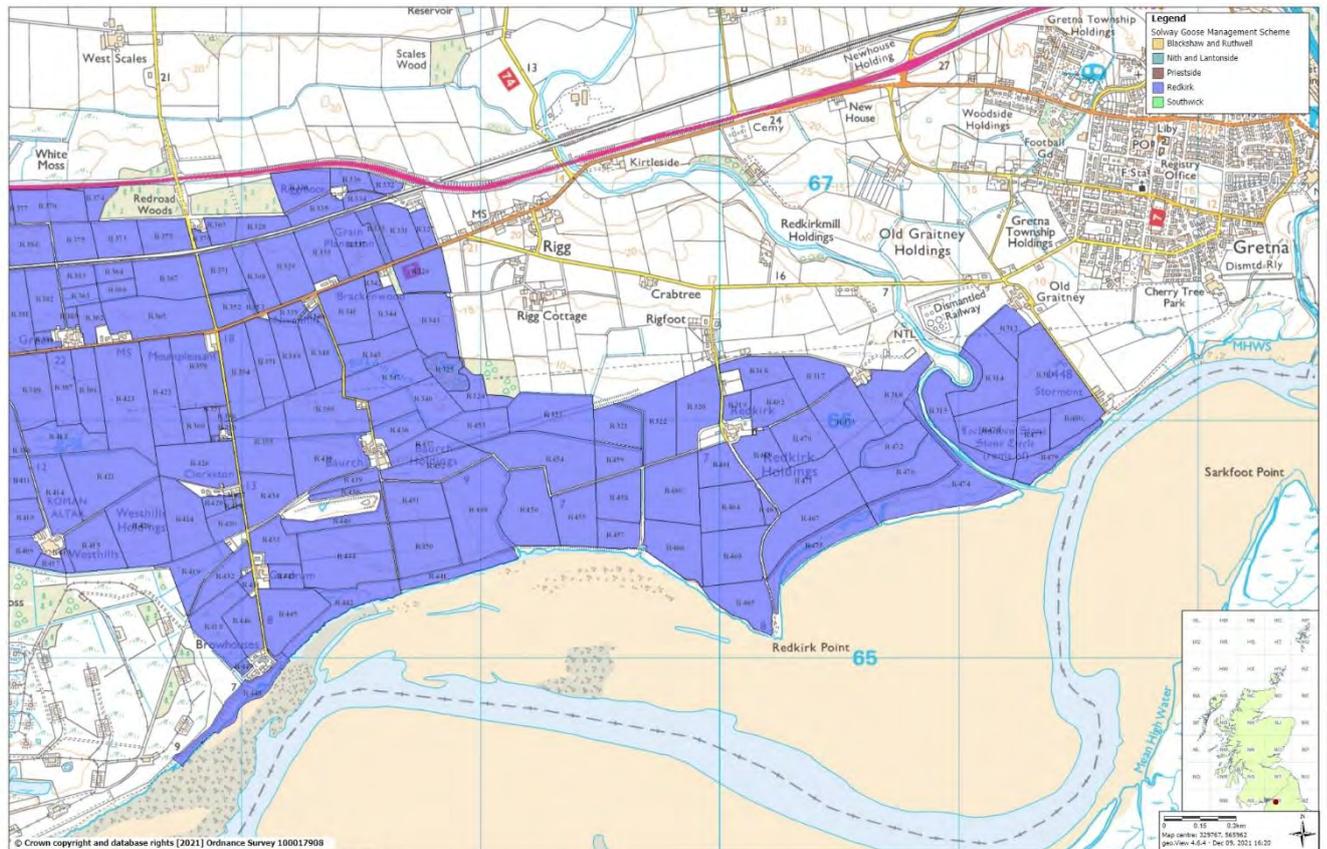
Redkirk Part 2



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3 Results

3.1 Barnacle Goose counts for the Management Scheme area (and beyond)

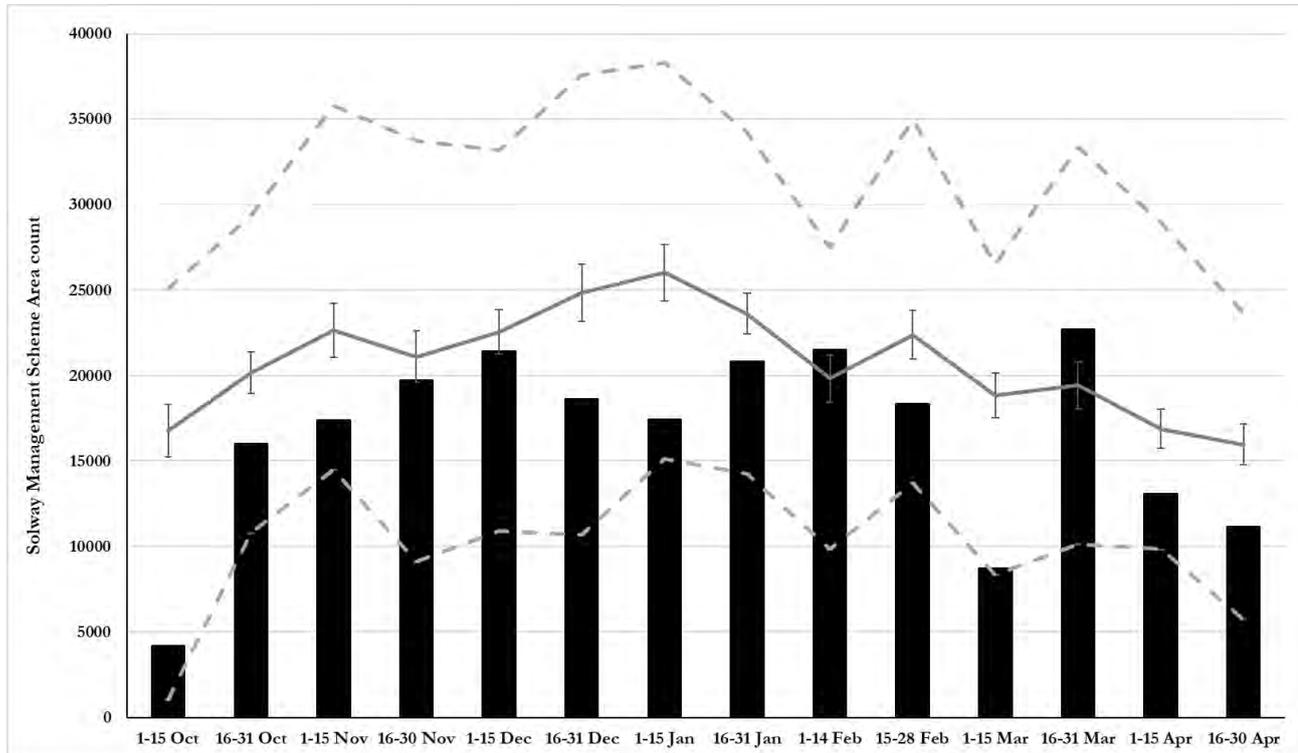


Figure 3. Svalbard Barnacle Goose 2022/23 half-month flock count totals (black bars) within the NS Solway Goose Management Scheme area from Southwick to Gretna compared to the mean \pm SE (dark grey line), minimum and maximum (dashed grey lines) counts for the period from 2008/09 to 2021/22 within the 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 NS route count. The methodology of the 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.*2-hour period aims to remove this bias. Fluctuations in goose numbers within the Scheme area also occur because of high tides (**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 forage outside the Scheme area (**Figure 3**).

Presumably due to a legacy effect of the HPAI die-off in winter 2021/22, the number of geese recorded within the Scheme area was significantly below average in 12 out of the 14 half-month periods monitored between October 2022 and April 2023 compared to the long-term average since 2008/09 (**Figure 3**). Goose numbers within the Scheme area were only higher than average in the first half of February and the second half of March 2023. The mean number of geese recorded during the route counts was the lowest on record since 2008/09 at 15,716 across all the fortnightly periods from October 2022 to April 2023 (*cf.* mean of 16,207 for October 2021 to April 2022) ranging from a minimum of 2,460 on 5 October 2022 (*cf.* 5,747 in 2021-2022) up to a maximum of 22,709 on 22 March 2023 (*cf.* 24,188 in 2021-2022). It is of note that the average number of geese was lower in 2022/23 within the Scheme area than during the HPAI winter, and although that was expected considering the deaths occurred throughout winter 2021/22 and thus lowering the average over that period, the new 2022/23 low suggests there may have been further deaths during the migratory, breeding and moulting periods of 2022, as the breeding productivity was recorded as one of the best on record (see below). As with October 2021, it is also of note that the geese seemed to arrive late on the Solway with less than 6,000 present by 11 October 2022.

Similarly, as with April 2022, the relatively low count for the Scheme area of ~11,000 before the last ten days of April possibly represented early departure of birds from the pastures after a mild winter, and was probably also due to the significant reduction in overall population size with saltmarsh areas possibly able to support a greater percentage of the population than usual with 65% of the population (*ca.* 19,700) on Rockcliffe/Cumbrian marshes, by 26 April. By 3 May ~30 birds were recorded in the Scheme area with zero present by 10 May, at a time when 5,100 remained on Rockcliffe, with the 2,900 recorded on 16 May dwindling to ~20 by 31 May 2023.

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. **NB:** with the agreement of Kate Campbell (NS), field B119 at Newfield Farm, has been split into three parts corresponding to old SNH field codes: [C20] = B119a; [C19a] = B119b; and [C19b+C19c] = B119c as this field in a key area of high goose usage is still split into three distinct parts.

Over the course of the 17 counts completed across the wider Scheme area 258,293 barnacle geese were recorded on 184 different field/merse compartments with a further 17,523 recorded on 20 compartments reported at the end of **Table 4** for the newly surveyed areas west of Southwick (though these areas have always been part of the JNCC census counts). These extra birds are *not* included in the comparisons shown in **Figure 3**.

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

NS-id	05/10/22	11/10/22	19/10/22	26/10/22	09/11/22	25/11/22	10/12/22	21/12/22	02/01/23	25/01/23	05/02/23	22/02/23	06/03/23	22/03/23	06/04/23	19/04/23	26/04/23	T_2223	N_2223
B001										3500								3500	1
B002															1700			1700	1
B004		10																10	1
B024						1720		38				310						2068	3
B025												35						35	1
B026		115	7		5			108										235	4
B027			130															130	1
B028				25	58	55												138	3
B030				190									380					570	2
B033					1850													1850	1
B034													65					65	1
B041				65	136					850								1051	3
B044							45			25								70	2
B045										38	260	26						324	3
B046				22	8	75		260						2				367	5
B048					55			90						5				150	3
B051										270								270	1
B057		110																110	1
B058												2400	180					2580	2
B059					12	28		80		14		3	280					417	6
B060	820				170				190	900		850			520	1000		4450	7
B064					20					840	380							1240	3
B065					45	95			1010					80				1230	4
B071														95				95	1
B075								1520		250				270				2040	3
B078				90	150	90							240	75				645	5
B079			2	14	55			25		30		82	85					293	7
B081						13		85		50		360	40	55		2		605	7
B083			1120	1840	95	55		170				11	65					3356	7
B084			1680	160	780	1240		70		9		390	1110			10		5449	9
B085								680										680	1
B090				4	10	35		23			82		64					218	6
B094											2160							2160	1
B095						3			2350									2353	2
B096						22		2					110					134	3
B106			9															9	1
B107											2160			930				3090	2
B109														38				38	1
B115			160			360		1400						2100				4020	4
B119a						205				160		112						477	3
B119b		1120	440	220	110									15				1905	5
B119c				380	105	2									12			499	4
B119d													310					310	1
B121		540	38	15	180					1070		62	830			285		3020	8
B122				850		170		80	2	110			2200					3412	6
B123		195												460		55		710	3
B124				190				120			1660		210					2180	4
B126								50						650				700	2
B136									320		140							460	2
B185						340												340	1
B187						1290												1290	1

P080								2	85									87	2
P085					64	90	14			190								358	4
P098			60										3					63	2
P100												35						35	1
P110										75								75	1
P242							1180	3										1183	2
P260							60											60	1
P264							40											40	1
R321							120											120	1
R322							60											60	1
R465							450											450	1
R474										60								60	1
S146																90		90	1
S187															140			140	1
S263													35					35	1
S264										45								45	1
S368							2700											2700	1
S378					1650													1650	1
S380								2980										2980	1
S386										1502	1280							2782	2
S389			4	560														564	2
S391			32	340	260					1100			1240	630	360			3962	7
S392				2820				120		105					3510			6555	4
S394	1450	190	170	680	280				580		1820	3020	2360	2735	1990	376	235	15886	13
S396				2320				2300										4620	2
S403				7														7	1
S406		104	100															204	2
S443							490											490	1
S546									55		85							140	2
S549										36								36	1
S550						110					140							250	2
S551										800								800	1
S580			3350		610	590												4550	3
S581				530		800						780						2110	3
S582						45												45	1
S592														200				200	1
S593														230		470		700	2
S594					2530	3000	2500	1950							105			10085	5
S595			580		240											50	1010	1880	4
S597														370				370	1
S598			210	530	7			660			2360					360		4127	6
S599				1620		960		1780								200		4560	4
S602						80		90										170	2
S603		200	65	130							1420			1500				3315	5
S604			1600								3650							5250	2
S605														30				30	1
S609	1			130				300				113				111		655	5
S610														350		697		1047	2
S613			300		1					900								1201	3
S614								850										850	1
S615						135				32				920	260	70		1417	5
S620			430												25	75		530	3
S622	1400	1200		160	255	690	670	2300	95	491		10		130		216	82	7699	13
S625		140	100	102	94		16		40	30	1060	250	380	1	18	35		2266	13
S626										1400								1400	1
S627			1300		6	70				6		18		30			64	1494	7
S630		1												50				51	2
S635						380							340					720	2
S636						210												210	1
S639									410									410	1
S641		40	594	128	160	390	40	440	1328		650	410	230	26	87			4523	13
S651			10		37													47	2
S658	14									2						1324		1340	3
S659											580							580	1
S660			9	260		35	5		80				240	135				764	7
S661			600	19		390										383		1392	4

B266						550												550	1	
B271					5											8			13	2
B273		43		30													15	140	228	4
N026		80						30		72		350							532	4
N042										115									115	1
N043						160													160	1
N044										130		60		430	125	46			791	5
N047										4									4	1
N062				130								3							133	2
N063				70															70	1
N086				90															90	1
N125								270											270	1
N177					340	120													460	2
N178						220													220	1
N186						480													480	1
N235										60									60	1
N237											230								230	1
N252										360									360	1
N253													120						120	1
N254			510																510	1
N277	695																		695	1
N292						300				800									1100	2
N295						1400													1400	1
N304																1800			1800	1
N497										175									175	1
N499						420													420	1
N515						430													430	1
N598										190									190	1
N614						245													245	1
N669										480			75						555	2
N670													560						560	1
N688								2											2	1
N706												160							160	1
N715												1800							1800	1
N749										240									240	1
N751								6											6	1
N755										690									690	1
N761																280			280	1
N799											100	85							185	2
N803		190						20	40	45	25		100	450		32		902	8	
N810													40	75					115	2
P035						42													42	1
P037						80													80	1
P051									15										15	1
P069									75										75	1
P070													1050						1050	1
P072	7		1300	160							180	12	45						1704	6
P079						60													60	1
P082											240								240	1
P084		380																	380	1
P085						90	20		55										165	3
P098				710										230					940	2
P100													620						620	1
P235										460									460	1
P242										620				160					780	2
P257								90	50	210									350	3
P258								70											70	1
P260								160											160	1
P261													1820						1820	1
P264								270											270	1
R210											210								210	1
R322								140		280									420	2
R449						160										25			185	2
R451													70						70	1
R452													360						360	1
R454																610			610	1

R455																		40			40	1
S198						35															35	1
S233									240												240	1
S251									25												25	1
S263							420						520								940	2
S264									400												400	1
S268										860											860	1
S276													10								10	1
S304						25															25	1
S311						50															50	1
S452		600																			600	1
Total	985	1695	1701	1085	570	1950	3357	748	1710	3915	2416	2588	5632	3265	1964	140	218	33939				17

xy-1						80															80	1
xy-2						370															370	1
xy-3						50															50	1
xy-4						340															340	1
xy-5						155		137													292	2
xy-6							3700														3700	1
xy-7							260														260	1
xy-8									30												30	1
xy-9									590		710										1300	2
xy-10									650												650	1
xy-11									30		45				1630						1705	3
xy-12									2140												2140	1
xy-13										1600											1600	1
xy-14											600										600	1
xy-15											860		4600		1590		1000				8050	4
xy-16											260	2273		2202							4735	3
xy-17											500										500	1
xy-18											2700										2700	1
xy-15													670		330						1000	2
xy-16													2800								2800	1
xy-17													1900		1200						3100	2
xy-18														470							470	1
xy-19														200							200	1
xy-20														1100							1100	1
xy-21														550							550	1
xy-22														2000							2000	1
xy-23														480							480	1
xy-24														225							225	1
xy-25														1200							1200	1
xy-26														900							900	1
xy-27														17	300						317	2
Total	0	0	0	0	0	995	3960	137	3440	1600	5675	2273	9970	9344	5050	0	1000	43444				17

3.3 Greylag Goose counts for the Management Scheme area

Very few Greylag Geese *Anser anser* were recorded within the Scheme area (Table 6). Post-moult flocks usually build up during late summer in the Nith area, with numbers declining from a few hundred to less than ten during the winter, but this has become less apparent in recent years with very low numbers recorded even across the enlarged survey area.

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

NS-id	05/10/22	11/10/22	19/10/22	26/10/22	09/11/22	25/11/22	10/12/22	21/12/22	02/01/23	25/01/23	05/02/23	22/02/23	06/03/23	22/03/23	06/04/23	19/04/23	26/04/23	T_2223	N-2223			
B106			25																	25	1	
B187						48															48	1
Total	0	0	25	0	0	48	0	0	0	0	0	0	0	0	0	0	0	0	0	73	17	
xy-1							65														65	1
xy-2														24	29						53	2
Total	0	0	40	0	0	0	65	0	0	0	0	0	0	24	29	0	0	0	0	118	17	

3.4 Canada Goose counts for the Management Scheme area

Reduced numbers of Canada Geese *Branta canadensis* of typically 60-130 birds were recorded within the Scheme area, most records occurring on the ponds and fields at WWT Caerlaverock where at least one pair had established a nest by April 2023, with another on nesting on Shearington Pond (**Table 7**). As with the Greylag Geese, with which they often associate in mixed flocks, post-moult flocks usually build up during late summer in the Nith area, with numbers declining in the second half of the winter to less than ten. A flock of 35 was noted at RSPB Crook of Baldoon on 25 November 2022.

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

NS-id	05/10/22	11/10/22	19/10/22	26/10/22	09/11/22	25/11/22	10/12/22	21/12/22	02/01/23	25/01/23	05/02/23	22/02/23	06/03/23	22/03/23	06/04/23	19/04/23	26/04/23	T_2223	N-2223
B017															2	2	2	6	3
B026	85																	85	1
B028				26														26	1
B076		15	20	5	60	60		35	75	10	4		4					288	10
B079				55														55	1
B081	3														2	2	2	9	4
B083			18															18	1
B090				40														40	1
B119		95																95	1
B189		5																5	1
B273			25															25	1
N277	8																	8	1
P038		7																7	1
S625									35		2							37	2
Total	96	122	63	126	60	60	0	35	110	10	6	0	4	0	4	4	4	704	17

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, typically hold up to 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 again from mid-February as birds start to migrate north to areas such as Thwaite from sites further south such as Martin Mere. Numbers then decrease rapidly from mid-March into early April as birds head north to Iceland. Flocks that were often just outside the area covered by the previous field coding system are now within the newly coded areas, though some still occur in newly surveyed areas without field codes to the west of Southwick (**Table 8**). Swan numbers this winter were still somewhat lower than normal and the WWT reserve ponds still had lower numbers for most of the winter perhaps reflecting the heavy HPAI losses sustained last winter at that site due the swan feeds concentrating birds up to twice per day alongside those dying on the feed ponds; this disease affected both the Caerlaverock and Nith populations that feed and roost at the Eastpark site and reduced numbers by about 30% in 2021/22.

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

NS-id	05/10/22	11/10/22	19/10/22	26/10/22	09/11/22	25/11/22	10/12/22	21/12/22	02/01/23	25/01/23	05/02/23	22/02/23	06/03/23	22/03/23	06/04/23	19/04/23	26/04/23	T_2223	N-2223
B076		12	60	55		65	45	90	100	6	65	75	65		2		2	642	13
B081							25	7	7			2	1		1			43	6
B189			6															6	1
B195								3										3	1
B215		33	11	6					25				25	21			2	123	7
B219							16	10		51	31		93	123	33	3		360	8
B220						59						5		17				81	3
B221											46		4		5			55	3
B225						8												8	1
B229										3								3	1
B230								3										3	1
B252									65									65	1
B266						25								86				111	2
B273																8		8	1
B274								2										2	1
B349			14	55	50													119	3
B351			18	16		24								215	68	24	8	373	7
B354										120		95	95					310	3
B385			15		6	4												25	3
N031								14										14	1

N042									12		6							18	2
N044					9													9	1
N063			35															35	1
N254		65																65	1
N282					60													60	1
N292						40												40	1
N293						40												40	1
N477									80		25	48	38					191	4
N478										12								12	1
N799						115												115	1
P072			12							3								15	2
P242														2				2	1
S622															20			20	1
Total	0	110	171	132	125	265	201	129	197	272	157	208	331	502	129	35	12	2976	17
xy-1			20															20	1
xy-2						11												11	1
xy-3						47												47	1
xy-4							34											34	1
xy-5							7		2									9	2
xy-6							24		51		60							135	3
xy-7								25	25					61				111	3
xy-8									3									3	1
xy-9											10				17			27	2
xy-10													65					65	1
xy-11													41					41	1
xy-12														66				66	1
xy-13														35				35	1
xy-14														62				62	1
Total	0	0	20	0	0	58	65	25	81	0	70	0	106	224	17	0	0	666	17

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 numbers mid-winter continued to be lower than the typical counts recorded in past winters presumably due to the continued effect of the large number of HPAI deaths due to the wildfowl feeds continued at WWT Caerlaverock in winter 2021/22 which brought healthy swans into proximity with dead and dying swans on the two main pools.

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

NS-id	05/10/22	11/10/22	19/10/22	26/10/22	09/11/22	25/11/22	10/12/22	21/12/22	02/01/23	25/01/23	05/02/23	22/02/23	06/03/23	22/03/23	06/04/23	19/04/23	26/04/23	T_2223	N-2223
B076		2	10	10	20	30	22	35	15	20	7	2	6		2	2	1	184	15
B081										2							1	3	2
B117	2	2																4	2
B220													4					4	1
B221													4		4			8	2
B411										2								2	1
P242							2							2				4	2
S641															2			2	1
Total	2	4	10	10	20	32	22	35	15	24	7	2	10	6	8	2	2	211	17
xy-1							22											22	1
xy-2							7											7	1
xy-3							6											6	1
xy-4								12	8									20	2
xy-5									1									1	1
xy-6											8							8	1
xy-7													6					6	1
Total	0	0	0	0	0	35	12	0	9	0	0	0	0	0	0	0	0	56	17

3.7 Deliberate disturbance to geese in the Management Scheme area

Disturbance activities thought to be directed towards geese were as follows (further details in Excel spreadsheet):

- From October canes with bags had been deployed at Midtown in an effort to reduced goose use of the newly drained and reseeded pasture north of the road at B090;
- Many spinning face scarers and scarecrows and a gas gun and a BOP kite were deployed on fields in the Newmains area near Kirkbean and Carsethorn, a similar number of devices being seen in a similar set of fields to last winter, with metal barrels on a field closer to Powillimount at S369;
- From February, two BOP kites on sticks were seen on B381 reseed (?) near Ladyhall from February;
- From mid-March two large floating upturned table-like structures with wire netting on them on field B076 “Whooper Pond” at WWT Caerlaverock was very effective at keeping all geese, swans and other wildfowl away from that area for the rest of the count period;
- On 6 March 2023, JB and NatureScot marksmen from Islay were encountered shooting Barnacle Geese in the Carsethorn and Cowcorse areas with ~8 birds killed on S581 at Cowcorse; in subsequent weeks various birds limping and with feather patches missing were encountered in that area and volunteer ring readers reported that the birds were “jumpier” and more wary than usual; this field is “Feeding Zone” where payment rates are intended to provide for undisturbed goose feeding; *birds were also shot on fields x,y,z (NB: it would be useful to know the exact fields shot over even if no birds shot as this may affect future use or the use recorded during the remaining counts in 2022/23 and thus aid our discussions with farmers about use).*

3.8 Count section dates and times of coverage

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

Type	JNCC	NS/JNCC	JNCC	JNCC	JNCC	NS	NS	JNCC	JNCC								
Day	Wednesday	Tuesday	Wednesday	Wednesday	Wednesday	Friday	Saturday	Wednesday	Monday	Wednesday	Sunday	Wednesday	Monday	Wednesday	Thursday	Wednesday	Wednesday
Date	05/10/22	11/10/22	19/10/22	26/10/22	09/11/22	25/11/22	10/12/22	21/12/22	02/01/23	25/01/23	05/02/23	22/02/23	06/03/23	22/03/23	06/04/23	19/04/23	26/04/23
Thwaite	12:15	10:15	10:30	12:20	10:25	11:15	14:40	10:35	13:00	11:45	12:00	10:40	14:20	10:10	11:50	09:50	09:45
Nith	13:20	08:30	08:50	14:10	08:20	12:40	12:30	09:00	11:10	10:00	09:45	08:45	12:50	08:30	09:40	08:35	08:30
Southernness	11:45	11:20	10:45	11:55	11:30	14:40	14:00	10:50	10:35	12:30	15:45	11:00	09:45	11:15	13:15	11:10	10:30
Gretna	10:20	11:00	11:15	11:45	11:10	09:20	15:45	11:30	14:40	13:00	12:45	11:25	15:10	11:05	12:50	10:45	10:30
Auchencairn	11:00	11:00	11:00	11:00	11:00	15:50	12:25	10:30	13:00	12:00	15:15	10:30	12:00	10:10	18:15	11:00	11:00
Wigtown	11:00	11:00	11:00	11:00	11:00	13:00	09:15	10:30	14:45	12:00	14:15	14:00	15:30	11:30	19:30	11:00	n.c.

For the core Scheme area there were ten Wednesday counts and approximately two counts on a Thursday and Friday with one count each on a Monday, Tuesday, Saturday and Sunday across the 17 count periods in total; however, when accounting for the extra days or half-days of effort expended across the broader counting area west to Wigtown the breakdown was approximately ten Wednesdays, and one to two days for every other day of the week (Table 10; details given in Excel).

3.9 Farmer liaisons regarding geese

As counts were conducted within the Scheme area, any significant conversations with land managers 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 February to discuss goose issues once they had received the field count data from NS. 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. Land managers engaging in conversations about geese were noted (Table 11).

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

February 2023
JJ at Upper Locharwoods said there had been no problems with the geese and seemed less barnacle geese about than in past winters though some mixed in with the pink-footed geese. Said that any use had been in the fields in the Scheme so nothing unusual to report. LG suggested he call if anything changed in that situation.
AM at Nether Locharwoods rang to say that his fields had been "polluted" with geese in the period mid-January. This did not coincide with the fortnightly counts and he thought it showed how the monitoring was lacking as birds often rested on core fields near the centre of the Scheme but might then descend on peripheral fields in bigger numbers at leaner times of the year to feed for short periods while removing significant amounts of grass - something he thought might happen in the West Preston area too. LG agreed this can happen to an extent but noted that he thought the monitoring had picked up on birds feeding there in November (and checked after call & found that to be the case in fields B185 & B187 with 340 and 1,290 respectively on 25 November) and so averaging over a number of years as is done for the Scheme by NS might still be capturing the use in large part although no monitoring Scheme on a limited budget is ever perfect of course and the ability to feed in local knowledge does have a role to play, though LG acknowledged he has less day-to-day impressions of goose use in the Caerlaverock area since leaving WWT.
StuB & SteB both in room at time of call & said things more normal than last winter in terms of movements & field use but nothing unusual to report. StuB hoped birds would not get on the Mossband fields at present as very flooded so could do a lot of damage there & had only been small occasional flocks on there to date. Lots of use of Hollands

B041 field by track/house with spill over into fields near that. LG suggested that Newfield B065 hill field near merse seemed to have been more than usual & SteB agreed with that impression & also that there had been very little use of the marshy field west of it (B063), but otherwise all fields high use as normal.
SM at West Preston said big numbers in usual fields all winter but none in pasture in centre of golf course yet (S386 & 387) where one is long rank grass and other is rape so geese unlikely to use until perhaps spring if they get cattle in there to bring it down or if geese get desperate with any snow etc. For Cowcourse SM agreed that geese not been in field on corner leading up to old plant nursery (S584) again probably because grass rank but might use more in spring if they get livestock in there to reduce it but had been some irregular use of fields reseeded to north side of the road which are not in the Scheme.
BO at Mid-Locharwoods used to have no.3 but has now bought no.4 too, usually good humoured in other years about the geese when talking about them with LG and usually no issues ever raised but notably aggrieved this winter; says he has gone from £4,200 to £1,300 yet counted 10,000 geese on his middle field two over from road south nearer the Lochar and has a grievance that he signed a two-year contract but that has been dissolved without discussion saying he raised issue with AW the farmer's rep and KC at NS; LG could not offer any opinion on that issue as does not know the detail of which fields are in or out of the Scheme or what the contract said. North of the road he said the second field over was hammered by the geese too but not the newly drained reseed right by the road and track. BO said he has been in Scheme 25 years and seen the geese go from 14,000 to over 40,000 so where are the extra 20,000+ going if not on his fields, bad line on the call, but I think BO said he had tenant's sheep on the land for 23 years and this is first time the tenant has said they are going to need extra feed; apparently MS who owned the land before was never happy with the situation as geese on the fields were never counted. LG explained that the geese are only counted approximately every two weeks but that his concerns would be passed on to KC at NatureScot.
AW at Newmains felt the geese had been hammering the usual fields in the usual places but nothing exceptional to report and just hoped that LG was counting them correctly, with the field out the back of the farm sheds being used heavily by the geese in the last couple of weeks.
JK at Cowcourse said nothing unusual but little use of fields north of the road but happy for SM at West Preston to speak with me about it.
AG at Midtown also seemed to be aggrieved a fair bit compared to past winters as he feels NS wrongly tried to downgrade some of his fields, that he said are well used by the geese, to scaring or buffer zone fields, which he felt made no sense as could mean gas guns being used in the middle of the core Scheme area which defeated the purpose of peaceful refuge areas for the geese to feed. He felt the Scheme needed to change to make single farm-scale payments that were in place for several years to save on the grief and significant stress the farmers get each year from debating whether a field should be in or out. He said he showed NS staff to fields that were potentially going to be downgraded and that those staff agreed they were covered in goose droppings and so reneged on the proposed downgrading of those fields. He suggested he would be spraying fields such as the rushy one near the Lochars but thought that was a shame as it is potentially of value to waders and natterjacks and yet he was forced to consider this option to try and get geese back there whereas he would rather get a payment for keeping it as a wetland of greater biodiversity value. He said he had lots of video footage he had sent to NS and also camera footage of geese on fields not shown as being used by the fortnightly counts.

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	05-Oct	11-Oct	19-Oct	26-Oct	09-Nov	21-Dec	25-Jan	22-Feb	22-Mar	19-Apr	26-Apr	03-May	10-May	16-May	18-May	23-May	26-May
Annan to Gretna	0	0	0	0	0	630	60	0	0	0	0	0	0	0	0	0	0
Ruthwell to Cummertrees	0	0	45	580	2090	4982	505	732	3496	0	0	0	0	0	0	0	0
Longbridgemuir	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caerlaverock	990	2358	4992	6775	5314	4839	11026	10536	11488	2990	4210	6	0	0	0	0	0
Kirkconnell & Ward Law	55	580	2262	1260	1840	2108	575	430	150	3020	10	0	0	0	0	0	0
Mersehead to Airds Pt	1415	3031	8222	7854	8140	5770	8677	6660	7571	5146	2613	25	0	0	0	0	0
Caulkerbush to Rascarrel	0	0	0	0	1020	0	270	0	0	0	0	0	0	0	0	0	0
Dundrennan to Wigtown	0	0	20	0	195	17	466	954	2326	2152	102	5	0	0	0	0	0
Rockcliffe Marsh	370	4300	8550	6300	9550	40	5810	8230	3000	13800	19550	26000	5100	2900	800	200	35
Burgh Marsh	0	2800	40	2576	0	20	50	1050	0	0	100	0	0	0	0	0	0
Bowness to Grune	32	800	1896	2353	2809	2700	2490	5400	1450	2864	65	1600	0	0	0	0	0
Solway total	2862	13869	26027	27698	30958	21106	29929	33992	29481	29972	26650	27636	5100	2900	800	200	35
Budle Bay	0	1440	2375	2463	2550	2500	n.c.	1	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.
Overall total	2862	15309	28402	30161	33508	23606	n.a.	33993	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Further notes, counts (for end of May and June) and caveats regarding these census totals are included in the Excel provided (**Table 12**). It should be noted that as with last autumn, mass arrival to the Solway was relatively late.

The build-up in the numbers of geese on the Solway during October produced count totals that remained relatively stable until a further influx to the Solway in February of the birds that had probably been wintering at Budle Bay, Northumberland; a GPS tagged “marker” bird within that group completing its migration to the Solway in the first week of February (**Figure 4**). Weather patterns were not very conducive to spring migration north in late April/early May and over 26,600 remained at the east end of the Solway on 3 May with a major exit shortly afterwards as wind patterns changed and a ‘High’ pressure established resulting in only 5,100 being present by 10 May 2023. Numbers then progressively diminished until only 35 remained into late May, with 11 still present at the end of June, possibly representing a group of birds in poor health due to the continued presence of HPAI in the population which had been responsible for deaths earlier in the season.

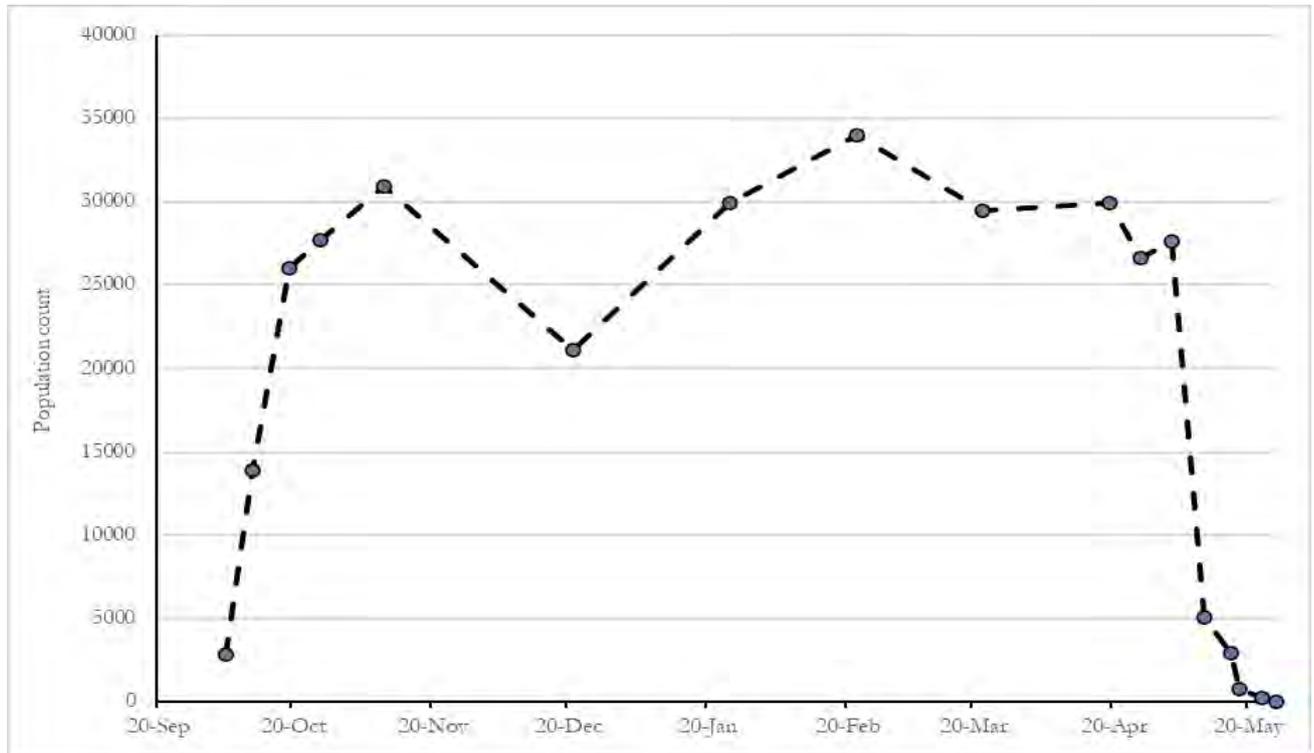


Figure 4. Total population of the Svalbard Barnacle Goose on the Inner Solway from October 2022 to May 2023 (21 December count total was probably low due to birds being missed inland at Rockcliffe after thaw following a ~2-week period of frozen ground conditions on the marsh).

In winters prior to the 2021/22 HPAI outbreak, an “adopted” population total for the Solway population of the Barnacle Goose and the flyway population (including Budle Bay) have been reported as part of the JNCC contract based on an averaging process to allow for the possibility of double-counting of birds in some of the key areas such as Rockcliffe Marsh - a vast expanse of remote saltmarsh at the east end of the Solway covered by two observers working the road network and vantage points on the south and north/east sides. Due to HPAI, this processing of the data was no longer relevant and instead maximum counts “before” and “after” the peak of the epidemic were reported for winter 2021/22, albeit birds were dying from HPAI during both periods.

Similarly, for 2022/23 the *peak* counts for the Solway and for the flyway (including Budle Bay, albeit there may be other sites on the east or west coasts that hold small numbers of Svalbard Barnacle Geese amongst populations of naturalised UK birds and for which WeBS data may be consulted) are reported.

The peak count for the Solway and the flyway coincided on 22 February 2023 with 33,992 and 33,993 respectively.

3.11 Brood size and juvenile productivity of the Svalbard Barnacle Goose

Table 13. Brood size and juvenile (juv) productivity for Svalbard Barnacle Goose on the Solway in winter 2022/23.

Date	Flock Size	Sample Size	Total Juvs	WWT-field	Crop	Brood of 1	Brood of 2	Brood of 3	Brood of 4	Brood of 5	Brood of 6	Single Juvs	% juvs	Obs
26/10/2022	146	146	56	DB96	merse	4	12	8	1				38.36	LRG
09/11/2022	2090	990	172	M1	pasture								17.37	LRG
09/11/2022	115	115	48	KM30	pasture	4	7	6	3				41.74	LRG
20/11/2022	395	395	48	KM6	merse	3	8	7	2				12.15	LRG
20/11/2022	450	450	106	P5	pasture	9	9	10	11	1			23.56	LRG
20/11/2022	215	215	42	P3/4	pasture	3	7	1	2				19.53	LRG
20/11/2022	272	250	24	B7	pasture	3	6	3					9.60	LRG
20/11/2022	785	735	125	C6	stubble under sow								17.01	LRG
20/11/2022	1650	645	124	E1	pasture								19.22	LRG
20/11/2022	730	730	32	A9/10	pasture								4.38	LRG
20/11/2022	220	210	18	A4	pasture								8.57	LRG
20/11/2022	145	145	12	A6	pasture								8.28	LRG
20/11/2022	136	136	33	O8	pasture	7	6	2	2				24.26	LRG
20/11/2022	156	156	10	OM1	merse	5	1	1					6.41	LRG
22/11/2022	1250	1025	251	V9b	pasture	6	10	13	7	2			24.49	LRG

22/11/2022	1880	890	103	V4	pasture												11.57	LRG					
22/11/2022	1890	1020	218	T8	stubble													21.37	LRG				
22/11/2022	990	980	178	T5	pasture													18.16	LRG				
22/11/2022	370	310	11	R9c	rough pasture													3.55	LRG				
22/11/2022	411	411	118	R4b	pasture	5	13	12	6	1								28.71	LRG				
22/11/2022	230	85	6	R2	rough pasture													7.06	LRG				
25/11/2022	64	64	30	PR79	pasture	1	3	5	2									46.88	LRG				
25/11/2022	13	13	7	PR57a	pasture			2	1									53.85	LRG				
08/12/2022	275	275	69	U1	pasture	4	13	7	2	2								25.09	LRG				
11/12/2022	1070	870	227	L1	pasture													26.09	LRG				
Total (LRG)		11261	2068			Brood size totals (LRG):																	
Overall juv%			18.36			54	97	76	38	6	0	Total broods	271										
						Number of juveniles per brood size category:																	
By observer:	LRG	11261	2068	18.36		54	194	228	152	30	0	Total juvs	658										
	*V↔B	5350	608	11.36															Mean brood	2.43			

**Observers V&B collected juvenile samples across 28 flocks but many were for repeat field areas and all were for flocks below 500 birds, with 50% below 100 birds, so the data are not presented fully here but are available in the GSMP Excel summary file (total broods = 93, max %juvs = 50.0, total juvs = 167, mean brood = 1.80).*

The juvenile productivity of the Svalbard Barnacle Goose observed in flocks sampled on the Inner Solway from October 2022 to December 2022 in the Priestsides, Stanhope, Caerlaverock, Lantonside, Kirkconnell, Carsethorn, and Southernness/Southwick areas on the north side of the Solway, plus Burgh Marsh on the south side, varied between 3.6% and 53.8% (**Table 13**; 0% to 22.6% in 2021-2022) with a mean of 18.4% young for 25 flocks with 11,261 geese sampled (3.9%; n = 24 flocks; 11,928 geese sampled in 2021-2022).

Across a subset of these areas, the total number of broods sampled was 271, with a mean family size of 2.4 young, range 1-5 young (mean 1.6 young; n = 128 broods; range 1-4 young in 2021-2022). As usual flocks in fringing areas tended to have the highest percentages of young e.g., as seen at Priestsides (fields PR57a & PR79; WWT field codes), Burgh Marsh (DB96) and Nethertown, Islesteps (KM30).

The percentage young in the population and large family sizes were the highest observed by LRG in 24 years of goose observations on the Solway, and perhaps represent, at least in part, a density-dependent response or nest site release mechanism/pair-bond break-up effect, following the large numbers of deaths in 2021/22 due to HPAI.

3.12 Leucistic Barnacle Geese

As with the 2021/22 season, a minimum of seven leucistic Barnacle Geese was recorded on 22 February 2023.

3.13 Other geese

One *Hutchinsii*-type small Canada Goose species was recorded in the Hollands Farm area (field B051 [WWT-id C6] stubble under sow) with 785 Barnacle Geese on 20 November 2022. One adult European white-fronted goose *Anser albifrons albifrons* was present with 1,290 Barnacle Geese and 670 Pink-footed Geese on Orchardton merse (WWT field code PK120) on 9 March 2023.

3.14 Acknowledgements

Thanks go to: Bob Jones for conducting census counts in the Rockcliffe/Burgh Marsh area; Mhairi Maclaughlan for counts covering the Bowness to Grune route; Marian & Dave Rochester for covering the Borgue to Wigtown route (supplemented for one count by Val & Bob Smith); Paul Tarling for covering south of the Crook of Baldoon; Ivan Lang for covering RSPB Crook of Baldoon; David Charnock for covering Rascarrel to Sandyhills; and Rowena Chambers, Paul Radford and the team for covering the Southwick area to Drumburn. Derek Forshaw kindly provided counts for Budle Bay, Northumberland. End of season counts in May and June for Rockcliffe Marsh were kindly provided by David Wright (CWT warden).