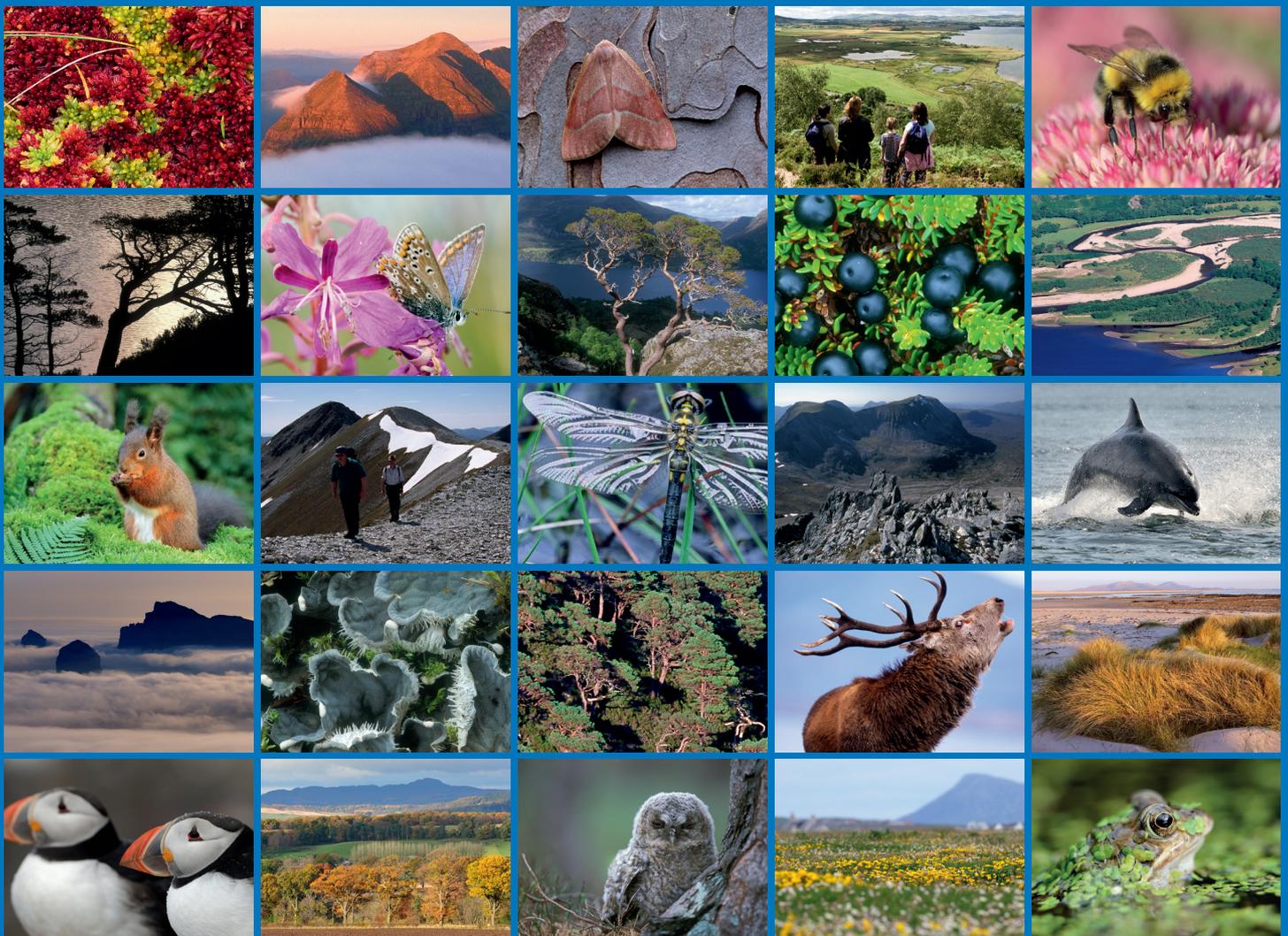


North Orkney proposed Special Protection Area (pSPA) – inshore wintering waterfowl survey 2017/18





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RESEARCH REPORT

Research Report No. 1074

North Orkney proposed Special Protection Area (pSPA) – inshore wintering waterfowl survey 2017/18

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RESEARCH REPORT

Summary

North Orkney proposed Special Protection Area (pSPA) – inshore wintering waterfowl survey 2017/18

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North Orkney pSPA; wintering waterfowl survey; great northern diver; Slavonian grebe; common eider; long-tailed duck; velvet scoter; red-breasted merganser; European shag.

Background

The Birds Directive (EC Directive on the conservation of wild birds (2009/147)) requires EU Member States to identify and classify Special Protection Areas (SPAs) for rare or vulnerable species listed in Annex I of the Directive, as well as for all regularly occurring migratory species. In 2016, following an extensive programme of marine bird survey and analysis, the public were consulted (SNH *et al*, 2018) on the case for classifying ten proposed Special Protection Areas (pSPAs) within Scottish territorial waters (out to 12 nm). These included the North Orkney pSPA (SNH, 2016) identified to safeguard areas used by non-breeding great northern diver, Slavonian grebe, common eider, long-tailed duck, velvet scoter, red-breasted merganser and European shag together with foraging areas used by breeding red-throated divers.

The identification of the North Orkney pSPA was underpinned by visual aerial and shore-based surveys of non-breeding wintering birds carried out in 2006/07, 2007/08 and 2008/09. Four species were counted in all three seasons and the remaining three from shore-based surveys in the latter two seasons only. The survey work detailed in this report was commissioned in order to provide systematic shore-based (vantage point) counts across the winter of 2017/18 for all seven species identified as qualifying wintering interests of the North Orkney pSPA, including a third season of data for Slavonian grebe, velvet scoter, and European shag. Five rounds of counts were completed across the site, one in each month from November 2017 to March 2018.

Main findings

- For all seven of the wintering qualifying interest species of the North Orkney pSPA, the 2017/18 counts exceeded 1% of the relevant GB wintering populations in every month and the peak counts were higher than any previously recorded. For European shag, counts in four months also exceeded 1% of the biogeographic population.
- For the three qualifying interests with only two years of previous shore-based count data, the 2017/18 surveys confirmed regular use of the site by populations of birds substantially exceeding the relevant population thresholds for SPA selection. The peak counts were:

303 Slavonian grebes (27.5% of GB wintering population); 244 velvet scoters (9.8% of GB wintering population) and 2,968 European shags (2.7% of the GB wintering population and 1.5% of the biogeographic population).

- For the other four qualifying interests peak counts were: 777 great northern divers (up to 31% of GB population); 3,806 common eiders (6.3% of GB wintering population); 2,651 long-tailed ducks (24.1% of GB wintering population) and 717 red-breasted mergansers (8.5% of GB wintering population).
- The peak count for great cormorant, which is not a qualifying interest of the North Orkney pSPA, was 660 birds (1.9% of GB wintering population).
- The distributions of all seven of the wintering qualifying interest species of the North Orkney pSPA are mapped as mean counts within each of 24 count sectors. Changes in numbers between count months are also described.
- The counts could not be corrected for decreasing detectability with distance, and so are minimum estimates. Corrections have been made for likely double counting when collating the raw data.
- The confidence in the reported counts for each of the seven species in each of the 24 count sectors and five count rounds was qualitatively scored as High, Medium or Low on the basis of objectively measured factors relating to species detectability, count conditions (sea state) and sector dimensions. About half of the counts were assessed as being in the highest confidence category and fewer than 20% were in the lowest category.

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1. INTRODUCTION

The Birds Directive (EC Directive on the conservation of wild birds (2009/147)) requires EU Member States to identify and classify Special Protection Areas (SPAs) for rare or vulnerable species listed in Annex I of the Directive, as well as for all regularly occurring migratory species. There are 44 such species of marine birds, including breeding and wintering seabirds and wintering waterfowl, that occur in notable numbers in UK waters every year. Scotland is of particular importance to a range of inshore wintering waterfowl, including Slavonian grebe, great northern, black-throated and red-throated divers, all of which are Annex 1 species, together with eight migratory duck species and European shag.

In 2016, following an extensive programme of marine bird survey and analysis by JNCC throughout the UK¹, SNH ran a public consultation (SNH *et al*, 2018) on behalf of Scottish Government on the case for classifying ten proposed Special Protection Areas (pSPAs) within Scottish territorial waters (out to 12 nm). In Orkney, these included the North Orkney pSPA (SNH, 2016) and Scapa Flow pSPA, which were identified to safeguard areas used by non-breeding divers, Slavonian grebes, seaducks and European shags and foraging areas used by breeding red-throated divers.

The North Orkney proposed Special Protection Area (pSPA) covers an area to the north of Mainland Orkney, stretching from Eynhallow Sound in the west to Deer Sound in the southeast, and including the waters around Egilsay, Wyre and Gairsay and partially around Rousay and Shapinsay (Figure 1). The qualifying features are non-breeding great northern diver (*Gavia immer*), Slavonian grebe (*Podiceps auritus*), common eider (*Somateria mollissima*), long-tailed duck (*Clangula hyemalis*), red-breasted merganser (*Mergus serrator*) velvet scoter (*Melanitta fusca*) and European shag (*Phalacrocorax aristotelis*) plus red-throated diver (*Gavia stellata*) in the breeding season.

The bird count data used to underpin selection of the North Orkney pSPA were derived from a combination of aerial and shore-based surveys in the winters of 2006/07, 2007/08 and 2008/09. There were two visual aerial counts (February 2007 and March 2008) and two shore-based surveys (in 2007/08 and 2008/09). Together, these covered the entire pSPA, but there were differences in coverage; the aerial counts omitted most of Eynhallow Sound and the shore-based counts omitted the north and east sides of Egilsay and the north side of Shapinsay, along with a narrow strip at the eastern boundary of the pSPA between Shapinsay and Deerness. The areas covered and the survey results are summarised in a JNCC report (Lawson *et al*, 2015).

The aerial surveys did not include European shag as a target species and did not detect velvet scoters or Slavonian grebes, which are more readily counted from land. Consequently only two winters of systematic survey data were available for these species, rather than the three normally required for assessing regularity of occurrence under the UK SPA Selection Guidelines (JNCC, 1999).

The survey work detailed in this report was commissioned in order to provide up to date systematic shore-based counts across the winter of 2017/18 for all seven species identified as qualifying wintering interests of the North Orkney pSPA, including a third season of data for Slavonian grebe, velvet scoter, and European shag. Five rounds of counts were completed across the site, one in each month from November 2017 to March 2018.

The results of a survey of inshore wintering waterfowl interests in the Scapa Flow pSPA over the same winter (2017/18) are reported elsewhere (Jackson, 2018).

¹ For further information see <http://jncc.defra.gov.uk/page-4184>

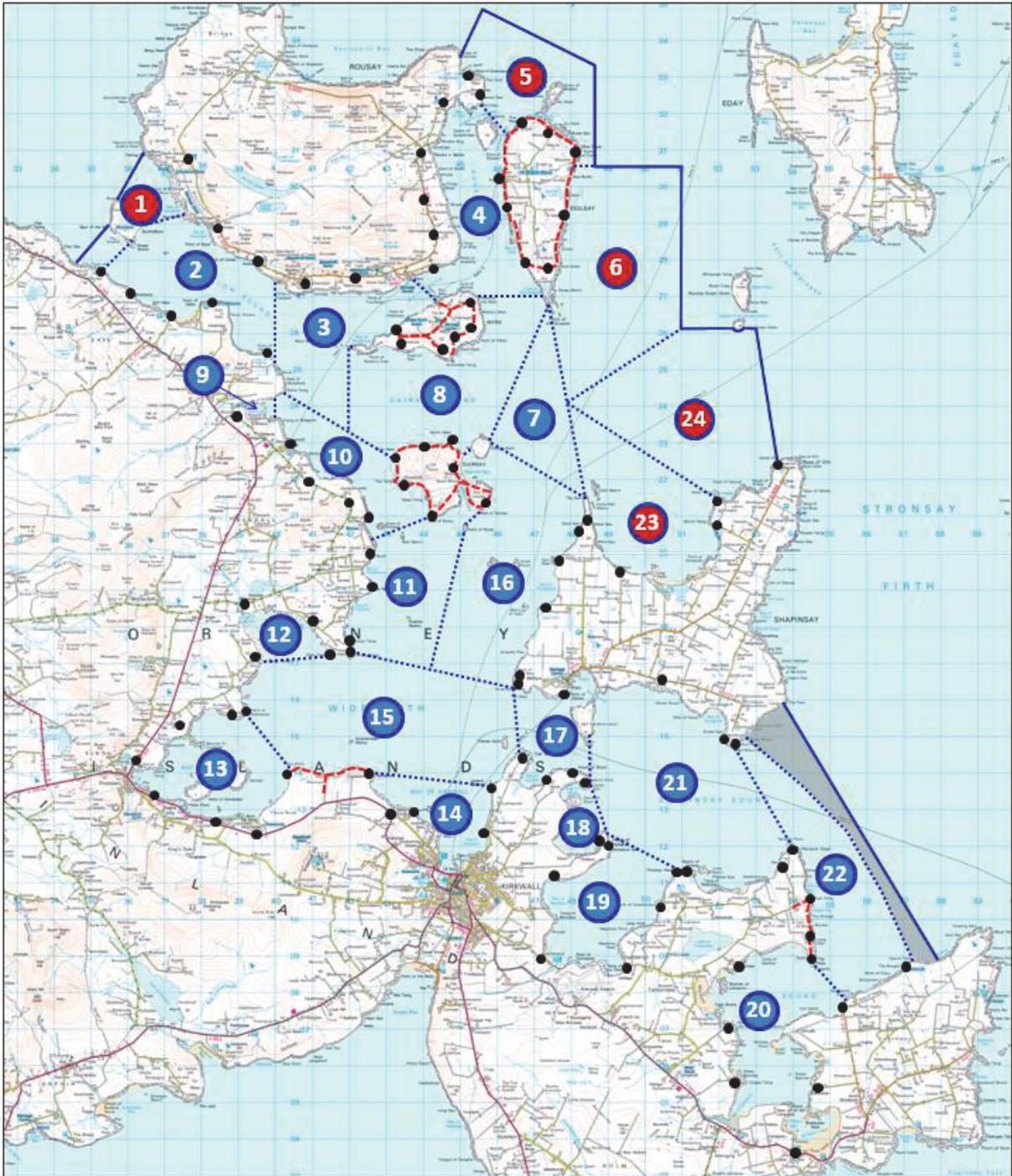


Figure 1. North Orkney pSPA area with count sectors and vantage points (black dots) used in 2017/18 (© Crown copyright and database right 2018. Ordnance Survey 100017908.)

The solid blue lines indicate the outer boundary of the pSPA. The numbers of the new count sectors (not included in any previous shore-based surveys) are shown in red; the greyed-out area was not included in this survey. Significant walking routes are shown as red dashed lines.

2. METHODS

2.1 Fieldwork methods

2.1.1 Target species

The primary target species were the proposed non-breeding qualifying interests of the North Orkney pSPA: great northern diver, Slavonian grebe, common eider, long-tailed duck, velvet scoter, red-breasted merganser, and European shag. In addition, records were kept of all other seaducks, divers, grebes and cormorant.

2.1.2 Count methods

Five count rounds were completed, one in each month from November 2017 to March 2018, by a team of three professional local ornithologists familiar with the survey area (Williams, 2002 & 2009). The whole area could be covered over 4.5 days in ideal conditions and with all surveyors available. The main factor affecting this was surveyor availability, since good weather was often only confirmed at short notice; if this occurred on a Sunday coverage could also be affected by the lack of Sunday ferries to the smaller islands. The periods within which each of the five count rounds were completed are shown in Table 1.

Table 1. Count periods for each count round.

Count round	Shore survey period	Survey dates
Round 1	2 nd to 20 th November 2017	6
Round 2	1 st to 20 th December 2017	5
Round 3	4 th to 25 th January 2018	6
Round 4	2 nd to 26 th February 2018	6
Round 5	7 th to 26 th March 2018	6

Counts were undertaken in sea conditions of no more than sea state 4, and for most of the counts the sea state was 3 or less. The majority were carried out in dry conditions, with only occasional rain or snow showers affecting them; if showers were too heavy to permit accurate counting the survey was suspended until better conditions resumed. Only one day (19th January) was badly affected, by prolonged snow; this meant that fewer VPs than planned could be covered and some areas had to be revisited on the next day.

All target species were searched for and recorded. Searches included birds on the sea and roosting birds on the adjacent shoreline, islets and rocks, which was particularly important for European shag and great cormorant. Flying birds were not included in the count totals unless the birds took off from or landed in the count area, although notes were made of larger flocks in flight across a sector.

2.1.3 Count sectors and vantage points

As illustrated in Figure 1, the counts were based on sectors, including those defined in previous shore-based surveys (Williams, 2009), plus additional sectors to cover parts of the pSPA previously only surveyed from the air (Lawson *et al.*, 2015). The entire pSPA was covered, except for the outer parts of the area between Egilsay and Shapinsay, which were well over 2 km from the shore, and a narrow strip at the eastern boundary between Shapinsay and Deerness, which extended beyond the boundary of the previously established count sector (sector 22).

The previous shore-based counts had been divided into two sub-areas (South: Wide Firth, Shapinsay Sound and Deer Sound and North: Sounds around Wyre) with duplicated sector numbers within each (Williams, 2002 & 2009). Therefore the old and new sectors were renumbered in a single revised series as shown in Figure 1 and detailed in Table 2.

Vantage points (VPs) were selected around each sector to provide full coverage of the inshore waters, out as far as was visible by telescope. The VPs were not adhered to rigidly on every count, since when sea conditions were particularly calm some intermediate VPs became unnecessary. For the smaller islands where the survey was done on foot (Egilsay, Wyre and Gairsay) and for some harder to access sections of the shore, where considerable walking was involved (e.g. the east side of Tankerness in sectors 20 and 22), the precise locations of the VPs could be flexible depending on the conditions at the time (e.g. light and wind direction) and the location of the birds. The general VP locations and the main walking routes are shown in Figure 1. For Mainland, Rousay and Shapinsay a car was used to cover most of the shore and these VPs were fixed at suitable stopping locations.

Table 2. Sector locations and numbering (see also Figure 1)

Sector location	Original sector number ^a	2017/18 sector number (Figure 1)
(Outer Eynhallow Sound)	-	1
Eynhallow Sound	North 1	2
Wyre Sound	North 2	3
Rousay Sound	North 3	4
(North of Egilsay)	-	5
(East of Egilsay)	-	6
Outer Gairsay, Egilsay, Shapinsay	South 13	7
Gairsay Sound	North 4	8
Woodwick	North 6	9
Rendall/Gairsay	North 5	10
Rendall	South 1	11
Bay of Isbister	South 2	12
Bay of Firth	South 3	13
Kirkwall Bay	South 4	14
Wide Firth	South 5	15
West Shapinsay	South 6	16
The String	South 7	17
Bay of Meil	South 8	18
Inganess Bay	South 9	19
Deer Sound	South 10	20
Shapinsay Sound	South 11	21
Outer Deer Sound	South 12	22
Veantrow Bay, Shapinsay	-	23
North Shapinsay	-	24

a: Sector numbers South 1, South 2 etc. were in the original Wide Firth, Shapinsay Sound and Deer Sound survey area and North 1, North 2 etc. were in the original Sounds around Wyre survey area.

2.1.4 Sector coverage

In general, each surveyor covered the same sectors on each count as this was more efficient once the route and VPs had been established on the first round. However there was some interchange on the smaller, walk-round islands and particularly around the central Wide Firth area. Routes were covered in the same direction where this allowed surveyors to be opposite each other at the same time along the various sounds between the islands, but there was some flexibility elsewhere. The general order of counting for each count round was from northwest to southeast.

The aim was to cover each sector over as short a time period as possible, preferably within one day, but this was not always achievable for sectors that were viewed from more than one island. For 17 of the 24 sectors the whole sector was counted in one day on at least four of the five count rounds. Full coverage of several other sectors usually took place over

two different days, and three sectors (7, 15 and 21) were covered over three different days on at least one of the counts. When possible, breaks between count days took place at narrower parts of the pSPA (e.g. after completion of sectors 11 and 16 (between Crookness, Rendall and Strombery, Shapinsay) and before or after sector 17 (The String, between St Ola and Shapinsay). This was intended to reduce the likelihood of large movements between sectors during non-count days, although double-counting due to such movements was identified in two instances (see section 2.1.6). The data spreadsheet accompanying this report (see section 3.1) includes a worksheet illustrating the distribution of count days by sector each month. Occasionally the durations of gaps between survey days were prolonged by lengthy periods of poorer weather (i.e. winds of Beaufort Force 4 - 5 or greater).

When surveyors were viewing the same area at the same time they were in contact by phone or radio to ensure that double counting did not occur. For the narrower sounds a more or less full count could be made from either side. At Rousay Sound (between Rousay and Egilsay) surveyors were usually present at different times on the same day and the count taken was the higher one for each species, plus any birds very close to shore that had not been noted as seen from the opposite side of the sound. For Wyre Sound (between Rousay and Wyre) surveyors were there on different days, and the count taken was the one from Rousay, since this covered the adjacent sectors to the west and east at the same time (thus reducing uncertainty arising from possible intervening movement of birds between sectors).

Partial coverage of the smaller sectors on different days posed a greater difficulty. Sector 10 was always completed in one day from the Mainland shore, but its southern end was visited subsequently on the Gairsay count. This southern part was the last to be counted from Mainland (towards evening) but the first to be counted from Gairsay (in the morning) when there were usually a few more birds present; in these instances, the Gairsay numbers were taken. For wider sectors such as 11, 15 and 21 the main coverage was from particular VPs, with subsidiary VPs on different days counting only the birds close in to shore. The northern and southern ends of sector 22 were far enough apart, often across a central stretch or rougher water, so that there was little viewing overlap.

The sectors with the poorest coverage were those whose outer or central parts lay furthest from the shore, particularly sector 7, where all of the VPs overlooking it were also set back some way from the shore in order to gain some height. At the north-eastern edge of the pSPA, the outer waters of sectors 6 and 24 lay well beyond 2 km from shore, often in somewhat choppy water, so that the counts of these sectors must be considered incomplete to an unknown degree.

2.1.5 Recording methods

A simple field data form (see Annex 1) was completed for each VP; most VPs covered only one sector but, where two sectors were counted from one VP, a separate form was filled in for each. This form captured contextual information (date, time, surveyor, sea state, weather, wind, visibility (including glare), tide) and also included a comment box for a subjective assessment of count quality (see also section 2.2).

There was space on the form to subdivide the counts for each species into different parts of the sector. This was important subsequently in judging which birds may have been seen twice, either by different surveyors on each side of a sector, or by the same surveyor moving around two sides of the same sector (e.g. sectors 17 and 22 and the larger bays of sectors 19 and 20). The form also enabled counts of birds seen close-in whilst walking or driving between VPs to be added to the closest VP count. The times noted were only those from a main VP, so some of the records were made outside of these timed periods.

2.1.6 Corrections for potential double counts

The potential for double-counting of large numbers of birds between different days within a count round was identified, and where possible corrected for, in two circumstances as described below.

The largest flocks of eider were concentrated at active fish cages, and groups of birds noted in flight at times indicated movement between them, such that some under or over-counting may have occurred for this species. Between November and February the numbers at each cage site were either stable, or steadily increasing, or steadily declining, without the sort of random changes that could potentially generate large errors. However, in March, an apparent large movement took place from the fish cages at Hatston (birds in sectors 14 and 15) to the Bay of Carness (sector 17) in the interval between the counts on 13th and 26th. On 13th March there were 830 eider at Hatston and 260 at Carness and on 26th March 891 at Carness and a check count of 500 at Hatston. The overall higher second figures are used as the count for the area, so the Hatston count on 13th has been reduced to 500 in the Count Master data and the Carness count on 13th is disregarded.

The only species that showed an unexpectedly high count in just one month (Figure A4.8) was great cormorant, which is not one of the qualifying interests of the North Orkney pSPA. Flocks of up to 230 were observed to move around together, and the total raw count in December was of 881 birds compared to a fairly steady 520-660 in all the other months. Large numbers were restricted to two areas, in sectors 3 and 4 (to the north of Wyre) and sector 8 (to the south of Wyre). In November there were 270 to the north and none to the south, whilst in January, February and March there were 200-350 to the south and few to the north. In December a large number of birds appeared to be counted twice, with 317 to the north on 1st and 221 to the south on 16th. Therefore, an adjustment was made to the raw data which treated the 221 birds on 16th as a double-count; this brings the December figure into line with the other months.

As for eider and cormorant, shag numbers depended on the locations of large flocks on the count days. Some of these flocks appeared to move beyond the pSPA boundary at times (e.g. a steady stream of birds flying northwest through sector 5 in November), which meant that they could be missed completely, and this is thought to explain the low counts in January and March (Figure A4.7). However, there was no indication of any double counting of large flocks within the survey area in the other three months and no major adjustments were made to European shag counts.

2.2 Count confidence

Various factors that could affect the accuracy of an overall count, and actions taken to minimise their effects, are summarised in Table 3. The main factor which cannot be managed in the field is bird movements within and between sectors between count days. Some movements may be tide related, and so could affect counts even if a sector was completed on consecutive days. Nevertheless, the timing of counts across a sector is recognised as one of the key factors affecting count confidence.

Given potential for count quality to be variable, the confidence in the species counts in each sector and count round was qualitatively scored as High, Medium or Low on the basis of objectively measured factors. These qualitative scores are not intended to imply any particular numerical measure of accuracy, but identify those circumstances under which there is the highest and lowest confidence in the figures.

Table 3. Factors potentially affecting count accuracy and actions taken to reduce their impact

Factor	Tendency to:	Action to reduce error	Outcome in this survey
Birds distant or difficult to see	Undercount	Select calm weather	Reduced or minimised in many sectors on each round
Birds actively diving	Undercount	Spend longer at VPs	Compromise reached; certain VPs covering wider or busier areas required
Birds swim/fly between sectors during count round	Under/overcount	Be quicker at VPs	lengthy watches, but most were relatively short
Birds move between sectors between count rounds	Under/overcount	Minimise days between counts within each round	Variable success since largely weather dependent
Double-counting within sectors on same day with same observer	Overcount	Keep a note of birds visible from more than one VP and include only once	Minimised
Double-counting within sectors on same day by different observers	Overcount	Liaise during and after counts	Minimised
Sector counted across two or more days	Under/overcount	Do main count on one day if possible and add only close-in birds on next; otherwise simply add birds from different areas together	A main count sometimes possible (e.g. at sector 15). In some large sectors e.g. 21 and 22, a central tidal race meant that birds on the northern and southern sides may have been effectively separated

2.2.1 Fixed factors affecting count confidence

Distance from the observer is often key to being able to detect birds, and forms the basis of a sector-specific coverage score, which is defined by the distance between VPs and the furthest parts of each sector. Four categories were used as shown in Table 4. The extent of potential under-estimation of numbers of birds present across an entire sector is highest for those with lower scores. Within sectors scoring 1 or 2, some areas more than 2 km from shore would, in effect, not have been counted, but it is important to note that this does not imply lower confidence in counts within those parts of the sector closer to the shore.

Table 4. Sector coverage scores from VPs

Score	Description	Applicable sectors
4	More or less all within 1 km from VPs	9, 12, 14, 17, 18
3	More or less all within 1.5 km from VPs	2, 4, 10, 13, 19, 20
2	More or less all within 2 km from VPs	1, 3, 5, 8, 11, 21, 22, 23
1	Greater than c. 1 km ² lies beyond 2 km from VPs	6, 7, 15, 16, 24

Some species are more obvious than others due to their size or behaviour (e.g. diving frequency or tendency to flock together). Four categories were devised for the most frequently recorded species, as shown in Table 5.

Table 5. Species detectability scores

Score	Description	Applicable species
4	Very obvious; or Obvious, often in flocks; or Obvious and usually close in	Great northern diver (ND); Eider (E.); Red-breasted merganser (RM)
3	Obvious but often very mobile; or Often distant; or Easy to misidentify on the water	Shag (SA); Velvet scoter (VS), red-throated diver (RH); Cormorant (CA)
2	Less obvious, usually close in	Goldeneye (GN), Slavonian grebe (SZ)
1	Less obvious, often distant	Long-tailed duck (LN)

For each sector and species the scores above were multiplied together and qualitative descriptors (Low, Medium or High) were then applied to these combined scores as illustrated by the matrix in Table 6.

These scores mean that for any sector with a substantial part of its area at more than 2 km from any VP, a low confidence score is generated for all species other than the most obvious ones. This is somewhat precautionary, as less obvious species usually found close in to shore (goldeneye and Slavonian grebe) will not be affected as much as those more commonly found at a distance. For the least detectable species, long-tailed duck, a low confidence score is generated in all sectors apart from those wholly within 1 km from VPs. High confidence is implied for the more obvious species out to 1.5 km from the VPs.

Table 6. Fixed factors score matrix

	Species score	1	2	3	4
Sector score	1	1 (low)	2 (low)	3 (low)	4 (medium)
2	2 (low)	4 (medium)	6 (medium)	8 (medium)	
3	3 (low)	6 (medium)	9 (high)	12 (high)	
4	4 (medium)	8 (medium)	12 (high)	16 (high)	

2.2.2 Variable factors affecting count confidence

The major variable affecting count confidence relates to the sea, weather and light conditions. The most important of these is taken to be sea state and for this exercise the 'net sea state' takes into account the subsidiary influences of weather and light. Thus sea state was initially scored as shown in Table 7, but corrected by moving the score down a level if other deleterious factors, as listed below, applied to a particular count:

- there was a significant swell
- there was more than light rain
- the visibility was recorded as 'poor' i.e. very dull or hazy or shimmering
- moderate or strong glare affected a large part of the viewing area

Table 7. Sea state scores

Score	Description
4	Sea state 0 - 1
3	Sea state 2
2	Sea state 3
1	Sea state 4

The overall sea state score for a sector was that recorded from the majority of VPs that covered it.

The time period taken to cover a sector also affects confidence in the count due to the mobility of birds, both within it and between it and other sectors. Scores for this factor were assigned as shown in Table 8.

Table 8. Timing scores per sector

Score	Description
4	All VPs counted in one day
3	All VPs counted within two days (or a single VP counted up to five days later, for close-in species only)
2	All VPs counted within three - five days
1	Six days or more to count all VPs

Counts that were not used in deriving the sector totals (i.e. because a good or better figure was available from other VPs) were excluded from this scoring exercise.

As for the fixed factor scoring described in section 2.2.2, the variable sea state and timing scores described in tables 5 and 6 were combined, by multiplication and qualitative descriptors (Low, Medium or High) were applied to these combined scores as illustrated by the matrix in Table 9.

The allocation of scores among categories reflects the likely effect that the various scenarios would have on the count. Thus, in recognition of the extent to which birds may move around, a count carried out over more than five days (timing score 1) will always generate a low confidence score, even if sea conditions are perfect. Conversely, a net sea state of 4 across a sector (conditions score of 1) generates low confidence irrespective of intervals between counts.

Table 9. Variable score matrix

	Sea state score 1	2	3	4
Timing score				
1	1 (low)	2 (low)	3 (low)	4 (low)
2	2 (low)	4 (low)	6 (medium)	8 (medium)
3	3 (low)	6 (medium)	9 (medium)	12 (high)
4	4 (low)	8 (medium)	12 (high)	16 (high)

2.2.3 Combination of Fixed and Variable scores

The overall score for each sector/species combination in each count round was derived using the same matrix format as above but combining the fixed scores (sector and species characteristics) and variable scores (timing and net sea state) as shown in Table 10.

This approach meant that: a low fixed or variable score would generate an overall low or medium count score; a medium fixed or variable score would generate an overall low, medium or high final score; and, a high fixed or variable score would generate an overall medium or high final score.

Table 10. Overall matrix for fixed and variable scores

	Fixed	Low	Medium	High
Variable				
Low		Low	Low	Medium
Medium		Low	Medium	High
High		Medium	High	High

Annex 3 shows the derivation of count confidence scores for each sector, species and count round.

3. RESULTS

3.1 Introduction

The original data, including details of adjustments made to field data to correct for possible duplicate counts (see section 2.1.6), are tabulated in a spreadsheet attached at Annex 2. Tables A4.1 to A4.5 in Annex 4 to this report summarise the corrected counts in each of the five count rounds by species and sector together with the confidence score categories (see section 2.2), derived as detailed in Annex 3.

As the counts were shore-based, it is not feasible to correct for the reduced detectability of birds at greater distances from the vantage points because distance from shore strongly influences bird densities for most species. Hence, the adjusted counts should be treated as minimum estimates of the numbers of birds present in each sector in each count round. The confidence scoring provides a qualitative indication of the potential degree of discrepancy between observed and actual numbers of birds present.

3.2 Target species numbers

All target species were recorded in numbers substantially greater than reported in Lawson *et al* (2015) for the original North Orkney Area of Search². Table 11 gives the total count for each target species for each count round, with the monthly means and peaks shown alongside the figures from Lawson *et al.* (2015) for comparison.

Table 11. Target species: total counts per count round, with 2017/18 mean and peak and comparison to previous highest systematic counts (Lawson et al., 2015)

Count round	Great northern diver	Slavonian grebe	Common eider	Long-tailed duck	Velvet scoter	Red-breasted merganser	European shag
1	441	200	2343	1274	131	546	2582
2	528	209	2102	1551	228	680	2968
3	777	241	2637	1696	244	713	1758
4	616	303	3343	2115	187	664	2652
5	742	298	3806	2651	225	717	2020
<i>Mean</i>	621	250	2846	1857	203	664	2396
Peak	777	303	3806	2651	244	717	2968
Previous peak count	415 ^a	131 ^b	1890 ^a	1018 ^a	165 ^b	409 ^c	1856 ^b
Previous mean of peaks	317	120	1471	952	147	279	1742

a: aerial survey in February 2007; b: shore-based count in 2007/08; c: shore-based count in 2008/09

3.2.1 Great northern diver

The numbers of great northern diver recorded in all five monthly counts during the 2017/18 survey of North Orkney pSPA (Table 11) substantially exceeded the UK SPA site selection guidelines stage 1.1 numerical threshold (50 birds) for inclusion of this Annex 1 species within the North Orkney pSPA. The current estimate for the GB wintering population of great northern diver (2,500 birds; Musgrove *et al.*, 2013) is awaiting systematic review in light of recent evidence that the GB wintering population exceeds 4,000 birds (e.g. Austin *et al.*,

² The mean of peak figures in Lawson *et al* (2015) for great northern diver, common eider, long-tailed duck and red-breasted merganser are higher than the estimated numbers within the final boundary of the North Orkney pSPA; see Site Selection Document (SNH, 2016) for details.

3.2.2 Slavonian grebe

The numbers of Slavonian grebe recorded in all five monthly counts during the 2017/18 survey of North Orkney pSPA (Table 11) substantially exceeded the UK SPA site selection guidelines stage 1.1 numerical threshold (1% GB, 11 individuals) for inclusion of this Annex 1 species within the North Orkney pSPA. The peak count of 303 individuals is equivalent to 27.5% of the GB wintering population (Musgrove *et al.*, 2013). Slavonian grebes are relatively difficult to detect and count, particularly in higher sea states, but are largely confined to close inshore waters. The overall confidence scores (section 3.4) indicate that the 2017/18 counts are likely to somewhat underestimate actual numbers within the site.

Numbers of Slavonian grebe within the site increased from November through to January and remained steady in February and March (Figure A5.2). The distribution of Slavonian grebe is illustrated in Figure 3. Slavonian grebes are largely confined to shallow nearshore waters, with the most notable concentrations in Bay of Firth, Wide Firth, Inganess Bay and Deerness Sound off Orkney Mainland and in Veantrow Bay (Shapinsay). Other notable areas were Eynhallow and Rousay Sounds.

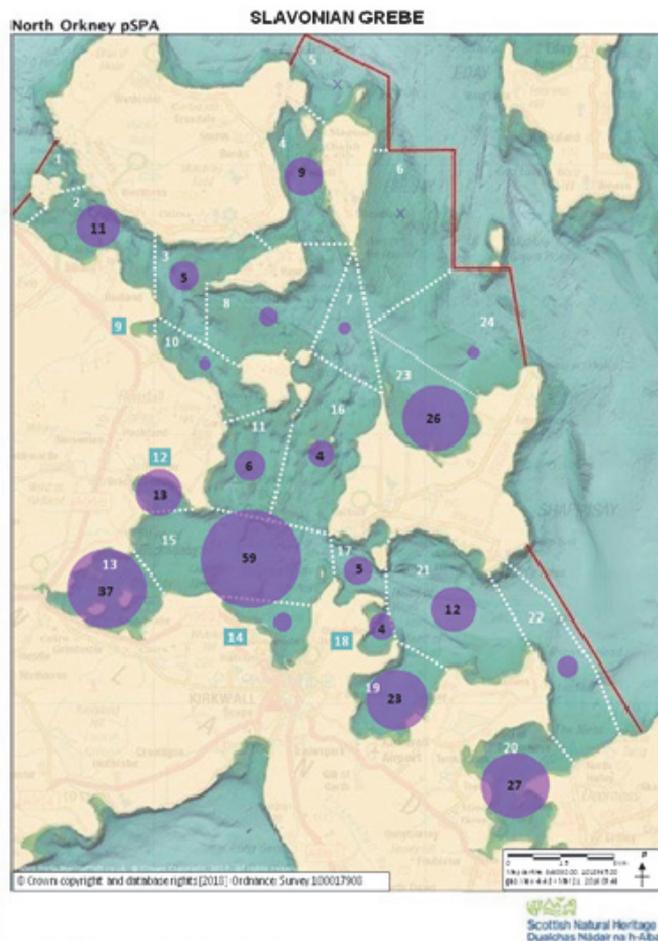


Figure 3. Slavonian grebe distribution 2017/18.

Sector numbers in white; area of circles in proportion to sector mean count; number not shown where less than 4; 'X' in sectors where mean is less than 1; seaward boundary of pSPA shown in red). © Crown Copyright, 2013. All rights reserved. License No. EK001-20131000. Not to be used for Navigation.

3.2.3 Common eider

The numbers of common eider recorded in all five monthly counts during the 2017/18 survey of North Orkney pSPA (Table 11) substantially exceeded the UK SPA site selection guidelines stage 1.4 numerical threshold (1% GB, 600 individuals) for inclusion of this migratory species within the North Orkney pSPA. The peak count of 3,806 individuals is equivalent to 6.3% of the GB wintering population (Musgrove *et al*, 2013). Common eiders are relatively easily to detect and count, as reflected in the generally high count confidence scores for this species (section 3.4). However, numbers in the north-eastern part of the site (outer parts of count sectors 6 and 24), previously surveyed from the air, may have been underestimated given distance to the coastal VPs (Table A3.1).

Numbers of common eider within the site increased steadily through the winter, following an initial dip between November and December (Figure A5.3). The distribution of common eider is illustrated in Figure 4. Common eiders were widely distributed throughout the site with the largest numbers recorded through the central part of the site extending from Wide Firth to Rousay Sound as well as in Deerness Sound in the southeast. Flocks of between 100 and 500 common eiders were noted on at least five occasions in association with salmon farms, often with smaller numbers of long-tailed ducks. Similar observations have been reported within the Scapa Flow pSPA (Jackson, 2018), but it was not within the scope of either survey to analyse the spatial distribution of marine birds in relation to salmon farms.

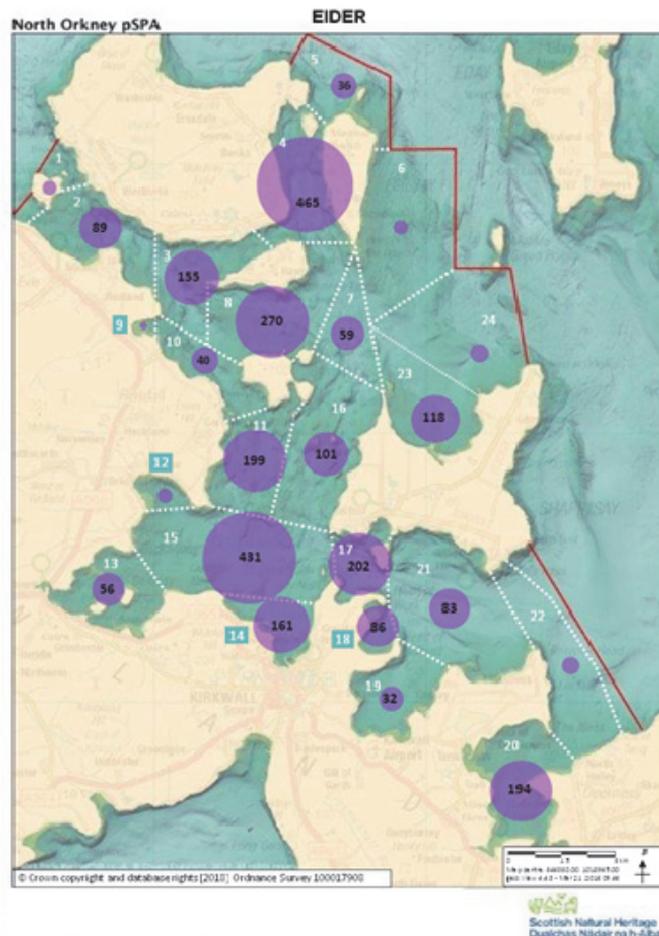


Figure 4. Common eider distribution 2017/18.

Sector numbers in white; area of circles in proportion to sector mean count; number not shown where less than 20; seaward boundary of pSPA shown in red). © Crown Copyright, 2013. All rights reserved. License No. EK001-20131000. Not to be used for Navigation.

3.2.4 Long-tailed duck

The numbers of long-tailed duck recorded in all five monthly counts during the 2017/18 survey of North Orkney pSPA (Table 11) substantially exceeded the UK SPA site selection guidelines stage 1.4 numerical threshold (1% GB, 110 individuals) for inclusion of this migratory species within the North Orkney pSPA. The peak count of 2,651 individuals is equivalent to 24.1% of the GB wintering population (Musgrove *et al.*, 2013). Long-tailed ducks are relatively easy to detect when in flocks but individual birds can be difficult to detect over long distances or in rougher seas and they are also relatively mobile. This is reflected in the relatively high proportion of low confidence scores for this species (section 3.4; Table A3.1) and the counts may substantially underestimate the numbers of long-tailed ducks present within the North Orkney pSPA in 207/18.

Numbers of long-tailed duck increased throughout the winter (Figure A5.4). The March peak possibly indicates the arrival of additional birds from other wintering areas prior to migration back to their northern breeding grounds. The distribution of long-tailed duck is illustrated in Figure 5. Long-tailed ducks were most abundant in the central and western parts of the site including in Wide Firth and in Eynhallow, Wyre and Gairsay Sounds. Flocks of up to 53 were noted on at least five occasions in association with salmon farms, such as in Veantrow Bay, Shapinsay, often with larger numbers of common eider. Similar observations have been reported within the Scapa Flow pSPA (Jackson, 2018) but it was not within the scope of either survey to analyse the spatial distribution of marine birds in relation to salmon farms.

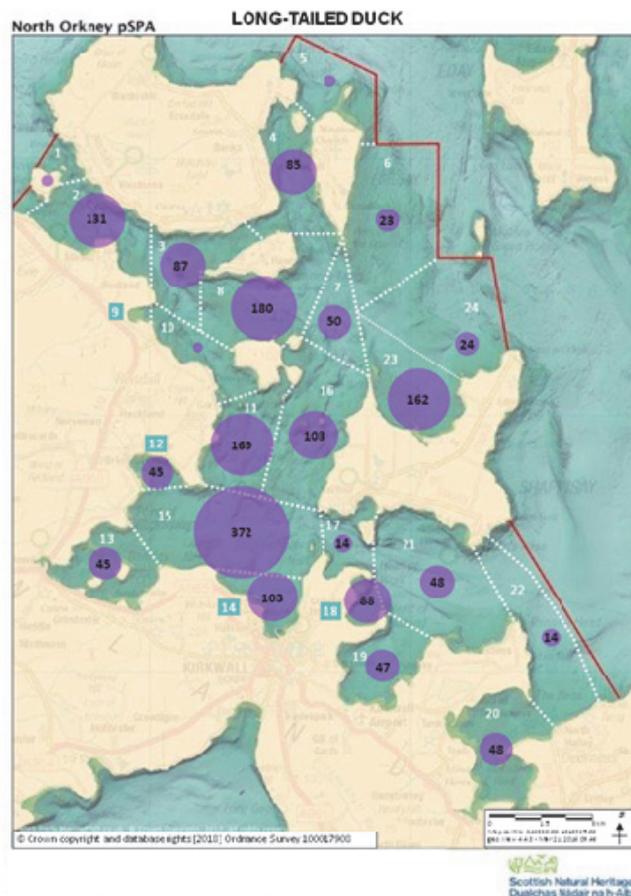


Figure 5. Long-tailed duck distribution 2017/18.

Sector numbers in white; area of circles in proportion to sector mean count; number not shown where less than 10; seaward boundary of pSPA shown in red) © Crown Copyright, 2013. All rights reserved. License No. EK001-20131000. Not to be used for Navigation.

3.2.5 Velvet scoter

The numbers of velvet scoter recorded in all five monthly counts during the 2017/18 survey of North Orkney pSPA (Table 11) substantially exceeded the UK SPA site selection guidelines stage 1.4 numerical threshold (50 individuals) for inclusion of this migratory species within the North Orkney pSPA. The peak count of 244 individuals is equivalent to 9.8% of the GB wintering population (Musgrove *et al.*, 2013). Velvet scoter are relatively obvious and often form substantial flocks, but can be difficult to separate from common scoter and may occur at some distance from shore. The overall confidence scores (section 3.4) indicate that the 2017/18 counts may somewhat underestimate actual numbers within the site.

Numbers of velvet scoter within the site increased after November and thereafter fluctuated around 200 birds throughout the winter (Figure A5.5). The distribution of velvet scoter is illustrated in Figure 6. Velvet scoters were largely confined to outer parts of larger bays off Mainland, with highest numbers in Wide Firth, Shapinsay Sound, Inganess Bay and entrance to Deer Sound.

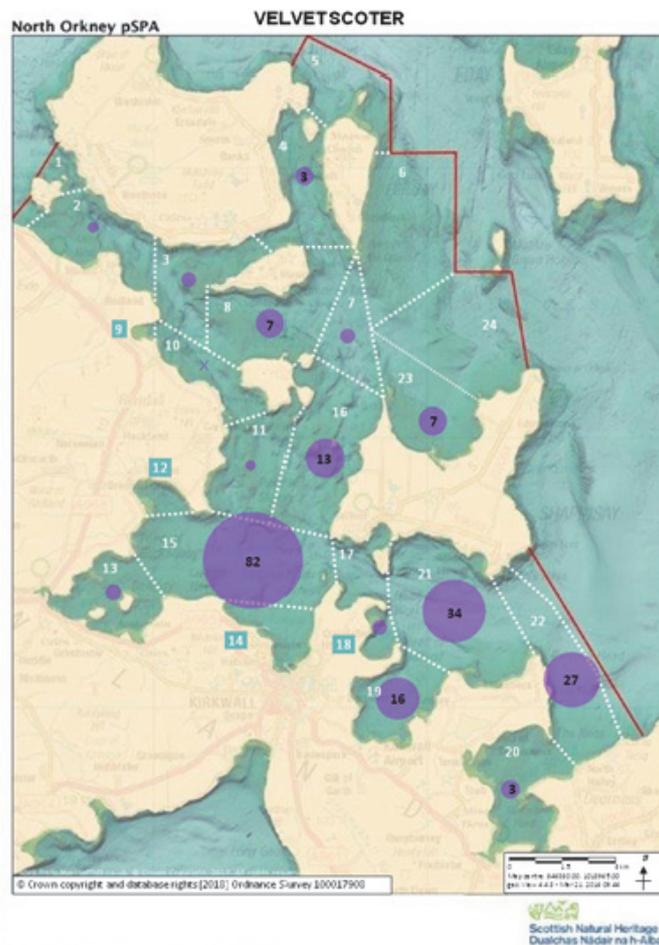


Figure 6. Velvet scoter distribution 2017/18.

Sector numbers in white; area of circles in proportion to sector mean count; number not shown where less than 3; 'X' in sectors where mean is less than 1; seaward boundary of pSPA shown in red) © Crown Copyright, 2013. All rights reserved. License No. EK001-20131000. Not to be used for Navigation.

3.2.6 Red-breasted merganser

The numbers of red-breasted merganser recorded in all five monthly counts during the 2017/18 survey of North Orkney pSPA (Table 11) substantially exceeded the UK SPA site selection guidelines stage 1.4 numerical threshold (84 individuals) for inclusion of this migratory species within the North Orkney pSPA. The peak count of 717 individuals is equivalent to 8.5% of the GB wintering population (Musgrove *et al.*, 2013).

Numbers of red-breasted merganser were relatively constant throughout the winter (Figure A5.6) as might be anticipated for this partially migratory species.

Red-breasted mergansers are confined to near-shore waters and easy to detect, as reflected in the generally high count confidence scores for this species (section 3.4) and also in the species' distribution Figure 7. The largest concentrations were found in shallow sheltered bays including Bays of Firth and Isbister and inner Wide Firth, Deer Sound and Veantrow bay, Shapinsay. Notable numbers were also present in the fringes of the sounds around Rousay.

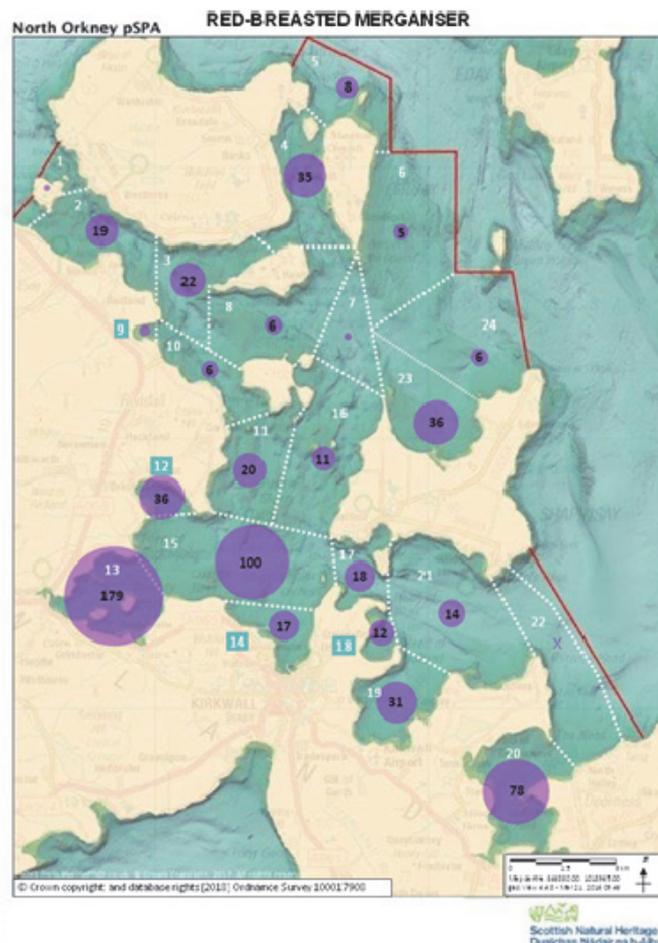


Figure 7. Red-breasted merganser distribution 2017/18.

Sector numbers in white; area of circles in proportion to sector mean count; number not shown where less than 5; 'X' in sectors where mean is less than 1; seaward boundary of pSPA shown in red) © Crown Copyright, 2013. All rights reserved. License No. EK001-20131000. Not to be used for Navigation.

3.2.7 European shag

The numbers of European shag recorded in all five monthly counts during the 2017/18 survey of North Orkney pSPA (Table 11) substantially exceeded the UK SPA site selection guidelines stage 1.4 numerical threshold (1% GB, 1,100 individuals) for inclusion of this migratory species within the North Orkney pSPA. Four of the five counts also exceeded the stage 1.2 numerical threshold (1% biogeographic, 2,000 individuals). The peak count of 2,968 individuals is equivalent to 2.7% of the GB wintering population and to 1.5% of the biogeographic population (Musgrove *et al.*, 2013; Wetlands International 2015). European shag is an inshore species, but can be missed given dark plumage and diving habits. The overall confidence scores (section 3.4) indicate that the 2017/18 counts are likely to somewhat underestimate actual numbers within the site.

European shags move relatively short distances from their breeding sites to their wintering grounds, especially where they inhabit relatively sheltered coastlines (Wernham *et al.*, 2002) and many of the birds wintering in the North Orkney pSPA will most likely be from the local breeding population. Numbers fluctuated during the winter (Figure A5.7) possibly reflecting movements of some large flocks back and forth across the site boundary. The decline in March may also reflect birds moving to their breeding colonies. European shags were found throughout the site with the largest concentrations in the sounds around Rousay (Figure 8).

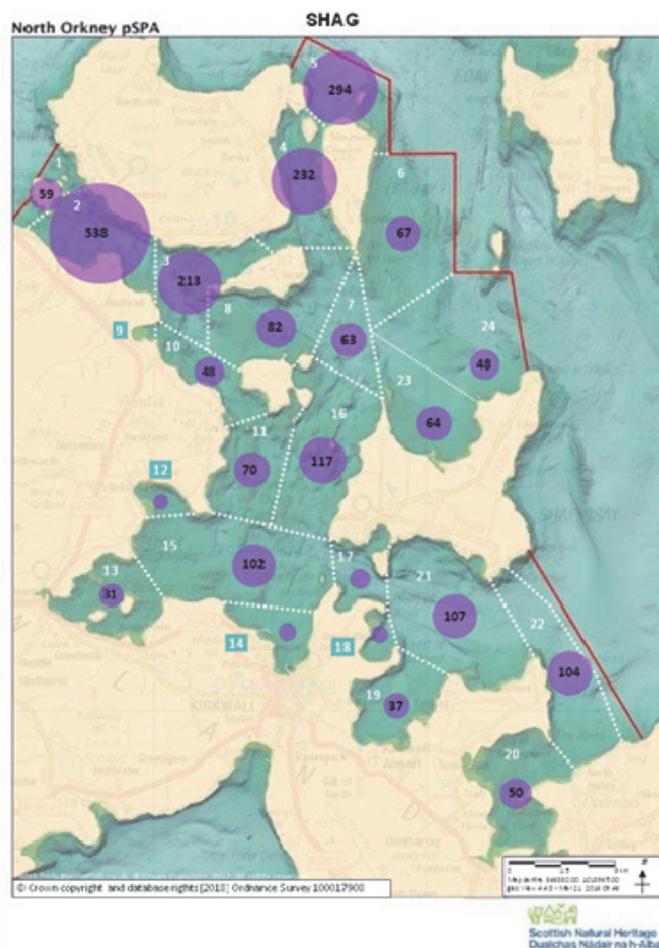


Figure 8. European shag distribution 2017/18.

Sector numbers in white; area of circles in proportion to sector mean count; number not shown where less than 25; seaward boundary of pSPA shown in red) © Crown Copyright, 2013. All rights reserved. License No. EK001-20131000. Not to be used for Navigation.

3.3 Non-target species

Several additional species were recorded as summarised in Table 12. The numbers of great cormorant exceeded 1% of the UK wintering population (350 individuals) in every month, with the peak count of 660 birds equivalent to 1.9% of GB population (Musgrove *et al.*, 2013). In addition to the non-target species listed in Table 12 there were records of just one or two individuals of goosander, little grebe, great-crested grebe and red-necked grebe in one or more counts.

Table 12. Non-target species: total counts per count round, with mean and peak and comparison to previous highest systematic counts and means of peak counts (Lawson *et al.*, 2015)

Count round	Common scoter	Surf scoter	Golden-eye	Red-throated diver	Black-throated diver	Cormorant
1	3	2	28	84	2	551
2	5	2	34	50	0	660
3	8	2	59	69	8	518
4	11	4	63	54	0	604
5	13	2	80	32	2	660
<i>Mean</i>	8	2	53	58	2	599
Peak	13	4	80	84	8	660
Previous peak count	133 ^{a3}	-	51 ^b	119 ^b	6 ^c	239 ^c
Previous mean peak	60	-	42	65	4	144

a: aerial survey in February 2007; b: shore-based count in 2007/08; c: shore-based count in 2008/09.

3.4 Count confidence scoring

Using the approach detailed in section 2.2 and summarised in Table 9, the final scoring for each count round is shown in the tables in Annex 3. The overall confidence scores are also indicated by the shading in the monthly count summary tables in Annex 4.

Across all five count rounds, 82% of counts by species and sector were classed as of high or moderate quality. Gaps between count days within sectors were shortest in December but count conditions were generally poorer, leading to more 'Medium' variable scores than any other month and making it fairly average overall. February was the poorest month with respect to timing of the counts, due to the lack of availability of one of the surveyors during the first good spell of weather and so had the highest number of 'Low' variable scores. However, the very good conditions meant that February also had the joint highest number of 'High' variable scores, with no 'Medium' variable scores and was fairly average overall. March was the best count month overall, with good timings and mostly good conditions on count days.

Eight sectors had essentially high confidence scores on every count (i.e. 'High' for three or four of the species categories). These were typically the smaller and/or more sheltered

³ Identifying scoter to species level from the air is challenging (Dawson *et al.*, 2008) and this was the only aerial survey in North Orkney in which either common or velvet scoter were recorded. The figure is considerably higher than shore-based counts of common scoter (maximum 12 in 2007/08 and 34 in 2008/09) but similar to those for velvet scoter (maximum 165 in 2007/08 and 129 in 2008/09). The 2017/18 counts also found velvet scoter to be substantially more abundant than common scoter in this area. Taken together, the shore-based counts suggest that there could have been an error in species assignment in the February 2007 aerial survey.

sectors (numbers 9, 12, 14, 17, 18 and 19) as well as larger ones where the counts enjoyed very good conditions each time (e.g. 23). A further four sectors (numbers 3, 8, 13 and 20) had high confidence scores on all but one of the counts. Two sectors (numbers 7 and 15) were of low confidence for at least two of the species categories on four out of the five counts, primarily due to their distance from VPs but also due to timing issues they never achieved more than medium confidence for most species. The remaining ten sectors had rather variable confidence scores between count rounds, being susceptible to timing issues on some counts and/or more exposed to poorer weather conditions at times.

Overall count confidence, defined by percentage of sectors across all rounds within which count confidence was high or moderate, was greatest for great northern diver, common eider and red-breasted merganser (all 89%) and lowest for long-tailed duck (62%) with the remaining three target species (velvet scoter, European shag and Slavonian grebe) intermediate (79 to 83%). However for velvet scoter, which forms dense flocks offshore, only around half the birds counted were within sectors for which count quality was judged to be high or moderate.

4. DISCUSSION

4.1 Overall numbers

All seven of the North Orkney pSPA non-breeding qualifying species were recorded in considerably higher numbers than in the previous counts (Table 11), confirming regular use by qualifying numbers of these birds.

The apparent increases in part reflect survey coverage in 2017/18, with five systematic counts achieved across the vast majority of the site (Figure 1). The estimates in Lawson *et al.* (2015) were derived from two visual aerial line transect surveys carried out in February 2007 and March 2008, together with several shore-based counts of the original sectors (Table 1) south of Gairsay across 2007/08 and 2008/09 and the six original sectors north of Gairsay in 2007/2008. The aerial surveys did not include waters between Eynhallow and Wyre (Sector 2 and adjacent parts of Sectors 3 and 10). Visual aerial surveys are generally less suited to detection of birds very close to shore than shore-based counts and the length of shoreline within the pSPA would have exaggerated this effect. Aerial counts were also done with just one pass, so that any birds which happened to be underwater at the time would also have been missed. However, the aerial survey data for great northern diver, eider and long-tailed duck presented in Lawson *et al.* (2015) were statistically corrected for decreasing detectability with distance from observer using Distance analysis (Buckland *et al.*, 2001).

Considering shore-based counts only, the figures in Table A1.6 in Lawson *et al.* (2015) do not include the six original sectors north of Gairsay (Table 1) which were counted only once in 2007/08 (in January 2008; E J Williams, *pers. comm.*). For comparability, and calculation of robust mean of peaks, only the data from the southern part of the area (original south sectors 1-13, Table 1), which were counted in both 2007/08 and 2008/09, were included in the totals shown for shore-based counts in Lawson *et al.* (2015).

Table 13 shows the numbers of birds recorded in the January 2008 shore-based count of the six original sectors north of Gairsay together with the peak shore-based counts for the same winter season (2007/08) in the southern sectors. These figures indicate that exclusion of the northern section of the site from the original shore based surveys would explain some of the apparent increase in numbers from 2007/08 and 2008/09 to 2017/18 (Table 11). In particular, numbers of common eider and long-tailed duck seen in the northern sectors in January 2008 were equivalent to 67% of the 2007/08 peak count recorded in the southern sectors. For great northern diver and European shag the proportions were 38% and 34%.

The new shore-based count sectors (numbers 1, 5, 6, 23 and 24; Figure 1) established in 2017/18 also increased coverage over that achieved in shore-based counts in 2007/08. The largest effect was for European shag, with 22% of the peak number of birds recorded in 2017/18 falling within these sectors. For common eider and long-tailed duck the equivalent figures were 13% and 11.5% while for the remaining four species 6% or fewer of the birds contributing to the peak 2017/18 counts were recorded from these new sectors.

Table 13. Comparison of peak shore-based counts in 2007/08 and 2017/18. The 2007/08 total is made up of the published JNCC figures (Lawson et al., 2015) plus those from the sounds around Wyre in January 2008 (data provided by E.J. Williams).

Count	Great northern diver	Slavonian grebe	Common eider	Long-tailed duck	Velvet scoter	Red-breasted merganser	European shag
JNCC shore-based 07-08 peak (southern sectors)	250	131	1156	897	165	278	1856
Jan 08 count (northern sectors)	96	6	774	604	14	71	624
Total 07-08	346	137	1930	1501	179	349	2480
Peak 17-18	777	303	3806	2651	244	717	2968
Peak 17-18 excl. new sectors	674	284	3679	2344	236	683	2328
Apparent increase from 07-08 total to 2017/18 peak excl. new sectors	328	147	1749	843	57	334	(-152)
Equivalent % change	+95%	+107%	+90%	+56%	+32%	+96%	-6%

However, as shown in Table 13, after adding in the Wyre counts in 2007/08 and deducting the new sectors in 2017/18, comparison of shore-based counts between 2007/08 and 2017/18 suggest substantial increases in numbers of great northern diver, Slavonian grebe, common eider and red-breasted merganser with lesser increases for long-tailed duck and velvet scoter. There is little apparent change in European shag numbers.

4.2 Species distributions across the pSPA

The distribution maps from the 2017/18 survey (Figures 2 to 8, section 3.2) have been compared to those in the SPA site selection document (SNH, 2016).

For great northern diver, the concentrations in the wider stretches of water in Wide Firth and Shapinsay Sound are consistent between the 2017/18 shore-based and earlier aerial surveys. However, with the exception of a count of 128 birds in sector 7 in January 2018, the notable concentrations found during the earlier aerial surveys to the south and east of Wyre and Egilsay were not apparent in 2017/18. This may arise in part from the different survey methods, but also suggests that different areas of the site may be of greater or lesser importance to great northern divers at different times both within and between winter seasons.

Slavonian grebes were observed in the sheltered bays along the Mainland shore in both 2017/18 and previous shore-based counts. The 2017/18 counts additionally indicated good numbers in Veantrow Bay, on the north side of Shapinsay; this area was not covered in the earlier shore-based counts.

The distribution of common eider in 2017/18 is also similar to that derived from the previous aerial surveys, although in 2017/18 the largest numbers were found a little to the north and south of the main area identified previously. The 2017/18 sector means also clearly indicate

the discrete flocks that occur beside fish farm sites. There is a similar picture for long-tailed duck, with a widespread distribution across the pSPA and higher densities towards the central sectors apparent from both the 2017/18 survey and previous aerial surveys. A concentration seen previously immediately northeast of Rousay was not apparent in 2017/18. Eynhallow Sound, which was not covered by the previous aerial survey, held notable numbers of long-tailed duck; this area is well-known to birdwatchers in Orkney for this species.

The largest numbers of velvet scoter in both the 2017/18 and previous shore-based surveys were found in Wide Firth and either side of Rerwick Head, St Andrews where notable flocks form. Large numbers of red-breasted mergansers have consistently been observed in the more sheltered bays of the Mainland shore, with the 2017/18 survey highlighting the importance of the Bay of Firth, as well as in Eynhallow Sound and Rousay Sound. Veantrow Bay, Shapinsay, which was not covered in the earlier shore-based survey, also held large numbers of red-breasted merganser in 2017/18.

European shags were found to be widely distributed by all shore-based surveys, but in 2017/18 were distinctly concentrated into the northwest parts of the site, around Rousay, whereas the previous surveys found large numbers across the site from Eynhallow Sound to the outer part of Deer Sound.

4.3 Passage birds

The pSPA is proposed specifically for wintering waterfowl. However, there is considerable anecdotal evidence, along with informal counts at individual locations, to suggest that the numbers of certain species can be higher in spring (April-May) than during the winter. Recent Orkney Bird Reports give some figures, with notably high counts recorded in the springs of 2010, 2011 and 2015 (Williams, 2011 and 2012; Branscombe, 2016).

In particular there can be large pre-migration gatherings of long-tailed ducks and flocks of 1,000 or more birds have been recorded. Rousay Sound held 1,000 on 5th May 2010; Lairò Water, Shapinsay held 1,030 on 25th April 2011 (with 450 at Head of Holland, St Ola on the same day) and there was a record count of 2,000 off Shapinsay on 17th April 2015.

Great northern divers also appear to congregate at this time of year, with 261 in Deer Sound on 14th April 2010 and 173 in that general area on 23rd April 2011. Within the winter period, 349 were counted from Rerwick Head, Tankerness on 10th March 2015; and 200 were still present there in spring (17th April).

Eider flocks may also be larger in the spring than winter and for this species high numbers associated with moulting males are also recorded in the summer; at least some of these birds may be from the local breeding population.

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ANNEX 1: BLANK FIELD SHEET FOR VP RECORDING

Start Miles						Day start	Day end	Hours	
End miles		miles claimed							
Date	Sector	VP ref		Start time	End time				Surveyor
Sea State	Precipitation	Wind Strength	Wind Direction	Cloud cover	Visibility	Glare	Kirkwall high tide	Tide state at VP	Count Quality
Species:		Totals							
Eider									
Long tailed Duck									
Velvet Scoter									
Red breasted Merganser									
Great northern Diver									
Shag on sea									
Shag roosting on shore									
Slavonian Grebe									
Other species:									
Date	Sector	VP ref		Start time	End time				Surveyor
Sea State	Precipitation	Wind Strength	Wind Direction	Cloud cover	Visibility	Glare	Kirkwall high tide	Tide state at VP	Count Quality
Species		Totals							
Eider									
Long tailed Duck									
Velvet Scoter									
Red breasted Merganser									
Great northern Diver									
Shag on sea									
Shag roosting on shore									
Slavonian Grebe									
Other species:									

ANNEX 2: ORIGINAL DATA

This Annex can be downloaded as a separate spreadsheet.

The worksheets within this spreadsheet are as follows:

Coverage by date: shows the distribution of count dates for each sector in each of the five count rounds.

Raw Count: shows the raw count data, as recorded in the field, for each count round, sector and VP. Cells highlighted yellow indicate figures subsequently adjusted to remove possible duplicate counts (see sections 2.1.4 and 2.1.5), with details of the adjustments given in the “Comment” column. This worksheet also includes VP grid references and all the contextual information recorded at each VP on each count date.

Count Master: shows the adjusted count data for each count round, sector and VP together with the contextual information recorded at each VP on each count date. These corrections include those described in section 2.1.6 to address single instances of apparent movements of large numbers of common eider and cormorant.

Count 1, Count 2, Count 3, Count 4 and Count 5: show the adjusted totals for each species and sector in each of the five count rounds together with a summary of relevant contextual information.

Spp count detail: summarises the counts for each species by sector and count round and includes site totals.

ANNEX 3: COUNT CONFIDENCE SCORES

Species codes in these tables are as follows:

ND: great northern diver; RM: red-breasted merganser; E: common eider; SA: European shag; VS: velvet scoter; RH: red-throated diver; CA: great cormorant; GN: goldeneye; SZ: Slavonian grebe; LN: long-tailed duck

Table A3.1. Fixed scores by sector and species-category

Sector	Coverage from VPs	Species detectability				Coverage x Detectability Scores ⁴			
		ND, RM, E.	SA, VS, RH, CA	GN, SZ	LN	ND, RM, E.	SA, VS, RH, CA	GN, SZ	LN
1	2	4	3	2	1	8	6	4	2
2	3	4	3	2	1	12	9	6	3
3	2	4	3	2	1	8	6	4	2
4	3	4	3	2	1	12	9	6	3
5	2	4	3	2	1	8	6	4	2
6	1	4	3	2	1	4	3	2	1
7	1	4	3	2	1	4	3	2	1
8	2	4	3	2	1	8	6	4	2
9	4	4	3	2	1	16	12	8	4
10	3	4	3	2	1	12	9	6	3
11	2	4	3	2	1	8	6	4	2
12	4	4	3	2	1	16	12	8	4
13	3	4	3	2	1	12	9	6	3
14	4	4	3	2	1	16	12	8	4
15	1	4	3	2	1	4	3	2	1
16	1	4	3	2	1	4	3	2	1
17	4	4	3	2	1	16	12	8	4
18	4	4	3	2	1	16	12	8	4
19	3	4	3	2	1	12	9	6	3
20	3	4	3	2	1	12	9	6	3
21	2	4	3	2	1	8	6	4	2
22	2	4	3	2	1	8	6	4	2
23	2	4	3	2	1	8	6	4	2
24	1	4	3	2	1	4	3	2	1

⁴ Shading indicates score category: dark grey High (H); light grey Medium (M); unshaded Low (L)

Table A3.2. Count round one confidence scores.

Overall matrix for fixed and variable scores (L = low; M = medium; H = high).

Sector	Fixed Coverage x Detectability scores (Table A3.1)				Timing (T) x Conditions (C) scores			Overall count confidence scores			
	ND, RM, E.	SA, VS, RH, CA	GN, SZ	LN	T	C	Score	ND, RM, E.	SA, VS, RH, CA	GN, SZ	LN
1	M	M	M	L	4	2	M	M	M	M	L
2	H	H	M	L	4	3	H	H	H	H	M
3	M	M	M	L	4	3	H	H	H	H	M
4	H	H	M	L	4	3	H	H	H	H	M
5	M	M	M	L	4	2	M	M	M	M	L
6	M	L	L	L	4	4	H	H	M	M	M
7	M	L	L	L	2	2	L	L	L	L	L
8	M	M	M	L	4	3	H	H	H	H	M
9	H	H	M	M	4	4	H	H	H	H	H
10	H	H	M	L	3	3	M	H	H	M	L
11	M	M	M	L	3	1	L	L	L	L	L
12	H	H	M	M	4	3	H	H	H	H	H
13	H	H	M	L	4	2	M	H	H	M	L
14	H	H	M	M	4	3	H	H	H	H	H
15	M	L	L	L	3	3	M	M	L	L	L
16	M	L	L	L	4	2	M	M	L	L	L
17	H	H	M	M	3	3	M	H	H	M	M
18	H	H	M	M	3	3	M	H	H	M	M
19	H	H	M	L	4	3	H	H	H	H	M
20	H	H	M	L	4	3	H	H	H	H	M
21	M	M	M	L	1	3	L	L	L	L	L
22	M	M	M	L	1	3	L	L	L	L	L
23	M	M	M	L	4	3	H	H	H	H	M
24	M	L	L	L	4	3	H	H	M	M	M

Table A3.3. Count round two confidence scores

Overall matrix for fixed and variable scores (L = low; M = medium; H = high).

Sector	Fixed Coverage x Detectability scores (Table A3.1)				Timing (T) x Conditions (C) scores			Overall count confidence scores			
	ND, RM, E.	SA, VS, RH, CA	GN, SZ	LN	T	C	Score	ND, RM, E.	SA, VS, RH, CA	GN, SZ	LN
1	M	M	M	L	4	2	M	M	M	M	L
2	H	H	M	L	4	2	M	H	H	M	L
3	M	M	M	L	4	3	H	H	H	H	M
4	H	H	M	L	4	2	M	H	H	M	L
5	M	M	M	L	4	2	M	M	M	M	L
6	M	L	L	L	4	2	M	M	L	L	L
7	M	L	L	L	1	3	L	L	L	L	L
8	M	M	M	L	4	2	M	M	M	M	L
9	H	H	M	M	4	3	H	H	H	H	H
10	H	H	M	L	1	2	L	M	M	L	L
11	M	M	M	L	4	3	H	H	H	H	M
12	H	H	M	M	4	3	H	H	H	H	H
13	H	H	M	L	4	3	H	H	H	H	M
14	H	H	M	M	4	4	H	H	H	H	H
15	M	L	L	L	4	3	H	H	M	M	M
16	M	L	L	L	2	3	M	M	L	L	L
17	H	H	M	M	4	4	H	H	H	H	H
18	H	H	M	M	4	3	H	H	H	H	H
19	H	H	M	L	4	3	H	H	H	H	M
20	H	H	M	L	4	3	H	H	H	H	M
21	M	M	M	L	4	2	M	M	M	M	L
22	M	M	M	L	4	2	M	M	M	M	L
23	M	M	M	L	4	4	H	H	H	H	M
24	M	L	L	L	4	4	H	H	M	M	M

Table A3.4. Count round three confidence scores

Overall matrix for fixed and variable scores (L = low; M = medium; H = high).

Sector	Fixed Coverage x Detectability scores (Table A3.1)				Timing (T) x Conditions (C) scores			Overall count confidence scores			
	ND, RM, E.	SA, VS, RH, CA	GN, SZ	LN				ND, RM, E.	SA, VS, RH, CA	GN, SZ	LN
1	M	M	M	L	4	3	H	H	H	H	M
2	H	H	M	L	4	2	M	H	H	M	L
3	M	M	M	L	4	2	M	M	M	M	L
4	H	H	M	L	4	2	M	H	H	M	L
5	M	M	M	L	4	2	M	M	M	M	L
6	M	L	L	L	4	1	L	L	L	L	L
7	M	L	L	L	1	3	L	L	L	L	L
8	M	M	M	L	4	3	H	H	H	H	M
9	H	H	M	M	4	3	H	H	H	H	H
10	H	H	M	L	1	2	L	M	M	L	L
11	M	M	M	L	2	3	M	M	M	M	L
12	H	H	M	M	4	3	H	H	H	H	H
13	H	H	M	L	4	3	H	H	H	H	M
14	H	H	M	M	4	4	H	H	H	H	H
15	M	L	L	L	2	3	M	M	L	L	L
16	M	L	L	L	4	4	H	H	M	M	M
17	H	H	M	M	4	4	H	H	H	H	H
18	H	H	M	M	4	3	H	H	H	H	H
19	H	H	M	L	4	4	H	H	H	H	M
20	H	H	M	L	3	3	M	H	H	M	L
21	M	M	M	L	4	2	M	M	M	M	L
22	M	M	M	L	4	3	H	H	H	H	M
23	M	M	M	L	4	4	H	H	H	H	M
24	M	L	L	L	4	4	H	H	M	M	M

Table A3.5. Count round four confidence scores

Overall matrix for fixed and variable scores (L = low; M = medium; H = high).

Sector	Fixed Coverage x Detectability scores (Table A3.1)				Timing (T) x Conditions (C) scores			Overall count confidence scores			
	ND, RM, E.	SA, VS, RH, CA	GN, SZ	LN				ND, RM, E.	SA, VS, RH, CA	GN, SZ	LN
1	M	M	M	L	4	3	H	H	H	H	M
2	H	H	M	L	4	3	H	H	H	H	M
3	M	M	M	L	4	3	H	H	H	H	M
4	H	H	M	L	1	4	L	M	M	L	L
5	M	M	M	L	1	3	L	L	L	L	L
6	M	L	L	L	4	3	H	H	M	M	M
7	M	L	L	L	3	4	H	H	M	M	M
8	M	M	M	L	4	4	H	H	H	H	M
9	H	H	M	M	4	4	H	H	H	H	H
10	H	H	M	L	1	4	L	M	M	L	L
11	M	M	M	L	1	4	L	L	L	L	L
12	H	H	M	M	4	4	H	H	H	H	H
13	H	H	M	L	4	4	H	H	H	H	M
14	H	H	M	M	4	4	H	H	H	H	H
15	M	L	L	L	1	4	L	L	L	L	L
16	M	L	L	L	4	4	H	H	M	M	M
17	H	H	M	M	4	3	H	H	H	H	H
18	H	H	M	M	4	3	H	H	H	H	H
19	H	H	M	L	4	3	H	H	H	H	M
20	H	H	M	L	4	3	H	H	H	H	M
21	M	M	M	L	1	3	L	L	L	L	L
22	M	M	M	L	1	3	L	L	L	L	L
23	M	M	M	L	4	4	H	H	H	H	M
24	M	L	L	L	4	4	H	H	M	M	M

Table A3.6. Count round five confidence scores

Overall matrix for fixed and variable scores (L = low; M = medium; H = high).

Sector	Fixed Coverage x Detectability scores (Table A3.1)				Timing (T) x Conditions (C) scores			Overall count confidence scores			
	ND, RM, E.	SA, VS, RH, CA	GN, SZ	LN				ND, RM, E.	SA, VS, RH, CA	GN, SZ	LN
1	M	M	M	L	4	3	H	H	H	H	M
2	H	H	M	L	4	3	H	H	H	H	M
3	M	M	M	L	4	3	H	H	H	H	M
4	H	H	M	L	4	3	H	H	H	H	M
5	M	M	M	L	4	3	H	H	H	H	M
6	M	L	L	L	4	2	M	M	L	L	L
7	M	L	L	L	3	3	M	M	L	L	L
8	M	M	M	L	4	3	H	H	H	H	M
9	H	H	M	M	4	3	H	H	H	H	H
10	H	H	M	L	3	3	M	H	M	M	L
11	M	M	M	L	2	2	L	L	L	L	L
12	H	H	M	M	4	4	H	H	H	H	H
13	H	H	M	L	4	3	H	H	H	H	M
14	H	H	M	M	4	4	H	H	H	H	H
15	M	L	L	L	2	4	M	M	L	L	L
16	M	L	L	L	4	4	H	H	M	M	M
17	H	H	M	M	4	3	H	H	H	H	H
18	H	H	M	M	4	3	H	H	H	H	H
19	H	H	M	L	4	3	H	H	H	H	M
20	H	H	M	L	4	3	H	H	H	H	M
21	M	M	M	L	2	3	M	M	M	M	L
22	M	M	M	L	2	3	M	M	M	M	L
23	M	M	M	L	4	3	H	H	H	H	M
24	M	L	L	L	4	4	H	H	M	M	M

ANNEX 4: SPECIES SECTOR TOTALS FOR EACH COUNT ROUND

Table A4.1. Count round one

Sector totals for the most frequently recorded species (shag and cormorant numbers are the combined total of birds on the water and roosting ashore within a sector). Shading indicates count confidence score: dark grey = high; light grey = medium; unshaded = low

Sector	Old sector no.	Target species							Non-target species		
		E	LN	VS	RM	ND	SA	SZ	GN	RH	CA
1	-	18	0	0	0	1	23	0	0	0	0
2	1 N	40	56	0	11	6	553	7	0	1	20
3	2 N	71	15	0	8	3	303	0	0	7	150
4	3 N	444	110	0	51	24	211	7	2	14	120
5	-	65	7	0	12	6	176	0	0	1	27
6	-	34	6	0	13	3	116	2	3	4	0
7	13 S	48	121	0	3	11	118	3	0	0	5
8	4 N	289	134	0	2	10	92	0	0	6	0
9	6 N	3	0	0	0	0	0	0	0	0	0
10	5 N	39	2	0	8	0	34	0	0	4	0
11	1 S	236	41	0	11	10	101	3	0	6	65
12	2 S	16	43	0	47	24	32	27	1	6	2
13	3 S	52	21	3	139	28	30	10	1	0	0
14	4 S	3	87	0	10	24	8	0	0	1	0
15	5 S	236	261	35	52	121	59	52	2	9	82
16	6 S	67	71	27	5	17	160	5	13	5	62
17	7 S	5	0	0	6	1	23	0	0	1	3
18	8 S	251	125	0	8	1	6	2	0	0	0
19	9 S	19	26	2	22	17	85	20	0	0	0
20	10 S	232	36	2	65	7	91	18	3	9	0
21	11 S	46	8	37	7	72	114	8	1	4	0
22	12 S	29	5	23	1	33	157	5	0	0	0
23	-	83	84	2	57	16	48	30	1	5	11
24	-	17	15	0	8	6	42	1	1	1	4
Totals		2343	1274	131	546	441	2582	200	28	84	551

E. = eider; LN = long-tailed duck; VS = velvet scoter; RM = red-breasted merganser;
 ND = great northern diver; SA = shag; SZ = Slavonian grebe; GN = goldeneye;
 RH = red-throated diver; CA = cormorant

Table A4.2. Count round two

Sector totals for the most frequently recorded species (shag and cormorant numbers are the combined total of birds on the water and roosting ashore within a sector). Shading indicates count confidence score: dark grey = high; light grey = medium; unshaded = low

Sector	Old sector no.	Target species						Non-target species			
		E	LN	VS	RM	ND	SA	SZ	GN	RH	CA
1	-	14	7	0	3	1	55	0	0	0	0
2	1 N	83	101	0	20	7	274	9	3	4	3
3	2 N	181	135	0	39	16	215	10	2	8	230
4	3 N	286	78	4	44	26	722	13	2	5	87
5	-	21	7	0	6	14	298	1	0	2	35
6	-	2	0	0	0	5	66	0	0	2	41
7	13 S	52	21	9	2	26	72	1	0	0	0
8	4 N	367	225	5	6	15	137	2	0	2	221
9	6 N	1	0	0	7	0	0	0	0	0	0
10	5 N	56	10	1	7	1	54	3	1	0	0
11	1 S	131	141	0	19	23	87	1	2	2	127
12	2 S	6	22	0	24	0	15	1	0	0	0
13	3 S	53	24	3	223	8	19	27	1	0	1
14	4 S	13	47	0	16	14	38	0	0	0	8
15	5 S	171	260	107	61	100	191	44	0	3	4
16	6 S	77	68	16	19	67	173	11	0	8	35
17	7 S	6	5	0	16	5	11	7	4	0	12
18	8 S	90	53	3	13	4	23	5	1	2	3
19	9 S	26	43	25	31	19	25	32	1	2	0
20	10 S	178	22	3	82	11	72	8	15	1	5
21	11 S	119	110	15	7	98	126	9	0	5	8
22	12 S	13	3	20	0	18	74	0	0	0	9
23	-	145	151	17	29	46	145	23	2	3	4
24	-	11	18	0	6	4	76	2	0	1	68
Totals		2102	1551	228	680	528	2968	209	34	50	901

E. = eider; LN = long-tailed duck; VS = velvet scoter; RM = red-breasted merganser;
 ND = great northern diver; SA = shag; SZ = Slavonian grebe; GN = goldeneye;
 RH = red-throated diver; CA = cormorant

Table A4.3. Count round three

Sector totals for the most frequently recorded species (shag and cormorant numbers are the combined total of birds on the water and roosting ashore within a sector). Shading indicates count confidence score: dark grey = high; light grey = medium; unshaded = low

Sector	Old sector no.	Target species						Non-target species			
		E	LN	VS	RM	ND	SA	SZ	GN	RH	CA
1	-	7	6	0	0	0	43	0	0	0	0
2	1 N	55	166	0	13	12	272	8	2	5	0
3	2 N	213	100	5	17	6	104	5	2	3	8
4	3 N	197	118	1	30	18	102	9	1	3	6
5	-	41	8	0	8	12	297	0	0	1	35
6	-	20	13	0	1	5	35	0	0	0	12
7	13 S	138	53	0	0	128	93	0	1	11	1
8	4 N	297	192	10	5	16	61	2	2	10	214
9	6 N	0	0	0	1	0	0	0	0	0	0
10	5 N	44	3	0	2	2	53	0	0	0	1
11	1 S	146	117	4	22	29	32	7	1	4	32
12	2 S	7	63	0	66	1	12	10	7	0	0
13	3 S	85	76	4	217	12	49	44	12	5	27
14	4 S	281	113	0	28	1	16	1	0	0	2
15	5 S	345	184	118	83	145	108	49	0	4	17
16	6 S	223	183	4	10	82	171	5	0	3	68
17	7 S	12	14	0	23	6	29	8	0	1	0
18	8 S	30	28	1	25	6	9	4	1	1	0
19	9 S	32	21	2	23	13	11	19	4	4	0
20	10 S	179	29	2	79	16	37	26	24	1	0
21	11 S	86	39	62	9	97	65	7	2	4	0
22	12 S	22	21	23	0	27	90	3	0	0	1
23	-	127	89	8	47	87	33	34	0	7	8
24	-	50	60	0	4	56	36	0	0	2	0
Totals		2637	1696	244	713	777	1758	241	59	69	518

E. = eider; LN = long-tailed duck; VS = velvet scoter; RM = red-breasted merganser;
 ND = great northern diver; SA = shag; SZ = Slavonian grebe; GN = goldeneye;
 RH = red-throated diver; CA = cormorant

Table A4.4. Count round four

Sector totals for the most frequently recorded species (shag and cormorant numbers are the combined total of birds on the water and roosting ashore within a sector). Shading indicates count confidence score: dark grey = high; light grey = medium; unshaded = low

Sector	Old sector no.	Target species							Non-target species		
		E	LN	VS	RM	ND	SA	SZ	GN	RH	CA
1	-	5	9	0	1	3	59	0	0	0	0
2	1 N	150	147	6	18	35	1340	13	11	7	1
3	2 N	153	106	0	16	3	262	6	0	5	0
4	3 N	669	38	8	20	6	33	11	1	4	14
5	-	42	0	0	5	14	194	0	1	0	75
6	-	4	68	0	7	9	41	0	3	2	5
7	13 S	42	37	0	2	32	20	0	0	3	53
8	4 N	201	158	13	10	10	69	3	2	3	200
9	6 N	0	0	0	3	0	0	0	1	0	0
10	5 N	36	2	0	5	4	55	0	0	3	29
11	1 S	273	256	0	24	54	26	10	4	3	80
12	2 S	25	75	0	25	3	3	10	0	3	0
13	3 S	26	68	0	123	5	25	35	0	0	1
14	4 S	3	12	0	17	3	17	0	0	1	0
15	5 S	1068	603	39	168	84	85	85	0	5	18
16	6 S	50	62	8	10	22	44	0	4	1	48
17	7 S	74	24	0	24	3	15	7	2	1	18
18	8 S	12	5	5	9	1	4	3	1	2	4
19	9 S	45	35	23	37	15	36	19	3	1	0
20	10 S	221	81	7	74	20	33	44	24	3	2
21	11 S	91	51	34	26	133	122	24	3	5	36
22	12 S	6	22	38	1	95	51	4	0	0	0
23	-	134	246	6	32	26	76	29	3	2	14
24	-	13	10	0	7	36	37	0	0	0	6
Totals		3343	2115	187	664	616	2647	303	63	54	604

E. = eider; LN = long-tailed duck; VS = velvet scoter; RM = red-breasted merganser;
 ND = great northern diver; SA = shag; SZ = Slavonian grebe; GN = goldeneye;
 RH = red-throated diver; CA = cormorant

Table A4.5. Count round five

Sector totals for the most frequently recorded species (shag and cormorant numbers are the combined total of birds on the water and roosting ashore within a sector). Shading indicates count confidence score: dark grey = high; light grey = medium; unshaded = low

Sector	Old sector no	Target species							Non-target species		
		E.	LN	VS	RM	ND	SA	SZ	GN	RH	CA
1	-	8	10	0	2	2	115	0	0	0	0
2	1 N	117	187	0	31	26	253	20	8	6	28
3	2 N	157	78	5	29	6	182	5	3	3	0
4	3 N	729	83	3	30	26	90	5	2	2	15
5	-	10	8	0	8	15	505	0	9	1	15
6	-	2	30	0	4	7	77	0	0	2	9
7	13 S	15	17	3	0	5	13	0	0	0	31
8	4 N	195	192	5	8	17	51	1	0	0	359
9	6 N	0	0	0	0	0	0	0	0	0	0
10	5 N	25	3	0	7	3	45	0	3	0	11
11	1 S	209	290	2	23	57	103	8	1	3	41
12	2 S	1	24	0	20	4	5	16	0	0	0
13	3 S	66	36	0	192	11	30	67	19	3	25
14	4 S	503	258	0	15	6	13	7	0	0	1
15	5 S	333	554	112	136	196	66	67	0	0	15
16	6 S	86	131	8	13	29	37	0	0	3	11
17	7 S	915	28	0	21	8	38	5	4	0	0
18	8 S	48	228	0	6	2	35	7	4	2	49
19	9 S	36	109	27	40	29	26	25	0	4	0
20	10 S	160	73	3	90	24	18	38	21	0	4
21	11 S	74	33	23	22	151	109	10	2	3	15
22	12 S	10	20	33	0	74	145	3	0	0	1
23	-	102	240	1	13	26	16	14	4	0	18
24	-	5	19	0	7	18	48	0	0	0	12
Totals		3806	2651	225	717	742	2020	298	80	32	660

E. = eider; LN = long-tailed duck; VS = velvet scoter; RM = red-breasted merganser;
 ND = great northern diver; SA = shag; SZ = Slavonian grebe; GN = goldeneye;
 RH = red-throated diver; CA = cormorant

ANNEX 5: SPECIES CHARTS BY MONTH

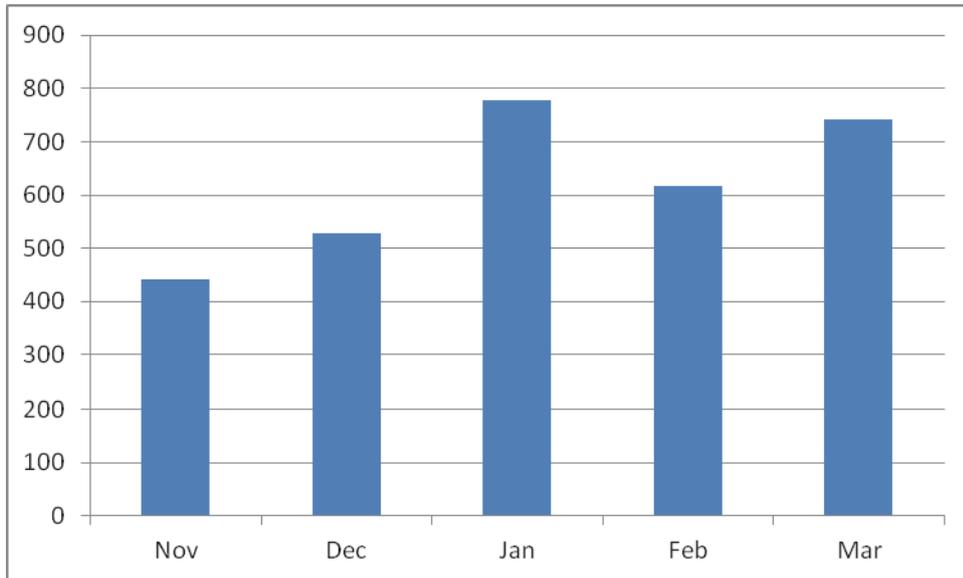


Figure A5.1. Great northern diver - monthly count totals 2017/18

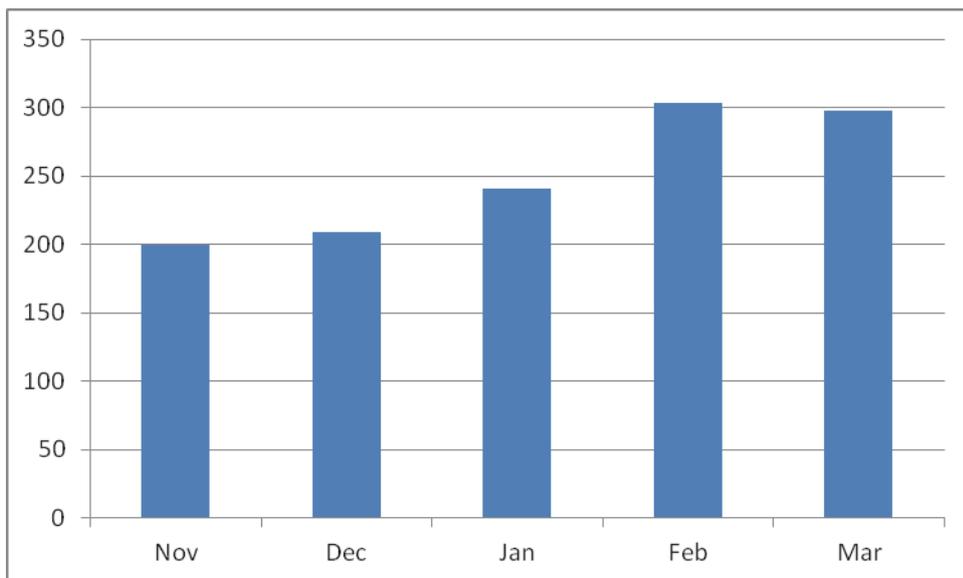


Figure A5.2. Slavonian grebe - monthly count totals 2017/18

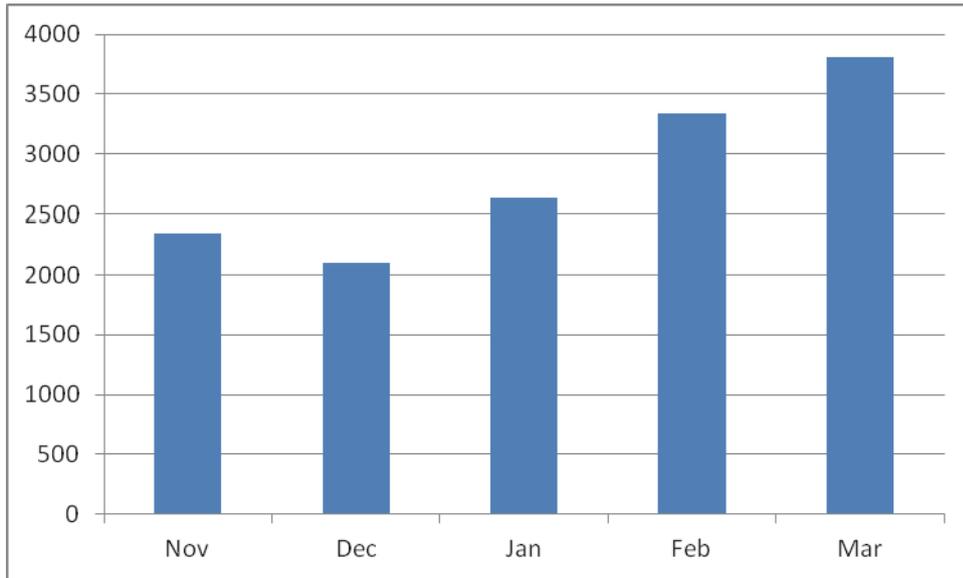


Figure A5.3. Common eider - monthly count totals 2017/18

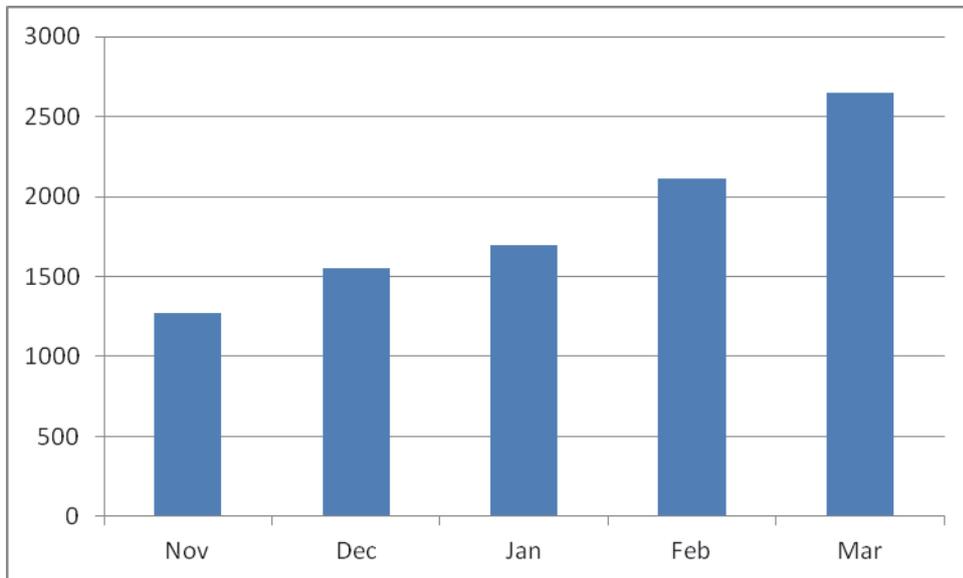


Figure A5.4. Long-tailed duck - monthly count totals 2017/18

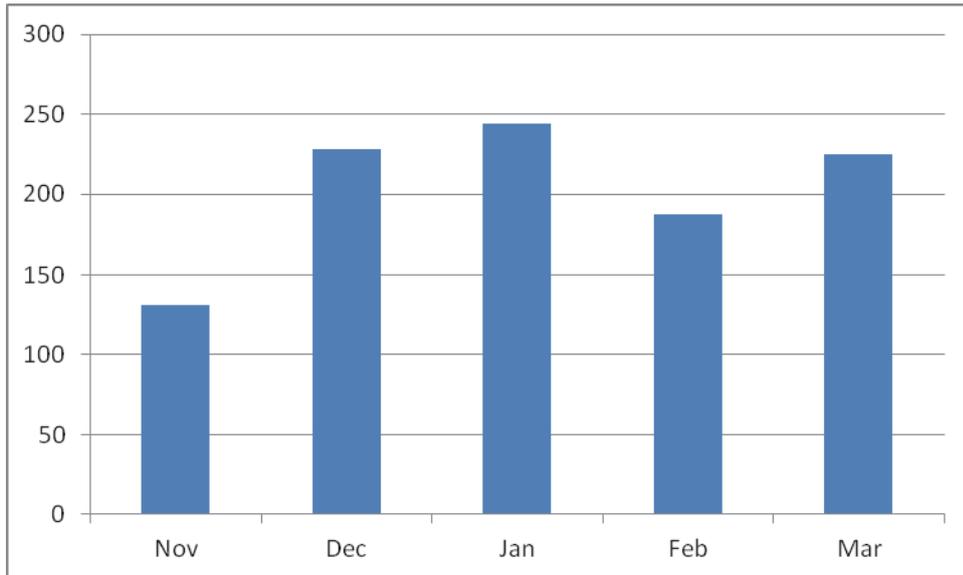


Figure A5.5. Velvet scoter - monthly count totals 2017/18

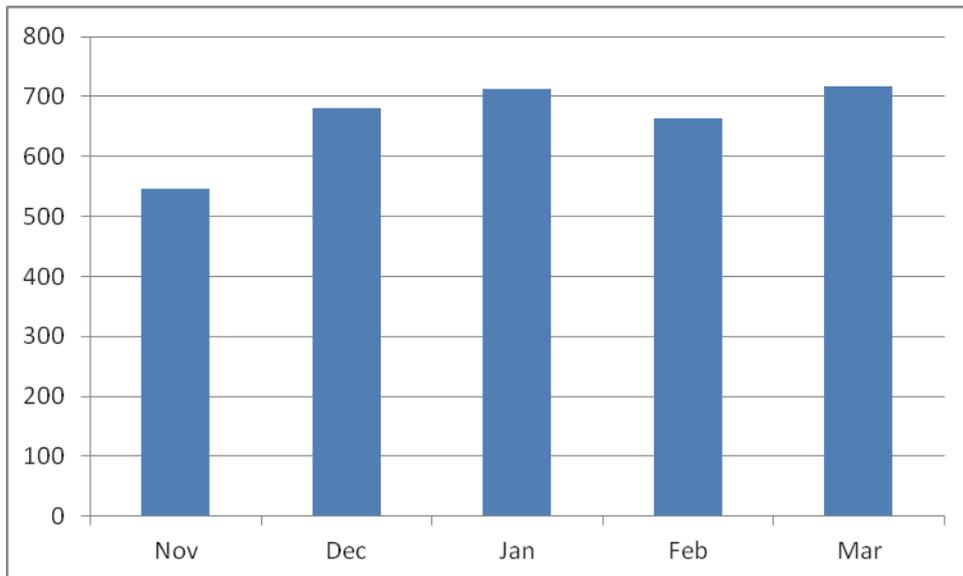


Figure A5.6. Red-breasted merganser - monthly count totals 2017/18

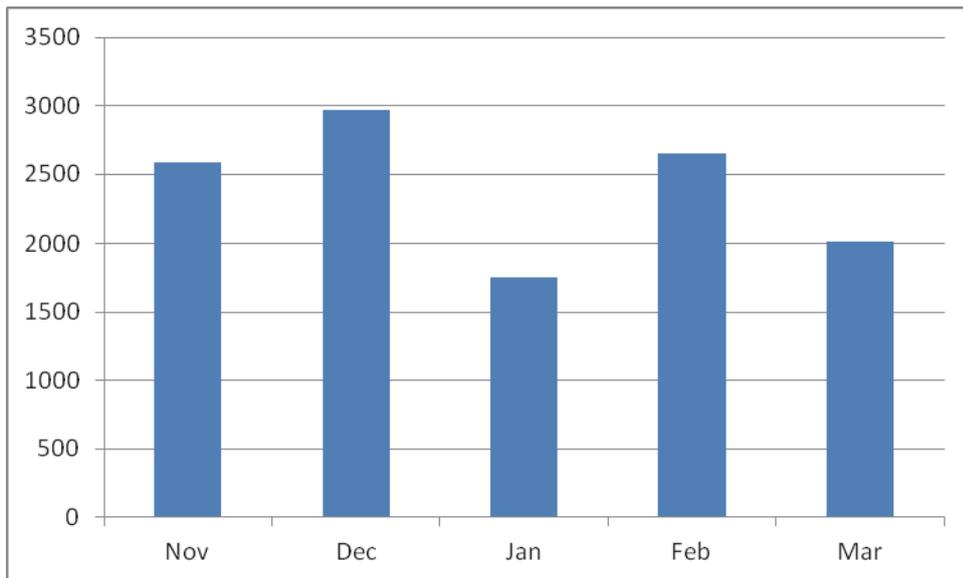


Figure A5.7. European shag - monthly count totals 2017/18

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