



**JNCC Report  
No. 407**

**The numbers of inshore waterbirds  
using Scapa Flow, Orkney, during the winter season; an assessment of the area's potential  
for qualification as a marine SPA**

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## Summary

This report describes data from five aerial surveys and nine land/boat-based surveys in the area of Scapa Flow, Orkney, carried out over a total of seven winter seasons. Aerial surveys (2002/03 to 2005/06) were conducted using line transect sampling techniques; for these, the data were analysed, where possible, using distance sampling in order to estimate the total numbers of birds using the area surveyed. In addition, land/boat-based surveys were carried out during winter periods of 1998/99, 2000/01 and 2006/07.

The species recorded during aerial surveys were: common eider *Somateria mollissima*, long-tailed duck *Clangula hyemalis*, common scoter *Melanitta nigra*, common goldeneye *Bucephala clangula*, red-breasted merganser *Mergus serrator*, red-throated diver *Gavia stellata*, and great northern diver *G. immer*. In addition land/boat-based counts documented velvet scoter *M. fusca*, goosander *M. merganser*, black-throated diver *G. arctica*, little grebe *Tachybaptus ruficollis*, red-necked grebe *Podiceps grisena* and Slavonian grebe *P. auritus*.

The first part of this report describes analyses of these data to determine the numbers of birds present for each species. The second part of this report assesses those numbers against the appropriate guideline thresholds, to determine whether the area, or a part of it meets the site selection requirements under Stage 1 of the UK Selection Guidelines.

Peak estimated numbers of black-throated divers recorded during land/boat-based surveys in Scapa Flow exceeded the appropriate Stage 1 threshold (50 individuals) for SPA qualification under the Selection Guidelines in three out of three seasons, as did the mean of peak estimates of 57 individual divers.

Peak estimated numbers of great northern diver in Scapa Flow exceeded the appropriate Stage 1 threshold (50 individuals) for SPA qualification under the Selection Guidelines in six out of seven seasons, as did the mean of peak estimates of 229 individual divers.

Peak estimated numbers of Slavonian grebe recorded during land/boat-based surveys in Scapa Flow exceeded the appropriate Stage 1 threshold (50 individuals) for SPA qualification in three out of three seasons, as did the mean of peak estimates of 135 individual grebes.

Peak estimated numbers of common eider, long-tailed duck, common scoter, velvet scoter, common goldeneye, red-breasted mergansers, goosander, red-throated diver, little grebe and red-necked grebe did not exceed the appropriate Stage 1 thresholds under the Selection Guidelines in any season in Scapa Flow, nor did the mean of peak estimates across all surveys exceed qualifying thresholds for these species in the area.

In addition, peak estimated numbers of European shag *Phalacrocorax aristotelis* recorded during land/boat-based surveys in Scapa Flow exceeded the appropriate Stage 1 threshold (2,000 individuals) for qualification under the SPA Selection Guidelines in three out of three seasons, as did the mean of peak estimates of 2,929 individual shags.

Based on the available data, only 3,829 individual waterbirds regularly use Scapa Flow. This estimate does not exceed the appropriate Stage 1 threshold for SPA qualification on the strength of an assemblage of non-breeding waterfowl (20,000 individuals). However, it is important to note the relative importance of such concentrations of birds in Scapa Flow in a national context.

Based on these analyses:

- During the winter season Scapa Flow meets the UK SPA Selection Guidelines at Stage 1.1 for consideration as a possible marine SPA for black-throated diver, great northern diver and Slavonian grebe.
- During the winter season Scapa Flow meets the UK SPA Selection Guidelines at Stage 1.2 for consideration as a possible marine SPA for European shag.
- During the winter season Scapa Flow does not meet UK SPA Selection Guidelines for an assemblage (Stage 1.3).

Species distributions using raw count data are presented here for information. Detailed spatial analyses of bird distributions and boundary location options will be required for any potential Special Protection Area, and these will be presented in a separate report.

## Contents

1	Introduction .....	5
1.1	Background .....	5
1.2	UK SPA Selection Guidelines.....	6
1.3	Scapa Flow .....	7
2	Methods.....	9
2.1	Target species.....	9
2.2	Line transect aerial surveys .....	10
2.3	Estimating bird numbers from aerial survey data .....	10
2.4	Waterbird assemblage population estimates .....	10
2.5	Winter land and boat-based surveys.....	11
3	Results .....	14
3.1	Aerial surveys.....	14
3.1.1	Number of birds recorded .....	14
3.1.2	Bird distributions .....	16
3.1.3	Population and density estimates from aerial surveys .....	17
3.2	Land and boat-based count surveys .....	19
3.2.1	Number of birds recorded .....	19
3.3	Mean of peak estimates for each species .....	21
3.3.1	Common eider.....	21
3.3.2	Long-tailed duck .....	21
3.3.3	Common scoter .....	22
3.3.4	Velvet scoter .....	23
3.3.5	Common goldeneye .....	23
3.3.6	Red-breasted merganser.....	23
3.3.7	Red-throated diver .....	24
3.3.8	Black-throated diver.....	25
3.3.9	Great northern diver.....	25
3.3.10	Grebe species .....	26
3.3.11	European shag.....	27
3.3.12	Waterbird assemblage.....	27
4	Discussion .....	29
4.1	Distance sampling analyses.....	29
4.2	Application of Stage 1 UK Selection Guidelines.....	29

4.2.1	Common eider.....	29
4.2.2	Long-tailed duck .....	29
4.2.3	All scoter species .....	30
4.2.4	Common goldeneye .....	31
4.2.5	Red-breasted merganser.....	31
4.2.6	Red-throated diver .....	32
4.2.7	Black-throated diver.....	32
4.2.8	Great northern diver.....	33
4.2.9	All grebe species .....	33
4.2.10	Little grebe and red-necked grebe.....	34
4.2.11	Slavonian grebe.....	34
4.2.12	Other waterbird species.....	34
4.2.13	Waterbird assemblage.....	35
5	Conclusions .....	36
6	Acknowledgements .....	37
7	References .....	38
	Appendix 1. Distribution of birds recorded during land, boat and aerial surveys.....	40
	Appendix 2. Peak seasonal population estimates for waterbird assemblage .....	51
	Appendix 3. Detailed population estimates .....	52

# 1 Introduction

## 1.1 Background

In 1979, the European Commission adopted the European Council (EC) Directive on the conservation of wild birds (commonly known as the 'Birds Directive'). The Birds Directive addresses "*the conservation of all species of naturally occurring birds in the wild state in the European territory of the Member States to which the treaty applies*" (79/409/EEC). It requires Member States to identify and classify in particular the "*most suitable territories*" in number and size as special protection areas (termed Special Protection Areas or SPAs by Member States) for the conservation of rare and vulnerable species listed on Annex I of the Directive, as well as regularly occurring migratory species.

Although this Birds Directive states that conservation measures should be taken both in "*the geographical sea and land area*", most SPAs in the United Kingdom (UK) do not extend further than mean low water mark (or mean low water springs in Scotland). Work to facilitate consideration of SPAs below this datum is currently being undertaken by the Joint Nature Conservation Committee (JNCC) in collaboration with the four statutory country conservation agencies: Council for Nature Conservation and the Countryside in Northern Ireland, the Countryside Council for Wales, Natural England and Scottish Natural Heritage (SNH).

A number of potential ways of addressing marine SPAs in the UK are currently being considered:

1. Marine extensions to existing seabird colony SPAs into the marine environment (McSorley *et al*, 2003; Webb & Reid 2004; McSorley *et al*, 2008);
2. Inshore areas used by waterbirds (eg seaduck, divers and grebes) outwith the breeding season (eg Webb *et al*, 2006, Dawson *et al*, 2007, Söhle *et al*, 2007);
3. Offshore areas used by wide-ranging seabirds, for feeding and for other activities (Kober *et al*, 2009); and
4. Other types of SPA.

The aim of this report is to determine whether the inshore areas of Scapa Flow or a part thereof, meet UK SPA Selection Guidelines (see below) in respect of the numbers of inshore waterbirds outwith the breeding season (Stroud *et al*, 2001).

If the investigated areas of Scapa Flow meet appropriate Stage 1 thresholds under the UK SPA Selection Guidelines then it may be considered further for classification, necessitating additional analyses of the data presented herein in order to define site boundaries.

## 1.2 UK SPA Selection Guidelines

Selection guidelines for SPAs in the UK (Stroud *et al*, 2001) advise that SPA qualification should be determined in two stages.

Stage 1: is intended to identify areas that are likely to qualify for SPA status on the basis of population threshold, and

Stage 2: (not considered in this report) is intended to further consider locations identified under Stage 1 to select the most suitable areas.

An area may be considered under any one of four components of Stage 1:

Stage 1.1. Numbers of species listed on Annex I of the EC Birds Directive should exceed 1% of the agreed Great Britain (GB) (or if relevant the all Ireland) population for the species on a regular basis.

Stage 1.2. For migratory species not listed on Annex I of the EC Birds Directive, numbers at a site should exceed 1% of the agreed biogeographical population for the species on a regular basis.

Stage 1.3. For waterbird species assemblages, more than 20,000 waterbirds (as defined by the Ramsar Committee), of at least two species, should occur regularly at a site.

Stage 1.4. Finally, where the application of stages 1.1-1.3 does not identify an adequate suite of areas, sites may be selected if they satisfy one or more of various ecological criteria listed under Stage 2 (eg by contributing significantly to the species' population viability, eg by virtue of population size and density, by contributing to species range, etc).

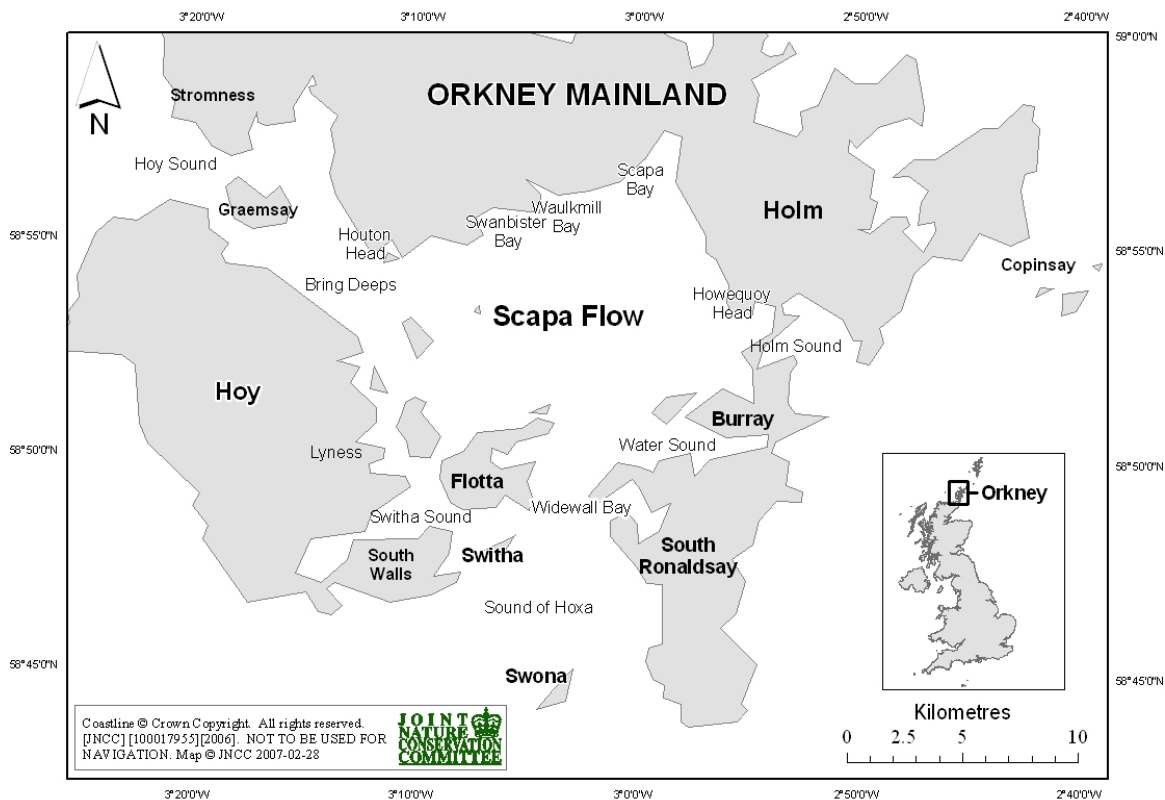
For species listed on Annex I of the Birds Directive, the appropriate population for comparison is the GB population (Baker *et al*, 2006; O'Brien *et al*, 2008 for red-throated diver); for regularly occurring migratory species, the appropriate population for comparison is the biogeographical population (Wetlands International 2006).

Webb & Reid (2004) considered definitions of regularity for inshore waterbird aggregations and suggested that the most appropriate definition to use is that of the Ramsar site selection criteria stated in The Convention on Wetlands (Criteria 5 & 6, Ramsar, 1971), where "*the requisite number of birds is known to have occurred in two thirds of the seasons for which adequate data are available*" and "*the mean of the maxima of those seasons in which the site is internationally important, taken over at least five years*".



### 1.3 Scapa Flow

Scapa Flow comprises a natural harbour almost entirely surrounded by mainland Orkney to the north and north-east, Hoy to the west, South Walls and Flotta to the south and Burray and South Ronaldsay to the east. The Churchill barriers link the latter two to Orkney mainland, and these allow only limited water exchange between Scapa Flow and the open sea. The main inputs to Scapa Flow from the open sea are to the south, between South Ronaldsay and South Walls (Hoy), and in the north-west, between Hoy and the Orkney mainland. Scapa Flow, as defined herein, extends beyond this natural harbour from east Copinsay to south of South Ronaldsay and west into Hoy Sound (Figure 1). The survey area comprises of up to 462km<sup>2</sup> of sea, most of it between 20 and 30m deep (Figure 2). Sediments are primarily sandy and muddy but become coarser in areas where tidal currents are stronger (Orkney Harbour Authority, 2007 <http://www.orkneyharbours.com>).



**Figure 1.** Scapa Flow, showing the inshore islands of the Orkney

An oil terminal has been operational on Flotta since 1976 and this has brought a large amount of associated shipping into Scapa Flow. The sheltered location has been increasingly used for ship to ship transfers of oil. In 2004, more than 2.5 million tonnes were transferred. A container shipment hub has also been proposed for the area (Orkney Harbour Authority, 2007 <http://www.orkneyharbours.com>).

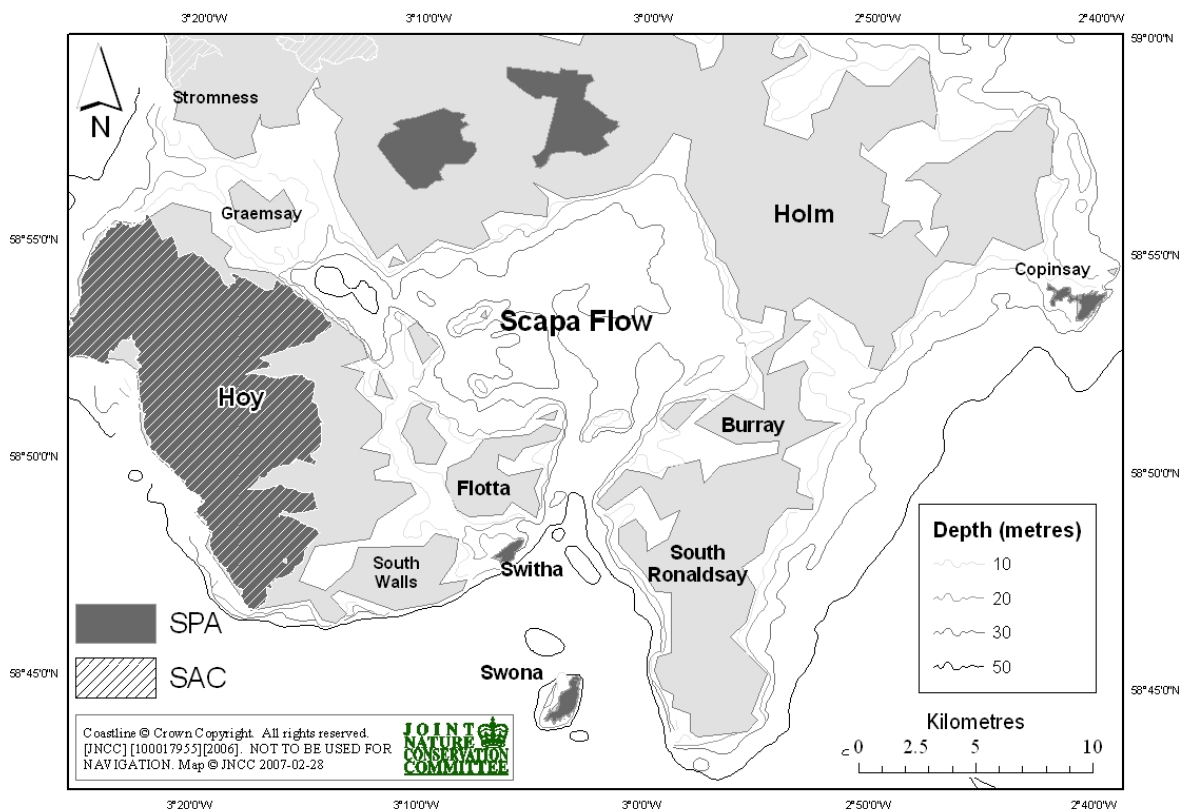
The numbers of inshore waterbirds using Scapa Flow, Orkney, during the winter season; assessment of the area's qualification for SPA status

Scapa Flow is very attractive to aquaculture developers and a number of fish and shellfish farms are in operation around the coast, most densely along the east coast of Hoy ([www.magic.gov.uk](http://www.magic.gov.uk)).

Terrestrial SPAs have already been designated at Switha, Pentland Firth Islands (Swona being the most northerly), Copinsay, Orkney mainland moors and Hoy (Figure 2). Hoy has also been designated as an SAC, particularly for blanket bogs, along with Stromness Heaths and coast.

Switha is an important island for barnacle geese *Branta leucopsis*; the Pentland Firth Islands for Arctic terns *Sterna paradisaea*, the mainland moors for red-throated divers *Gavia stellata*, hen harrier *Circus cyaneus* and short-eared owl *Asio flammeus*; Copinsay for its assemblage of seabirds including common guillemot *Uria aalge*, black-legged kittiwake *Rissa tridactyla*, great black-backed gull *Larus marinus* and northern fulmar *Fulmarus glacialis*; and Hoy for peregrine *Falco peregrinus*, red-throated diver, great skua *Catharacta skua* and its assemblage of nesting birds including Atlantic puffin *Fratercula arctica*, common guillemot, black-legged kittiwake, great black-backed gull, Arctic skua *Stercorarius parasiticus*, northern fulmar and great skua.

The current SPAs comprise terrestrial and intertidal habitats, affording protection mainly to breeding but also some wintering birds. However, the waters of Scapa Flow host large numbers of birds outwith the existing SPAs (Dean *et al*, 2004) and particularly outside the breeding season.



**Figure 2.** Scapa Flow showing bathymetry and existing SPAs and SACs.

## 2 Methods

The data used in these analyses originate from five line transect aerial surveys (carried out during 2002/03 to 2005/06) and nine land and boat-based surveys (carried out during 1998/99, 2000/01 and 2006/07) of Scapa Flow. Surveys were conducted between November and March to enable estimates of wintering populations to be made. No data were collected during migration periods, or for aggregations of moulting birds.

Aerial surveys are a time and cost-effective technique for surveying large inshore areas for aggregations of some species of inshore waterbirds. A few species are less easily detected due to their small size, tendency to dive as the survey plane approaches or difficulties in accurate identification. Hence such surveys rarely record common goldeneye, black-throated diver and grebe species (Wilson *et al*, 2006, Söhle *et al*, 2006, Lewis *et al*, 2008). Therefore, additional data from land and boat-based surveys were required to assess the number of inshore waterbirds using the waters of Scapa Flow during the winter period. Land and boat-based surveys allow more time for detection and also more accurate identification of certain species

### 2.1 Target species

The target species for aerial surveys were those inshore waterbirds that spend the winter period within coastal areas of the UK and are listed in Table 1 of the African-Eurasian Waterbird Agreement Action Plan (Convention of Migratory Species 1999): [http://www.unep-aewa.org/documents/agreement\\_text/eng/pdf/aewa\\_agreement\\_text\\_2009\\_2012\\_complete.pdf](http://www.unep-aewa.org/documents/agreement_text/eng/pdf/aewa_agreement_text_2009_2012_complete.pdf) or in Annex I of the EC Birds Directive (79/409/EEC), or are migratory species that occur regularly in the UK. These species comprise greater scaup *Aythya marila*, common eider, long-tailed duck, common scoter, velvet scoter, common goldeneye, red-breasted merganser, goosander, red-throated diver, black-throated diver, great northern diver, great crested grebe *Podiceps cristatus*, red-necked grebe, Slavonian grebe and black-necked grebe *P. nigricollis*.

In addition to these species the land/boat based surveys also recorded mute swan *Cygnus olor*, greylag goose *Anser anser*, common shelduck *Tadorna tadorna*, Eurasian wigeon *Anser penelope*, gadwall *Anas strepera*, common teal *Anser crecca*, mallard *Anas platyrhynchos*, northern pintail *Anas acuta*, northern shoveler *Anas clypeata*, great cormorant *Phalacrocorax carbo* and European shag.

Where the national population of wintering waterbirds is very small, it is recommended to apply a minimum SPA qualification threshold of 50 individuals (Stroud *et al*, 2001; Salmon, 1981). In the case of the black-throated diver the threshold for such assessment is 50 individuals because the current GB wintering population estimate is 700 individuals (Baker *et al*, 2006). The current GB winter population estimate for great northern diver is 2,500-3,000 individuals (Baker *et al*, 2006); therefore the recommended SPA qualification threshold is 50 individuals. The current GB winter population estimate for Slavonian grebes is 725 individuals (Baker *et al*, 2006), but again the recommended SPA qualification threshold is 50 individuals.

## 2.2 Line transect aerial surveys

The data used in these analyses originate from five line transect aerial surveys from 12 December 2002 to 22 February 2006 of Scapa Flow, all carried out by the JNCC. Aerial surveys were conducted using a Partenavia (PN-68) or a Britten-Norman Islander (BN2A) aircraft flown along a systematic pattern of line transects. All bird observations were allocated to one of four distance bands (A = 44-162m, B = 163-282m, C = 283-426m and D = 427-1000m) according to the perpendicular distance of the birds from the transect line. For each bird, or flock of birds, the geographical location using a GPS, the time at which it occurred (perpendicular to the aircraft), the distance band, the species, and number of birds was recorded. Further details on JNCC aerial survey methods are described in Dean *et al* (2003), Dean *et al* (2004), Wilson *et al* (2006), Söhle *et al* (2006) and Lewis *et al* (2008).

## 2.3 Estimating bird numbers from aerial survey data

Two methods were used to estimate bird density and abundance:

1. Extrapolation of mean density derived from distance sampling is one of the most robust methods for estimating total population size (Buckland *et al*, 2001). In carrying out distance sampling, data were analysed using the software *Distance* 5.0. (Thomas *et al*, 2004). For each species and survey a detection function was chosen that provided the best fit to the data on the basis of minimising the Akaike Information Criterion. The majority of best-fits was obtained using half-normal or hazard-rate models with zero adjustments and using the size-bias regression method of cluster size estimation. Where possible, non-parametric bootstrapping, re-sampling transects as samples with replacements, was used to produce 95% confidence limits for abundance estimates (Buckland *et al*, 2001).
2. Extrapolation of density derived from strip transects. Where the number of observations for the line transect surveys was too small to permit density estimation using distance sampling (ie generally less than 14-16 observations), surveys were treated as strip transect surveys and density was estimated directly from raw counts. Detection functions generated by distance sampling analysis showed that detection rate was much lower in bands C and D than in bands A and B. These more distant bands were excluded from this analysis to avoid underestimating density. Transect widths were therefore assumed to be 476m wide, ie  $2 \times (118+120)$ . This was multiplied by the length of the total survey transects flown to give the area over which observers counted. The number of birds observed in bands A and B was divided by the area over which observers counted to give an estimated bird density. This density was then extrapolated across the entire study area to estimate total numbers.

## 2.4 Waterbird assemblage population estimates

The total population estimates for all species for each survey were calculated; the peak total for each season (maximum estimate) was then determined and divided by the number of the most

recent five year survey seasons in order to determine the mean peak estimate for a waterbird assemblage.

## **2.5 Winter land and boat-based surveys**

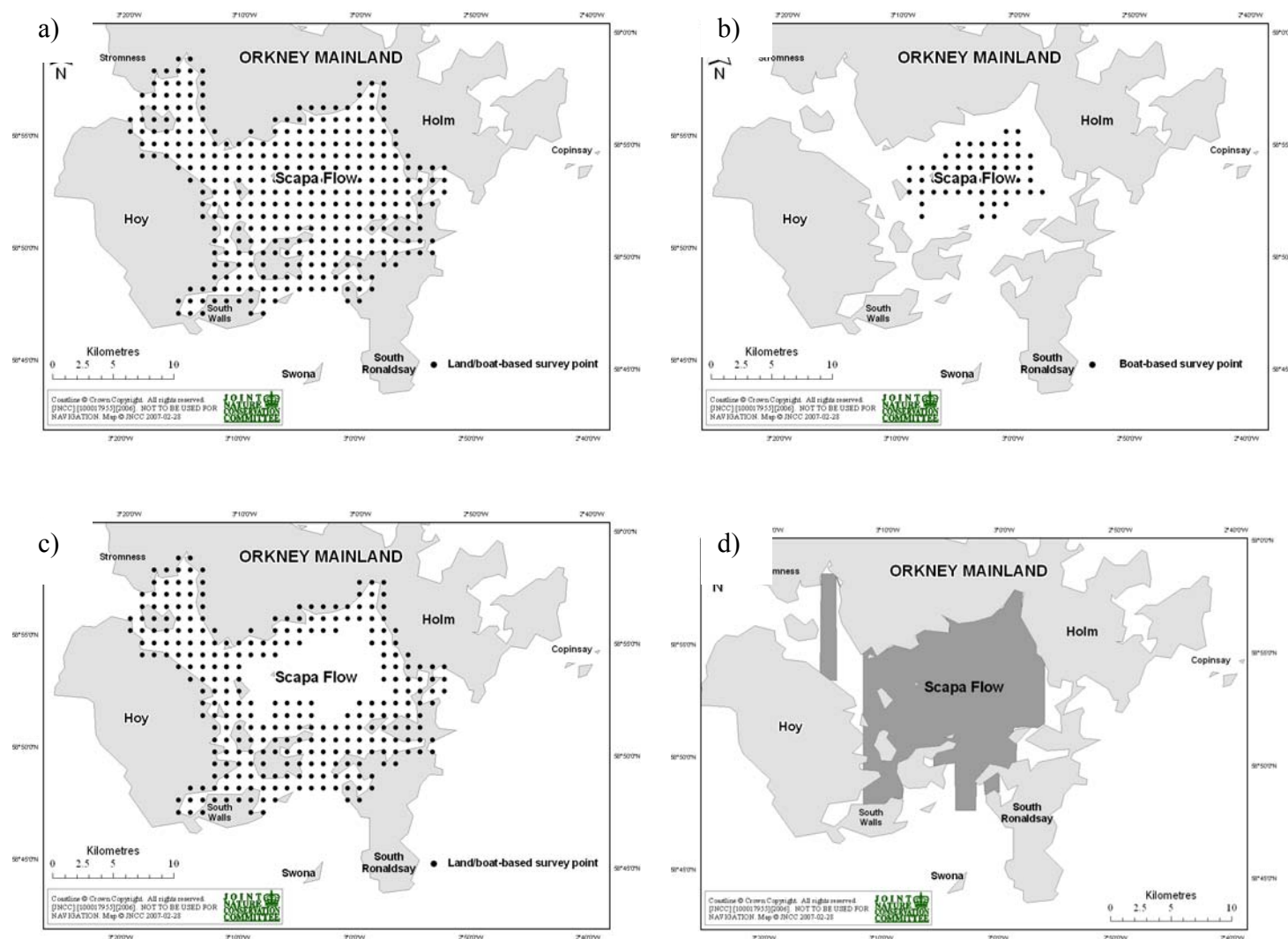
Comprehensive land and boat-based counts were undertaken in 1998/99, 2000/01 and 2006/07. The earlier two counts were commissioned by the RSPB and the most recent by JNCC. In 1998/99, a count was completed in every month from October to March. Only those in November, December, January and March are presented in this report as they include seasonal peaks for nearly all species discussed in this report as well as for the assemblage as a whole. Selecting these counts also maintains consistency with data from 2000/01, when only three counts were performed, in November, January and March. In 2006/07 only two counts were completed, in November and January.

The survey area was split into 44 sectors, 43 being adjacent to land and one at sea. Therefore in 43 sectors, birds were counted from land and in the latter sector counts were made from a boat. Land-based counts were carried out at 132 count points and birds were recorded in 1km Ordnance Survey grid squares. Repeated counts were made from each of the 132 count points using a tripod mounted telescope with a 32x80 fixed eyepiece. The maximum distance from the shore within which birds could be counted was estimated to be approximately 2km in optimal conditions. All species observed on the water were counted and recorded. To avoid double counting, flying birds were excluded from the calculations, and counts were timed to less than 20 minutes. Whenever possible, counts were conducted when there was good visibility and low wind speed (Beaufort Scale force 3 or less) to optimise coverage and detectability. Counts were performed over a number of days across the whole month.

Boat surveys were conducted from a small vessel with an observer height of 1.5m above sea level and were run only on days with a wind speed of Beaufort Scale force 1 or less, to optimise visibility. Four line transects were spaced 2km apart. Assuming uniform detectability over 1km on both port and starboard side, this allowed for complete coverage of the area. In order to minimise the number of birds that were not detected by the observers and to avoid double counting of birds, this method required intensive and systematic coverage of the survey area. 10x42 binoculars were used to detect seaducks and divers, which tend to take evasive action some distance ahead of approaching boats and cannot be adequately surveyed using the naked eye. The boat travelled at 12km per hour, covering 1km in 5 minutes. The resulting data were 5-minute sample counts of all birds on the water within a 2x1000m wide strip-transect (on both sides of the boat). Use of a Global Positioning System (GPS) ensured that this route was repeatable. A minimum of two observers was used, although most surveys were conducted with three observers.

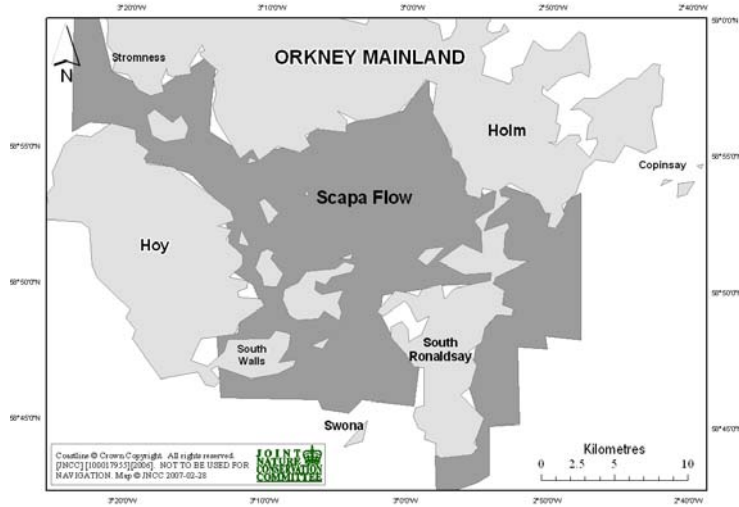
Raw counts were used to estimate population sizes where data were collected from land and boat-based counts, as these data were treated as total counts for the survey area.

**Figure 3 a-d.** Scapa Flow surveys coverage for land and boat-based surveys: a) November 1998 to January 2001, b) March 2001 (boat-based survey displayed only, though 73% of land-based survey was completed), c) November 2006/February 2007; and aerial line transect survey coverage d) 12 December 2002.

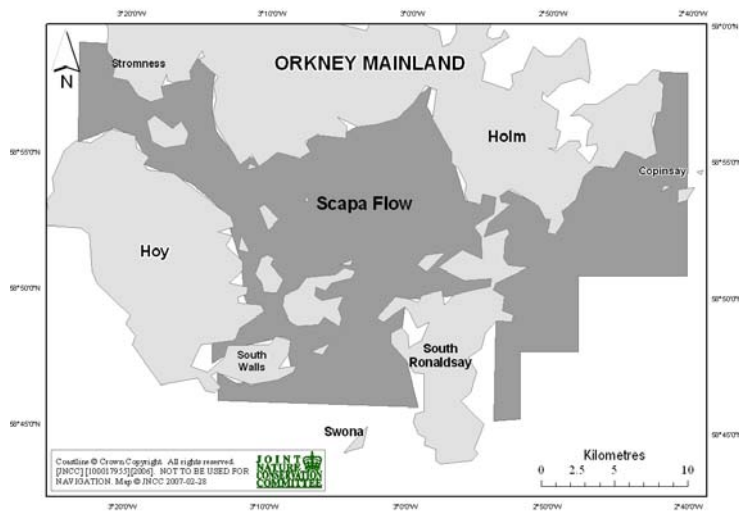


The numbers of inshore waterbirds using Scapa Flow, Orkney, during the winter season; assessment of the area's qualification for SPA status

e)



f)



**Figure 2 e-f.** Scapa Flow surveys coverage for aerial line transect surveys: e) 12 February 2004 and 7 March 2005 f) January/February 2006.

### **3 Results**

Caution should be applied when comparing the raw counts of all surveys; it should be remembered that the counts from land and boat-based surveys represent total raw counts of the area, whereas aerial survey data represent sample counts. Also caution should be applied when comparing land-based surveys as coverage differed between surveys (see section 2.4 above).

#### **3.1 Aerial surveys**

##### **3.1.1 Number of birds recorded**

Five aerial line transect surveys were conducted in Scapa Flow between 12 December 2002 and 22 February 2006. Seven of the target species were recorded on aerial surveys. Sufficient data to enable distance analysis or extrapolation from raw counts were collected for all species recorded: common eider, long-tailed duck, common scoter, common goldeneye, red-breasted merganser, red-throated diver and great northern diver (Table 1). Additionally, some divers could not be identified to species level and therefore were recorded as unidentified diver species.

Of all divers observed during line transect surveys (310), 91% of birds were identified as great northern divers, 5% were red-throated divers and 4% could not be identified to species level (Table 2). The land-based counts showed that black-throated divers were also present (8.7%) (Table 3). The unidentified diver records could therefore not be assigned to any species and were omitted from further analysis.

Aerial surveys rarely record common goldeneye, black-throated diver and grebe species (Wilson *et al*, 2006, Söhle *et al*, 2006, Lewis *et al*, 2008). Land-based surveys allow time for detection and identification of birds to species level, particularly smaller or less abundant species which may otherwise be overlooked.



**Table 1.** The total number of birds (and flocks) counted in Scapa Flow during aerial line transect surveys from December 2002 to February 2006. Numbers represent the total raw counts of all birds recorded.

Survey date	Common eider	Long-tailed duck	Common scoter	Common goldeneye	Red-breasted merganser	Red-throated diver	Great northern diver	Unidentified diver
<b>Season 2002/03</b>								
12 December 2002	153 (41)	43 (14)	3 (1)	0	11 (3)	0	9 (8)	4 (4)
<b>Season 2003/04</b>								
12 February 2004	832 (116)	210 (55)	53 (3)	0	29 (15)	2 (2)	156 (78)	9 (8)
<b>Season 2004/05</b>								
07 March 2005	599 (113)	146 (22)	0	0	11 (8)	4 (2)	33 (23)	0
<b>Season 2005/06</b>								
29 January 2006	356 (93)	192 (44)	0	0	35 (12)	1 (1)	56 (39)	2 (2)
22 February 2006	614 (54)	129 (22)	5 (1)	2 (2)	24 (11)	6 (4)	28 (23)	0

### 3.1.2 Bird distributions

Distributions of common eider, long-tailed duck, red-breasted merganser, red-throated diver, black-throated diver, great northern diver and Slavonian grebe recorded during land/boat-based and aerial surveys are presented in Appendix A, Figures A1 to A7.

#### *Common eider (Appendix A1, Figure A a – h)*

Common eider were recorded both during land/boat-based and aerial surveys. Common eider were distributed all around the coastline but with notable concentrations around Bay of Ireland stretching south of Graemsay, Lyness and the surrounding area, Scapa Bay and Water Sound. The aerial survey coverage on 12 December 2002 was the smallest which is reflected in the lower number of eiders recorded during that flight. Land/boat-based surveys complimented aerial surveys well, particularly in areas offshore from Scapa Bay, off the Dam of Hoxa towards Water Sound, offshore around Flotta, Fara, Cava and Graemsay.

#### *Long-tailed duck (Appendix A, Figure A2 a – h)*

Long-tailed duck were recorded during both land/boat-based and aerial surveys. Observations of long-tailed duck were well spread around the coastline of Scapa Flow. However, in most of surveys the highest concentrations of birds were to the east and south of Graemsay and around Lyness. The aerial survey coverage on 12 December 2002 was the smallest which is reflected in the lower number of long-tailed ducks recorded during that flight. Land/boat-based surveys complimented aerial surveys well, particularly in areas along the coastline south-west from Kirkwall, south and south-east off Graemsay and between the islands of Flotta, Fara and Cava.

#### *Red-breasted merganser (Appendix A, Figure A3 a – h)*

Red-breasted merganser was recorded during both land/boat-based and aerial surveys. Almost all observations of red-breasted mergansers were close to the coast. The most important areas were Bay of Ireland, Swanbister Bay, Howequoy Head down to Widewall Bay, Flotta and the east coast of Hoy. Land/boat-based surveys complimented aerial surveys well, particularly in areas along the Churchill Barriers and offshore from the Bay of Ireland.

#### *Red-throated diver (Appendix A, Figure A4 a – c)*

Only low numbers of red-throated divers were observed during aerial surveys. Land-based surveys repeatedly recorded birds around Widewall Bay, Water Sound and the Bay of Ireland. In January 2006 additional sites holding concentrations were the areas east of Flotta and north of South Walls.

#### *Black-throated diver (Appendix A, Figure A5 a – c)*

Black-throated divers were not recorded during aerial surveys. Almost all observations from other surveys were of birds close to the coast. In December 1998 birds were spread evenly around the coastline in Scapa Flow. In November 2000 and January 2007 birds were more scattered but in consistent areas between Graemsay and Houton Head, off Lyness on Hoy, close to Waulkmill Bay, and along the coast west of Holm.

*Great northern diver (Appendix A, Figure A6 a – h)*

All surveys reported high numbers of great northern diver. The highest numbers were recorded in Scapa Flow between January and March. Most surveys showed their distribution to be loosely concentrated in the central areas of Scapa Flow, with no apparent preference to be close to the coast. The aerial survey coverage on 12 December 2002 was the smallest which is reflected in the lower number of great northern divers recorded during that flight. Land/boat-based surveys complimented aerial surveys well, particularly in areas along the coastline south-west from Kirkwall, offshore around Graemsay and along the Churchill Barriers

*Slavonian grebe (Appendix A, Figure A6 a – c)*

High counts of Slavonian grebes were made during land-based counts, with birds concentrating in the Bay of Ireland, Swanbister and Waulkmill Bay, the coast west of Holm, Water Sound, and in particular in Echnaloch Bay to the north-west of Burray.

### **3.1.3 Population and density estimates from aerial surveys**

Population estimates reported here (Table 2) are derived from total raw counts, extrapolation from raw counts or distance sampling (see section 2.3). 95% confidence limits are presented for distance sampling estimates, but it was not possible to derive confidence intervals for extrapolated counts. Detailed results for each survey are presented in Appendix C, Tables C1-C5.

**Table 2.** Summary of population estimates for selected species in Scapa Flow during aerial survey periods from 2002/03 to 2005/06. Estimates are derived from distance sampling, except those denoted with an asterisk (\*), which have been extrapolated from raw counts. Lower and upper 95% confidence limits are presented in brackets. Numbers in shaded cells exceed the appropriate Stage 1 thresholds under the UK SPA site selection guidelines.

Survey date	Common eider	Long-tailed duck	Common scoter	Common goldeneye	Red-breasted merganser	Red-throated diver	Great northern diver	Assemblage of all species
SPA qualification threshold	12,850	20,000	16,000	11,500	1,700	170	50	20,000
<b>Season 2002/03</b>								
12 December 2002	721 (327-1591)	96 (44-162)	26*	0	49*	0 40	* 9	32
<b>Season 2003/04</b>								
12 February 2004	2555 (1666-3918)	614 [556 (447-1269) plus 58]	413* 0		123 (46-227)	8*	269 [233 (142-536) plus 36]	3713
<b>Season 2004/05</b>								
07 March 2005	1659 [1454 (1160-3285) plus 205]	450 [365 (155-860) plus 85]	0	0	45*	32*	165 (74-245)	2186
<b>Season 2005/06</b>								
29 January 2006	1335 (884-2351)	828 [763 (302-1517) plus 65]	0	0	134*	7*	275 (135-462)	2304
22 February 2006	1097 [747 (390-1226) plus 350]	511 [469 (230-1137) plus 42]	32*	38*	72*	20*	121 (62-195)	1770

## **3.2 Land and boat-based count surveys**

Land and boat-based counts were performed over a number of days spread across the whole month, but because of adverse weather or unforeseen circumstances, they were not always completed to a desirable level of accuracy.

Counts in March 2001 were completed in winds up to Beaufort Scale force 3. Birds are less likely to have been detected during such surveys. The land-based part of the survey was severely disrupted by travel restrictions imposed as a result of the outbreak of foot and mouth disease in the UK. Consequently, counts from only 73% of the counting points along Scapa Flow were made; 41% of these being complete area counts and 32% were partial area counts. However, the boat-based survey was completed (Figure 3b). These counts especially the completed ones were well placed, both spatially and temporally, in Scapa Flow. Counts in 2006/07 were delayed by poor weather and took up two weeks to complete because of suboptimal counting conditions.

The counts achieved are, therefore, neither full surveys nor directly comparable with each other but are the best data available and considered fit for present purposes.

### **3.2.1 Number of birds recorded**

Twenty-nine species were recorded during land and boat-based surveys of Scapa Flow (Appendix B, Table B1). Of these data, 14 were analysed for this report while numbers of other species were not significant in a marine SPA context, or were too low to draw any meaningful conclusions on their distribution. Total numbers of each of the 14 species recorded on each land and boat-based survey are presented in Table 1.

In Scapa Flow, the most abundant species in descending order were common eider, long-tailed duck, common scoter, velvet scoter, common goldeneye, red-breasted merganser, goosander, red-throated diver, black-throated diver, great northern diver, little grebe, red-necked grebe and Slavonian grebe.

**Table 3.** The total number of birds counted in Scapa Flow during land and boat-based surveys conducted during 1998/99, 2000/01 and 2006/07. Numbers represent the total raw counts of all birds recorded. Numbers in shaded cells exceed the appropriate Stage 1 thresholds under the UK SPA site selection guidelines (Stroud *et al*, 2001).

Survey date	Common eider	Long-tailed duck	Common scoter	Velvet scoter	Common goldeneye	Red-breasted merganser	Goosander	Red-throated diver	Black-throated diver	Great northern diver	Little grebe	Red-necked grebe	Slavonian grebe	European shag	Total per survey
SPA qualification threshold	12,850	20,000	16,000	10,000	11,500	1,700	2,700	170	50	50	4,000	510	50	2,000	
<b>Season 1998/99</b>															
November 1998	2308	1224	3	7	71	628	1	59	49	540	7	3	102	3393	5002
December 1998	1792	1433	0	9	248	477	0	26	57	644	10	4	91	2276	4791
January 1999	1680	1582	2	19	282	477	3	29	47	145	8	21	124	2154	4419
March 1999	2038	1246	2	7	231	324	1	38	42	781	2	23	74	744	4809
<b>Season 2000/01</b>															
November 2000	1980	1184	7	11	40	488	0	82	58	438	5	10	74	3161	4377
January 2001	1809	1474	3	9	254	388	0	22	54	411	6	3	141	1593	4574
March 2001	1635	993	6	6	199	292	0	20	18	359	4	1	59	629	3592
<b>Season 2006/07</b>															
November 2006	1441	834	3	5	38	501	0	56	25	288	2	0	83	2233	3276
February 2007	1693	1122	6	10	121	437	0	15	57	298	7	2	139	706	3907

### 3.3 Mean of peak estimates for each species

#### 3.3.1 Common eider

Table 4 shows the peak population estimates for common eider in Scapa Flow for each season. Common eiders were the most numerous species present in Scapa Flow during aerial surveys and land and boat-based (Table 1 and 3). Total population numbers were relatively unchanged over the survey period, apart from the survey on 12 December 2002 when the population estimate was at its lowest with 721 individual birds (Table 2). All distance sampling derived population estimates for common eider had relatively small confidence intervals associated with them (Appendix C, Table C1). No estimates came close to exceeding the stage 1 SPA qualifying threshold in any season.

**Table 4.** Peak seasonal population estimates for common eider in the Scapa Flow for land/boat-based counts from 1998/99, 2000/01 and 2006/07 and aerial surveys from 2002/03 to 2005/06.

Season	Maximum estimate	Method	Date
<b>SPA qualification threshold = 12,850</b>			
1998/99	2308	land/boat-based raw count	November 1998
2000/01	1980	land/boat-based raw count	November 2000
2002/03	721	aerial survey distance sampling	12 December 2002
2003/04	2555	aerial survey distance sampling	12 February 2004
2004/05	1659	aerial survey distance sampling	7 March 2005
2005/06	1335	aerial survey distance sampling	29 January 2006
2006/07	1693	land/boat-based raw count	January 2007
Mean of five most recent seasons	<b>1593</b>		

#### 3.3.2 Long-tailed duck

Table 5 shows the peak population estimates for long-tailed duck in Scapa Flow for each season. During aerial surveys and land and boat-based surveys Long-tailed ducks were the second most numerous species present in the Scapa Flow (Table 1 and 3). Most distance sampling derived population estimates (12 February 2004, 7 March 2005 and 22 February 2006) had large confidence intervals associated with them (Appendix C, Table C2) and should be treated with caution. No estimates came close to exceeding the stage 1 SPA qualifying threshold in any season.

The numbers of inshore waterbirds using Scapa Flow during the non-breeding season, and an assessment of the area's qualification for SPA status

**Table 5.** Peak seasonal population estimates for long-tailed duck in the Scapa Flow for land/boat-based counts from 1998/99, 2000/01 and 2006/07 and aerial surveys from 2002/03 to 2005/06.

Season	Maximum estimate	Method	Date
<b>SPA qualification threshold = 20,000</b>			
1998/99	1582	land/boat-based raw count	January 1999
2000/01	1474	land/boat-based raw count	January 2001
2002/03	96	aerial survey distance sampling	12 December 2002
2003/04	614	aerial survey distance sampling	12 February 2004
2004/05	450	aerial survey distance sampling	7 March 2005
2005/06	828	aerial survey distance sampling	29 January 2006
2006/07	1122	land/boat-based raw count	January 2007
Mean of five most recent seasons	<b>622</b>		

### 3.3.3 Common scoter

Table 6 shows the peak population estimates for common scoter in Scapa Flow for each season.

Common scoters were recorded in low numbers during land/boat-based surveys and slightly higher numbers during three of five aerial surveys (Table 1 and 3). However, sample sizes were low and therefore estimates were derived from extrapolation of raw counts. No estimates came close to exceeding the stage 1 SPA qualifying threshold in any season.

**Table 6.** Peak seasonal population estimates for common scoter in the Scapa Flow for land/boat-based counts from 1998/99, 2000/01 and 2006/07 and aerial surveys from 2002/03 to 2005/06.

Season	Maximum estimate	Method	Date
<b>SPA qualification threshold = 16,000</b>			
1998/99	3	land/boat-based raw count	November 1998
2000/01	7	land/boat-based raw count	November 2000
2002/03	26	aerial survey extrapolated	12 December 2002
2003/04	413	aerial survey extrapolated	12 February 2004
2004/05	0	n/a	7 March 2005
2005/06	32	aerial survey extrapolated	22 February 2006
2006/07	6	land/boat-based raw count	January 2007
Mean of five most recent seasons	<b>95</b>		



The numbers of inshore waterbirds using Scapa Flow during the non-breeding season, and an assessment of the area's qualification for SPA status

### 3.3.4 Velvet scoter

Table 7 shows the peak population estimates for velvet scoter in Scapa Flow for each season.

Velvet scoters were not recorded during aerial surveys (Table 1 and 3), but were during the land and boat based surveys. Total population counts ranged from 5 to 19 individuals during land and boat-based counts. No estimates came close to exceeding the stage 1 SPA qualifying threshold in any season.

**Table 7.** Peak seasonal population counts for velvet scoter in the Scapa Flow for land/boat-based surveys from 1998/99, 2000/01 and 2006/07.

Season	Maximum estimate	Method	Date
<b>SPA qualification threshold = 10,000</b>			
1998/99	19	land/boat-based raw count	November 1998
2000/01	11	land/boat-based raw count	November 2000
2006/07	10	land/boat-based raw count	January 2007
Mean of three most recent seasons	<b>13</b>		

### 3.3.5 Common goldeneye

Table 8 shows the peak population estimates for common goldeneye in Scapa Flow for each season. Common goldeneye was recorded in low numbers during both land and boat-based and aerial surveys. There was only one observation of common goldeneye during aerial surveys (Table 2). No estimates came close to exceeding the stage 1 SPA qualifying threshold in any season.

**Table 8.** Peak seasonal population counts for common goldeneye in the Scapa Flow for land/boat-based surveys from 1998/99, 2000/01 and 2006/07.

Season	Maximum estimate	Method	Date
<b>SPA qualification threshold = 11,500</b>			
1998/99	282	land/boat-based raw count	November 1998
2000/01	254	land/boat-based raw count	November 2000
2006/07	121	land/boat-based raw count	January 2007
Mean of three most recent seasons	<b>219</b>		

### 3.3.6 Red-breasted merganser

Table 9 shows the peak population estimates for red-breasted merganser in Scapa Flow for each season. It was only possible to perform distance analysis for one aerial survey; estimates for the other four aerial surveys are derived from extrapolation of the raw mean

The numbers of inshore waterbirds using Scapa Flow during the non-breeding season, and an assessment of the area's qualification for SPA status

density (Table 2). No estimates came close to exceeding the stage 1 SPA qualifying threshold in any season.

**Table 9.** Peak seasonal population counts for red-breasted merganser in the Scapa Flow for land/boat-based and aerial surveys from 1998/99, 2000/01 and 2006/07.

Season	Maximum estimate	Method	Date
<b>SPA qualification threshold = 1,700</b>			
1998/99	628	land/boat-based raw count	November 1998
2000/01	488	land/boat-based raw count	November 2000
2002/03	49	aerial survey extrapolated	12 December 2002
2003/04	123	aerial survey distance sampling	12 February 2004
2004/05	45	aerial survey extrapolated	7 March 2005
2005/06	134	aerial survey extrapolated	29 January 2006
2006/07	501	land/boat-based raw count	November 2007
Mean of five most recent seasons	<b>170</b>		

### 3.3.7 Red-throated diver

Table 10 shows the peak population estimates for red-throated divers in Scapa Flow for each season.

During aerial surveys red-throated divers were recorded in low numbers (Table 1). Consequently, all population estimates were extrapolations from raw data. No estimates came close to exceeding the stage 1 SPA qualifying threshold in any season.

**Table 10.** Peak seasonal population estimates for red-throated diver in the Scapa Flow for land/boat-based counts from 1998/99, 2000/01 and 2006/07 and aerial surveys from 2002/03 to 2005/06.

Season	Maximum estimate	Method	Date
<b>SPA qualification threshold = 170</b>			
1998/99	59	land/boat-based raw count	November 1998
2000/01	82	land/boat-based raw count	November 2000
2002/03	0	n/a	12 December 2002
2003/04	8	aerial survey extrapolated	12 February 2004
2004/05	32	aerial survey extrapolated	7 March 2005
2005/06	20	aerial survey extrapolated	22 February 2006
2006/07	56	land/boat-based raw count	November 2007
Mean of five most recent seasons	<b>23</b>		

### 3.3.8 Black-throated diver

Table 11 shows the peak population estimates for black-throated diver in Scapa Flow for each season.

Black-throated divers were not recorded during aerial surveys (Table 1 and 3), therefore the mean of the three most recent seasons is based entirely on land/boat-based counts. Three estimates out of three seasons exceeded the Stage 1 threshold, and so did the mean peak of the three most recent seasons.

**Table 11.** Peak seasonal population counts for black-throated diver in the Scapa Flow for land/boat-based surveys from 1998/99, 2000/01 and 2006/07. Highlighted cells indicate counts that exceed the SPA Stage 1 selection thresholds of 50 birds (Baker *et al*, 2006).

Season	Maximum estimate	Method	Date
<b>SPA qualification threshold = 50</b>			
1998/99	57	land/boat-based raw count	December 1999
2000/01	58	land/boat-based raw count	November 2000
2006/07	57	land/boat-based raw count	January 2007
Mean of three most recent seasons	57		

### 3.3.9 Great northern diver

Table 12 shows the peak population estimates for great northern diver in Scapa Flow for each season. Great northern diver was the most numerous diver species counted throughout the survey period (Table 1 and 3). The highest population estimates for great northern divers were derived from the land and boat-based surveys. All but one population estimate of great northern diver were derived from distance sampling analysis. All distance sampling derived estimates for the species had relatively small confidence intervals associated with them (Appendix C, Table C5). Four estimates out of five seasons exceeded the Stage 1 threshold and so did the mean peak estimate of the five most recent seasons.

**Table 12.** Peak seasonal population estimates for great northern diver in the Scapa Flow for land/boat-based counts from 1998/99, 2000/01 and 2006/07 and aerial surveys from 2002/03 to 2005/06. Highlighted cells indicate counts that exceed the SPA Stage 1 selection thresholds of 50 birds (Baker *et al*, 2006).

Season	Maximum estimate	Method	Date
<b>SPA qualification threshold = 50</b>			
1998/99	781	land/boat-based raw count	March 1999
2000/01	438	land/boat-based raw count	November 2000
2002/03	40	aerial survey extrapolated	12 December 2002
2003/04	269	aerial survey distance sampling	12 February 2004
2004/05	165	aerial survey distance sampling	7 March 2005
2005/06	275	aerial survey distance sampling	29 January 2006
2006/07	398	land/boat-based raw count	January 2007
Mean of five most recent seasons	229		

### 3.3.10 Grebe species

Table 13 shows the peak population estimates for little, red-necked and Slavonian grebe in Scapa Flow for each season. Grebes are recorded only rarely on aerial surveys as they tend to dive when low-flying aircraft approach, and are also usually located close inshore so are easily missed as the aircraft turns between transects. Therefore all population estimates are derived from land/boat-based counts.

The total population estimates for little grebes ranged from two to 10 individuals, while those for red-necked grebes ranged from one to 23 individuals. No estimates for either of these species came close to exceeding the stage 1 threshold in any season (Table 13).

Slavonian grebe was the most numerous grebe species recorded throughout the survey area. The total population estimates for Slavonian grebes ranged from 59 to 141. Three estimates out of three seasons exceeded the Stage 1 threshold, and so did the mean peak of the three most recent seasons (Table 13).

The numbers of inshore waterbirds using Scapa Flow during the non-breeding season, and an assessment of the area's qualification for SPA status

**Table 13.** Peak seasonal population estimates for little grebe, red-necked grebe and Slavonian grebe in Scapa Flow for land and boat-based counts from 1998/99, 2000/01 and 2006/07. Highlighted cells indicate counts that exceed the SPA Stage 1 selection thresholds of 50 birds for Slavonian grebe (Baker *et al*, 2006).

	<b>Little grebe</b>		<b>Red-necked grebe</b>		<b>Slavonian grebe</b>	
<b>SPA qualification threshold</b>	<b>4,000</b>		<b>510</b>		<b>50</b>	
<b>Season</b>	<b>Maximum estimate</b>	<b>Date</b>	<b>Maximum estimate</b>	<b>Date</b>	<b>Maximum estimate</b>	<b>Date</b>
1998/99 1	0	January 1999	23 March	1999	124	January 1999
2000/01	6	November 2000	10 No	vember 2000	141	January 2001
2006/07	7 J	anuary 2007	2 Janu	ary 2007	139	January 2007
Mean of three most recent seasons	<b>8</b>		<b>12</b>		<b>135</b>	

### 3.3.11 European shag

Table 14 shows the peak population estimates for European shag in Scapa Flow for each season. The shag is not a target species for the aerial surveys, therefore all population estimates are derived from land/boat-based counts. Total population counts ranged from 2,233 to 3,393 individuals. All estimates in three seasons exceeded the Stage 1 threshold, and so did the mean peak of these.

**Table 14.** Peak seasonal population estimates for European shag in the Scapa Flow for land and boat-based surveys from 1998/99, 2000/01 and 2006/07. Highlighted cells indicate counts that exceed the SPA Stage 1 selection thresholds (Wetlands International 2006).

<b>Season</b>	<b>Maximum estimate</b>	<b>Method</b>	<b>Date</b>
<b>SPA qualification threshold = 2000</b>			
1998/99	3393	land/boat-based raw count	January 1999
2000/01	3161	land/boat-based raw count	November 2000
2006/07	2233	land/boat-based raw count	November 2006
Mean of three most recent seasons	<b>2,929</b>		

### 3.3.12 Waterbird assemblage

Population estimates for all species recorded (including non-target species) were summed for each season to produce population estimates for the waterbird assemblage using Scapa Flow. The peak total population estimates of all species for each season are

The numbers of inshore waterbirds using Scapa Flow during the non-breeding season, and an assessment of the area's qualification for SPA status

presented in Appendix B, Table B1 and the total population estimate of the waterbird assemblage for each season is summarised in Table 15. 49% of the waterbird assemblage estimate was derived from land and boat-based counts. The maximum peak assemblage of 13,516 individual waterbirds did not exceed the Stage 1.3 threshold of 20,000 individuals.

**Table 15:** Peak population estimates of the waterbird assemblage using Scapa Flow each season and the mean peak population estimate which is based on the five most recent seasons.

Season	Peak population estimate of waterbird assemblage	Date
1998/99 1312	7	November 1998
2000/01 1351	6	January 2001
2002/03 932		December 2002
2003/04 3982		February 2004
2004/05 2352		March 2005
2005/06 2579		February 2006
2006/07 9302		November 2006
Mean of five most recent seasons	<b>3829</b>	

## **4 Discussion**

### **4.1 Distance sampling analyses**

Sufficient data to allow distance analysis were available only for common eider long-tailed duck and great northern diver in Scapa Flow.

It was also possible to model a detection function for one out of five red-breasted merganser surveys. However, for the red-breasted merganser surveys, other and those for common scoter, common goldeneye and red-throated diver, it was not possible to model detection functions.

Where it was not possible to model a detection function either raw counts were used or mean density was extrapolated from raw counts.

### **4.2 Application of Stage 1 UK Selection Guidelines**

#### **4.2.1 Common eider**

The common eider is a regularly occurring migratory species in the UK. Therefore, Stage 1.2 of the UK SPA Selection Guidelines should be applied in the initial assessment of whether the site might be suitable for further consideration for classification as a SPA for the species (Stroud *et al*, 2001). The threshold for such assessment is 1% of the relevant biogeographical wintering population, in this case 12,850 individuals (Wetlands International 2006).

Population estimates were obtained from raw counts (land/boat based surveys) and distance sampling analysis (aerial surveys). Peak population estimates for each survey of common eider ranged from 721 to 2,555 individual birds, with a mean of peak counts of 1,593 (Table 4). Population estimates were relatively consistent across seasons. All survey densities and population estimates derived from distance sampling analysis had narrow 95% confidence intervals. Current online WeBS count data (at <http://blx1.bto.org/websonline/>) from Water Sound and Widewall Bay show only low numbers of birds with a 5 year mean peak of 100 and 21 individuals perspective from 2000/01 to 2004/05.

Peak estimated numbers of common eider in Scapa Flow did not exceed the threshold in any of five seasons, nor did the mean of peak estimated numbers for the five seasons. Therefore, this site does not meet the requirements of Stage 1.2 of the SPA Selection Guidelines for this species.

#### **4.2.2 Long-tailed duck**

Long-tailed duck is a regularly occurring migratory species in the UK. Therefore, Stage 1.2 of the UK SPA Selection Guidelines should be applied in the initial assessment of whether the site might be suitable for further consideration for classification as an SPA

for the species (Stroud *et al*, 2001). The threshold for such assessment is 1% of the relevant biogeographical wintering population, in this case 20,000 individuals (Wetlands International 2006).

Long-tailed ducks occurred in low numbers in Scapa Flow outwith the breeding season. Whereas good numbers of long-tailed ducks are known to have occurred in Scapa Flow for many decades (Lea & Bourne 1975; Lea 1980; Christer 1989; Williams 2000), peak population estimates for each of the current survey seasons ranged from 96 (based on small sample size) to 1,582, with a mean of peak counts of 622 individual birds (Table 5). Most estimates of long-tailed duck have large 95% confidence intervals associated with them, indicating low reliability in these numbers, but they are currently the best available estimates. The data also indicated some variation in population estimates across seasons. WeBS counts for long-tailed duck in Scapa Flow are relatively scarce. Current online WeBS count data (available at <http://blx1.bto.org/websonline/>) from Water Sound and Widewall Bay show very low numbers of birds with a 5 year mean peak of 77 and 29 individuals respectively from 2000/01 to 2004/05.

Peak estimated numbers of long-tailed duck in Scapa Flow did not exceed the qualifying threshold in any season, nor did the mean of peak estimated numbers for the five most recent seasons. Therefore, this site does not meet the requirements of Stage 1.2 of the SPA Selection Guidelines for this species.

#### **4.2.3 All scoter species**

Common and velvet scoter are regularly occurring migratory species in the UK. Therefore, Stage 1.2 of the UK SPA Selection Guidelines should be applied in the initial assessment of whether the site might be suitable for further consideration for classification as an SPA for these species (Stroud *et al*, 2001). The threshold for such assessment is 1% of the relevant biogeographical wintering population, in this case 16,000 and 10,000 individuals for common and velvet scoter respectively (Wetlands International 2006).

Common scoters were recorded in slightly higher numbers during aerial surveys compared with land and boat-based surveys (Table 3). Peak population estimates for each season ranged from 0 to 413, with a mean of peak counts of 95 individual birds (Table 6). The data indicated some variation in population estimates across seasons.

Velvet scoters were recorded only during land/boat-based surveys in Scapa Flow. This is possibly due to difficulties in identifying them to species level from the air, especially if they are distributed among common scoters. Peak population estimates for each season ranged from 5 to 19, with a mean of peak counts of 13 individual birds (Table 7).

Peak estimated numbers of common and velvet scoter in Scapa Flow did not exceed the threshold in any season, nor did the mean of peak estimated numbers for the five (common scoter, Table 6) or the three (velvet scoter, Table 7) most recent seasons.



Therefore, this site does not meet the requirements of Stage 1.2 of the SPA Selection Guidelines for these species.

#### **4.2.4 Common goldeneye**

Common goldeneye is a regularly occurring migratory species in the UK. Therefore, Stage 1.2 of the UK SPA Selection Guidelines should be applied in the initial assessment of whether the site might be suitable for further consideration for classification as an SPA for the species (Stroud *et al*, 2001). The threshold for such assessment is 1% of the relevant biogeographical wintering population, in this case 11,500 individuals (Wetlands International 2006).

Common goldeneye was only recorded once during aerial surveys. Higher numbers were observed during land-based counts, suggesting common goldeneye are under-recorded by aerial surveys and that land-based surveys provide more reliable population estimates for this species. This is possibly due to the difficulty in detecting them from the air, especially if they are distributed close to the coast at the end of a transect where the aircraft may begin turning. Consequently, the mean of the three most recent seasons is based entirely on land/boat-based counts. Population estimates for each survey of common goldeneye ranged from 38 to 282 with a mean of peak count of 219 (Table 8). WeBS counts for common goldeneye in Scapa Flow are scarce. Current online WeBS count data (available at <http://blx1.bto.org/websonline/>) from the Water Sound and Widewall Bay show only low numbers of birds with a 5 year mean peak of 23 and 27 individuals respectively from 2000/01 to 2004/05.

Peak estimated numbers of common goldeneye in Scapa Flow did not exceed the threshold in any of the five seasons, nor did the mean of peak estimated numbers for the five seasons. Therefore, this site does not meet the requirements of Stage 1.2 of the SPA Selection Guidelines for this species.

#### **4.2.5 Red-breasted merganser**

The red-breasted merganser is a regularly occurring migratory species in the UK. Therefore, Stage 1.2 of the UK SPA Selection Guidelines should be applied in the initial assessment of whether the site might be suitable for further consideration for classification as an SPA for the species (Stroud *et al*, 2001). The threshold for such assessment is 1% of the relevant biogeographical wintering population, in this case 1,700 individuals (Wetlands International 2006).

Population estimates were obtained from raw counts (land/boat based surveys) and distance sampling analysis (aerial surveys). Peak population estimates for each survey of red-breasted merganser ranged from 45 to 628 individual birds, with a mean of peak counts of 170 (Table 9). Higher numbers were observed during land-based counts, suggesting that aerial surveys may under-record their numbers and that land-based surveys provide more reliable population estimates for this species. This is possibly due to poorer detection of birds from the air when they are distributed close to the coast at the

end of a transect where the aircraft may begin turning. Current WeBS counts data (available at <http://blx1.bto.org/websonline/>) from the Water Sound and Widewall Bay show only low numbers of birds with a 5 year mean peak of 62 and 21 individuals respectively from 2000/01 to 2004/05.

Peak estimated numbers of red-breasted merganser in Scapa Flow did not exceed this threshold in seven out of seven seasons, nor did the mean of peak estimated numbers for the five most recent seasons. Therefore, this site does not meet the requirements of Stage 1.2 of the SPA Selection Guidelines for this species.

#### **4.2.6 Red-throated diver**

The red-throated diver is listed on Annex I of the EC Birds Directive. Therefore, Stage 1.1 of the UK SPA Selection Guidelines should be applied in the initial assessment of whether a site might be suitable for classification as an SPA for the species (Stroud *et al*, 2001). The threshold for such assessment is 1% of the published GB wintering population, in this case 170 individuals (O'Brien *et al*, 2008).

Counts of red-throated divers were slightly higher during land/boat-based counts compared with aerial surveys. Peak population estimates for each survey of red-throated diver ranged from 7 to 82 individual birds, with a mean of peak counts of 23 (Table 10). Interestingly, peak numbers from land-based survey all came from November counts, suggesting that some birds do not use the waters of Scapa Flow for the entire winter. Current WeBS count data (available at <http://blx1.bto.org/websonline/>) from the Water Sound and Widewall Bay show very low numbers of birds with a 5 year mean peak of six and eight individuals respectively from 2000/01 to 2004/05.

Peak estimated numbers of red-throated diver in Scapa Flow did not exceed this threshold in any of the seven seasons, nor did the mean of peak estimated numbers for the five most recent seasons. Therefore, this site does not meet the requirements of Stage 1.1 of the SPA Selection Guidelines for this species.

#### **4.2.7 Black-throated diver**

The black-throated diver is listed on Annex I of the EC Birds Directive. Therefore, Stage 1.1 of the UK SPA Selection Guidelines should be applied in the initial assessment of whether a site might be suitable for classification as an SPA for the species (Stroud *et al*, 2001). The threshold for such assessment is 1% of the GB wintering population. The current GB wintering population for this species is estimated to be 700 birds. In cases such as this, where a population is sufficiently small, it is standard practice to set the Stage 1.1 threshold at 50 individuals. (Stroud *et al*, 2001, Baker *et al*, 2006).

Black-throated divers were not recorded during aerial surveys (Table 3). This is possibly due to difficulties in positively identifying them to species level from the air, especially if they are distributed close to the coast at the end of transect where the aircraft may begin turning. Black-throated divers are probably more likely to be recorded as unidentified

species in an area where all three species of divers occur. Recent WeBS counts of Scapa Flow are scarce. However, data available at <http://blx1.bto.org/websonline/> from the Water Sound show very low numbers of birds with a five year mean peak of only three individuals. During the same time (from 2004/05 to 2008/09) no black-throated divers were detected in Widewall Bay.

Peak population estimates for each survey of black-throated diver ranged from 57 to 58 individual birds, with a mean of peak counts of 57 (Table 11). Peak estimated numbers of black-throated diver in Scapa Flow exceeded the threshold in all three seasons of land/boat-based surveys. Therefore, this site meets the requirements of Stage 1.1 of the SPA Selection Guidelines for this species.

#### **4.2.8 Great northern diver**

The great northern diver is listed on Annex I of the EC Birds Directive. Therefore, Stage 1.1 of the UK SPA Selection Guidelines should be applied in the initial assessment of whether a site might be suitable for classification as an SPA for the species (Stroud *et al*, 2001). The threshold for such assessment is 1% of the GB wintering population. The current GB wintering population for this species is estimated to be between 2500-3000 birds. In cases such as this, where a population is sufficiently small, it is standard practise to set the Stage 1.1 threshold at 50 individuals (Stroud *et al*, 2001, Baker *et al*, 2006).

There was high variation in the peak population estimates of great northern divers for each season, ranging from 40 to 781, with a mean of peak counts of 229 individual birds (Table 12). Such variation is likely to be due to significant geographical movement of the birds in relation to certain parameters affecting their behaviour (eg food availability) rather than inaccurate surveys. The estimates for each season all exceeded the qualifying threshold of 50 individuals. Up to 16% of the GB winter population was recorded in Scapa Flow; therefore this area is clearly a very important site for great northern divers. There is evidence that relatively high numbers of great northern divers in Scapa Flow have occurred for some time (Booth *et al*, 1984; Williams 2000).

Peak estimated numbers of great northern diver in Scapa Flow exceeded this threshold in seven out of seven seasons. Additionally, the mean of peak estimated numbers for the five most recent seasons in exceeded this threshold. Therefore, this site meets the requirements of Stage 1.1 of the SPA Selection Guidelines for this species.

#### **4.2.9 All grebe species**

Grebes are recorded only rarely on aerial surveys as they tend to dive when low-flying aircraft approach. Consequently they can be difficult to identify to species level from the air, and are also usually located close inshore so are easily missed as the aircraft turns between transects. Therefore, land-based surveys, which allow more time for detection and more accurate identification of species, are most effective for surveying grebes.

#### **4.2.10 Little grebe and red-necked grebe**

Little grebe and red-necked grebe are regularly occurring migratory species in the UK. Therefore, Stage 1.2 of the UK SPA Selection Guidelines should be applied in the initial assessment of whether the site might be suitable for further consideration for classification as an SPA for these species (Stroud *et al*, 2001). The threshold for such assessment is 1% of the relevant biogeographical wintering population, in this case 4,000 and 510 individuals for little grebe and red-necked grebe respectively (Wetlands International 2006).

Peak estimated numbers of little grebe and red-necked grebe in Scapa Flow did not exceed the threshold in any of the three seasons, nor did the mean of peak estimated numbers for the three most recent seasons. Therefore, this site does not meet the requirements of Stage 1.2 of the SPA Selection Guidelines for these species.

#### **4.2.11 Slavonian grebe**

Slavonian grebe is listed on Annex I of the EC Birds Directive. Therefore, Stage 1.1 of the UK SPA Selection Guidelines should be applied in the initial assessment of whether a site might be suitable for classification as an SPA for the species (Stroud *et al*, 2001). The threshold for such assessment is 1% of the GB wintering population. The current GB wintering population for this species is estimated to be 725 birds. In cases such as this, where a population is sufficiently small, it is standard practice to set the Stage 1.1 threshold at 50 individuals (Stroud *et al*, 2001, Baker *et al*, 2006).

Peak population estimates for each survey of Slavonian grebe ranged from 59 to 141 individual birds, with a mean of peak counts of 135 (Table 13). Although breeding in Scotland in low numbers, most Slavonian grebes wintering in Britain are thought to breed in Iceland and Norway (Wernham *et al*, 2002). Peak seasonal population estimates ranged from 18-19% of the estimated GB wintering population. There is some evidence that nationally important numbers of Slavonian grebes occurred in Scapa Flow for some time (Evans 2000).

Peak estimated numbers of Slavonian grebes in Scapa Flow exceeded the threshold in all three seasons, as did the mean of peak estimated numbers for the three seasons. Therefore, this area meets the requirement of Stage 1.1 of the SPA Selection Guidelines for this species.

#### **4.2.12 Other waterbird species**

No other species of inshore waterbird observed in Scapa Flow (such as other seaduck, diver or grebe species) were recorded in sufficient numbers to reliably estimate total population size (Table 1). It is unlikely that any of these species regularly occur in numbers that would meet SPA Stage 1 SPA Selection Guidelines.

However, the European shag is regarded as a regularly occurring migratory species in the UK. Therefore, Stage 1.2 of the UK SPA Selection Guidelines should be applied in the initial assessment of whether the site might be suitable for further consideration for classification as an SPA for the species (Stroud *et al*, 2001). The threshold for such assessment is 1% of the relevant biogeographical wintering population, in this case 2,000 individuals (Wetlands International 2006).

Peak estimated numbers of the European shag in Scapa Flow exceeded the threshold in all three seasons, as did the mean of peak estimated numbers for the three seasons. Therefore, this site meets the requirements of Stage 1.2 of the UK SPA Selection Guidelines for this species.

#### **4.2.13 Waterbird assemblage**

The threshold for an assemblage of waterbirds to merit qualification as an SPA is that the area where it occurs should host more than 20,000 individuals of two or more species (Stroud *et al*, 2001). Regularity is assessed as for single species guidelines (Stages 1.1 and 1.2) and as described in Webb and Reid (2004).

The mean peak estimates of inshore waterbirds in Scapa Flow resulted in a total of 3,829 individual birds (Table 15). Therefore, the waterbird assemblage in Scapa Flow does not meet the requirements for Stage 1.3 of the UK SPA Selection Guidelines.

## 5 Conclusions

On the basis of the UK SPA Selection Guidelines (Stroud *et al*, 2001) Scapa Flow qualifies as an SPA for black-throated diver, great northern diver and Slavonian grebe at Stage 1.1. and for European Shag at Stage 1.2 during the winter period. Therefore, when the complete suite of marine SPAs in inshore areas is being determined the inshore areas of Scapa Flow (or parts thereof), should be considered for inclusion.

If the inshore areas of Scapa Flow are further considered for SPA classification then additional analysis will be required of the data presented here in order to determine a boundary for that SPA.

Based on the available data, Scapa Flow does not meet the UK SPA selection guidelines at Stage 1.3 for a water bird assemblage. However, the accumulated peak numbers and densities of birds in Scapa Flow relative to other inshore search areas are important in a Scottish context.

Once dedicated surveys have clarified the relative importance of other potential areas for the various species around the shores of both mainland Scotland and its islands, consideration may also be given to inclusion of other species using stage 1.4 of the SPA UK Site Selection Guidelines.

## **6 Acknowledgements**

We are thankful for the hard work, local knowledge and expertise of Jim Williams in completing land and boat-based counts of Scapa Flow, and to Richard Schofield and Mark Lewis who acted as observers during aerial surveys.

We thank the pilots from Ravenair and Hebridean Air Services for undertaking surveys at short notice in a safe and professional manner.

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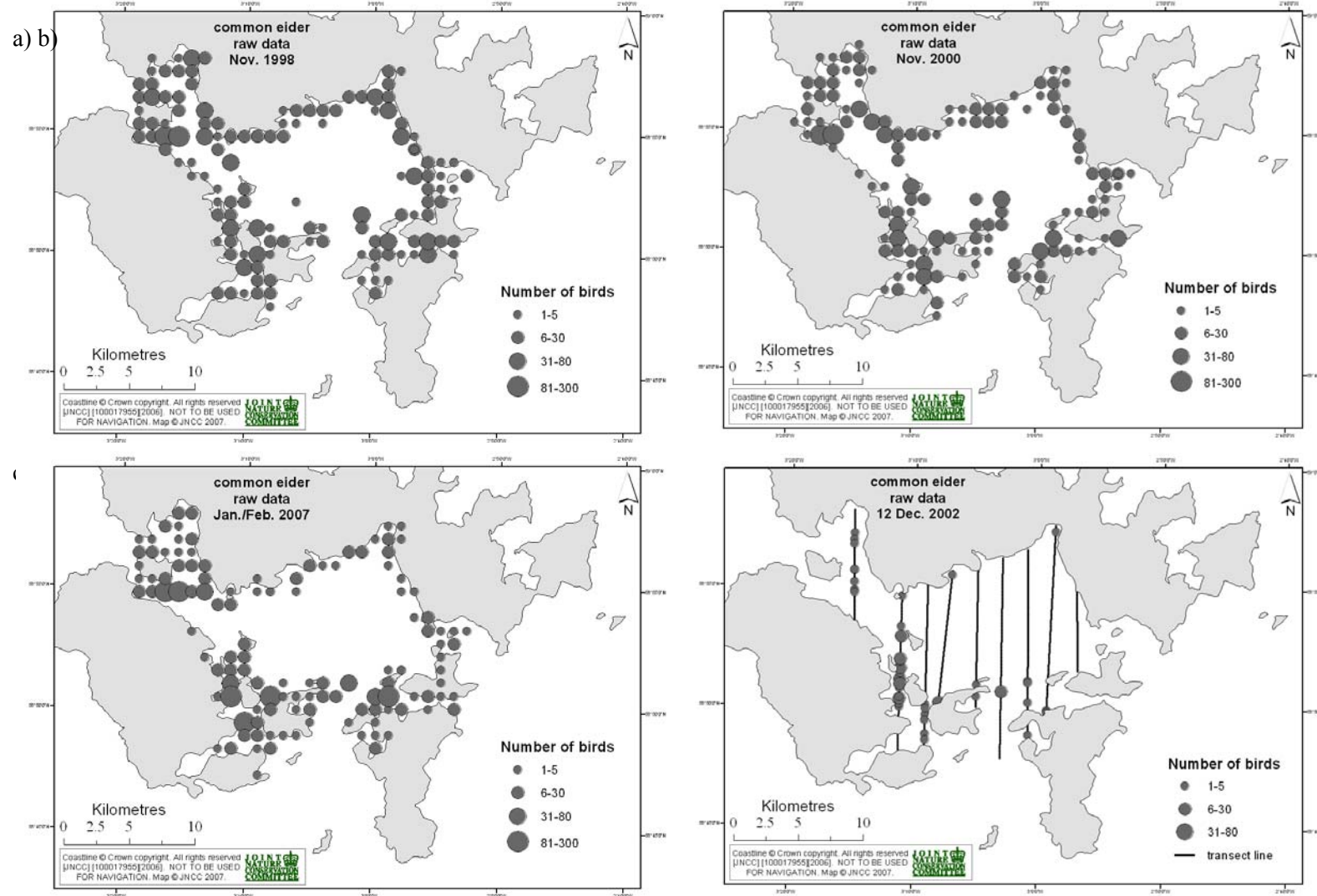
WERNHAM, C., TOMS, M., MARCHANT, J., CLARK, J., SIRIWARDENA, G. & BAILLIE, S. (EDs). 2002. The Migration Atlas. Movements of the birds of Britain and Ireland. T & AD Poyser, London.

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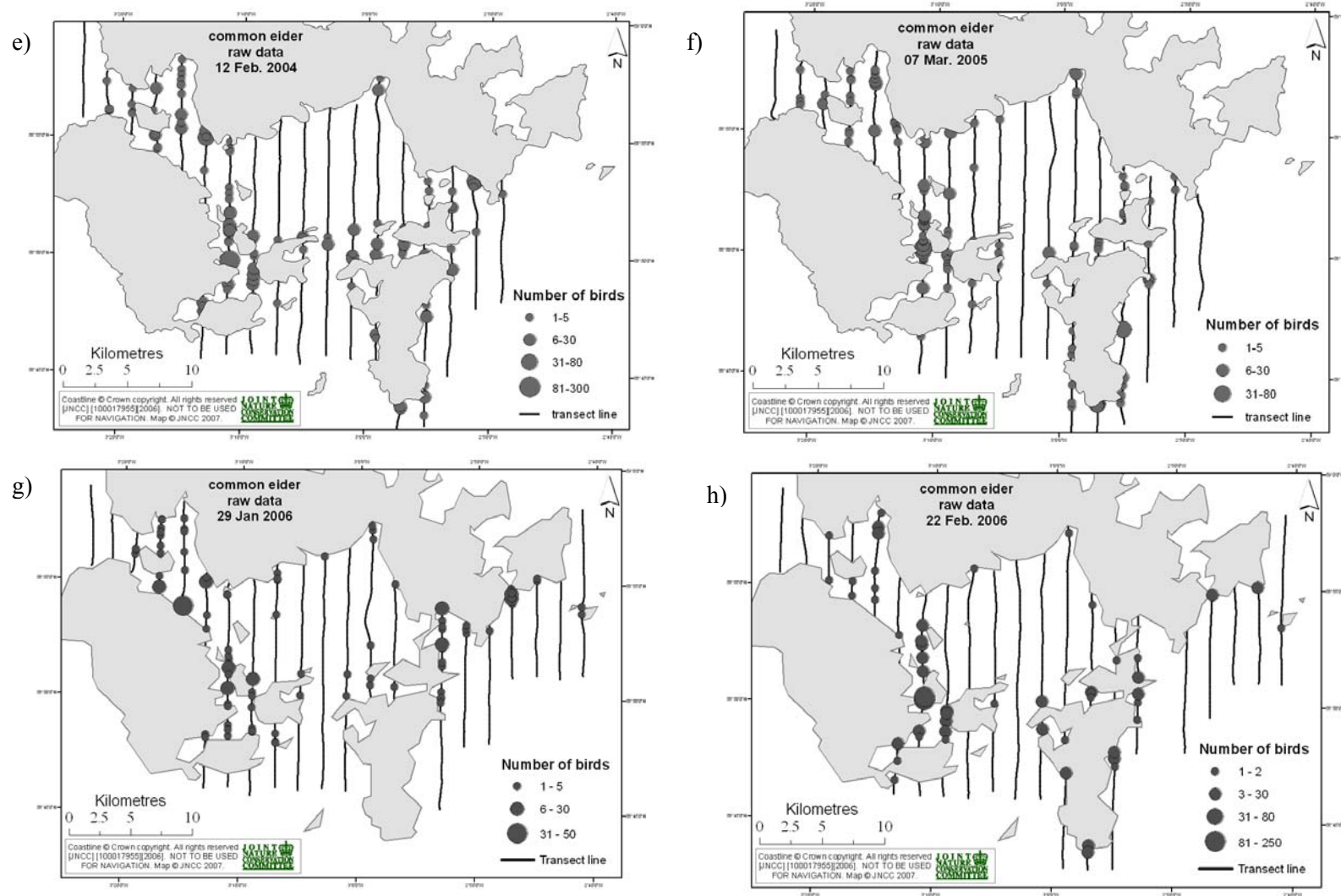
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## Appendix 1. Distribution of birds recorded during land, boat and aerial surveys

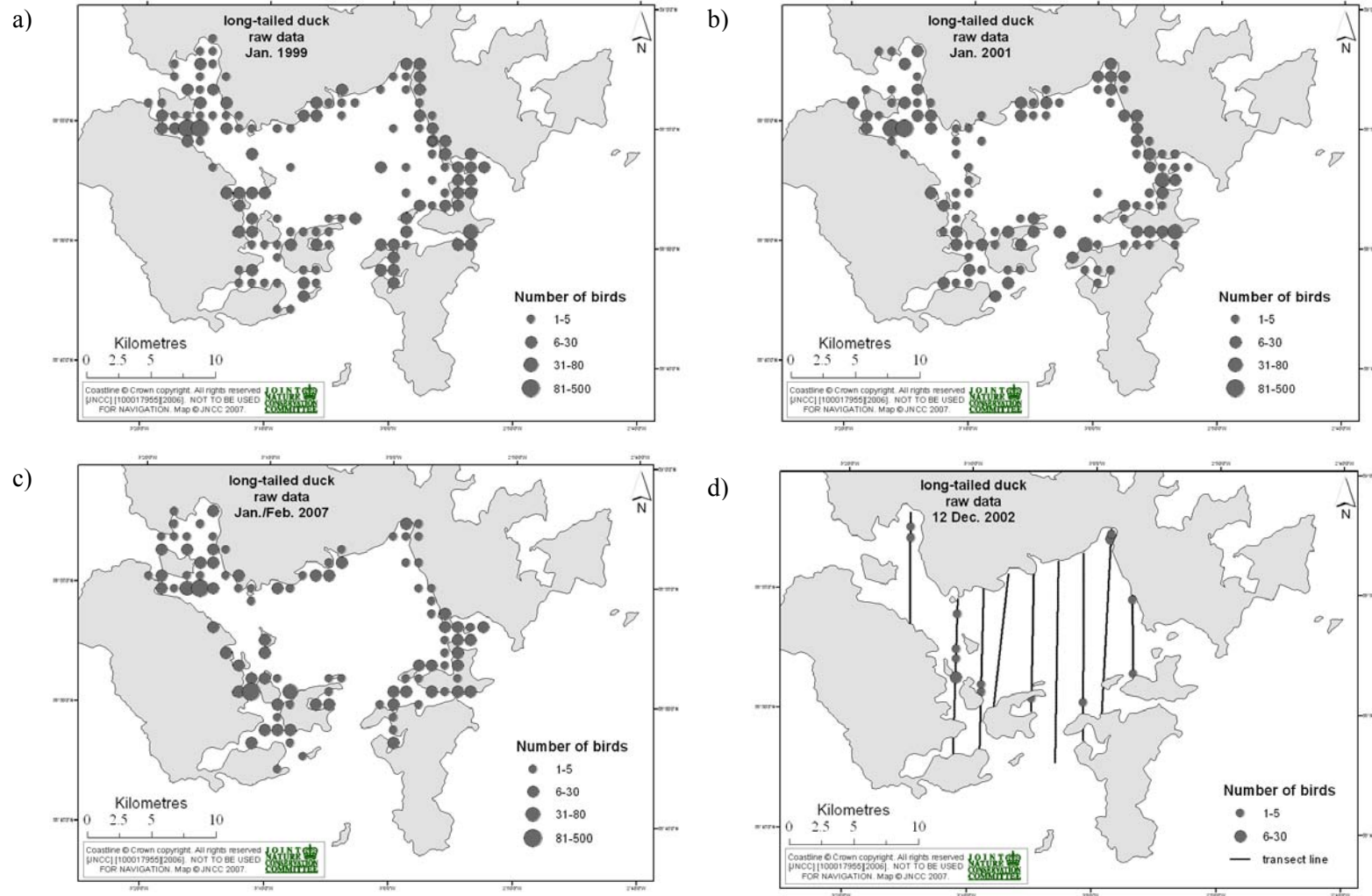
**Figure A1.** Distribution of common eider in Scapa Flow recorded during land and boat-based counts conducted in a) November 1998, b) November 2000, c) January/February 2007 and recorded during line-transect aerial survey conducted on d) 12 December 2002.



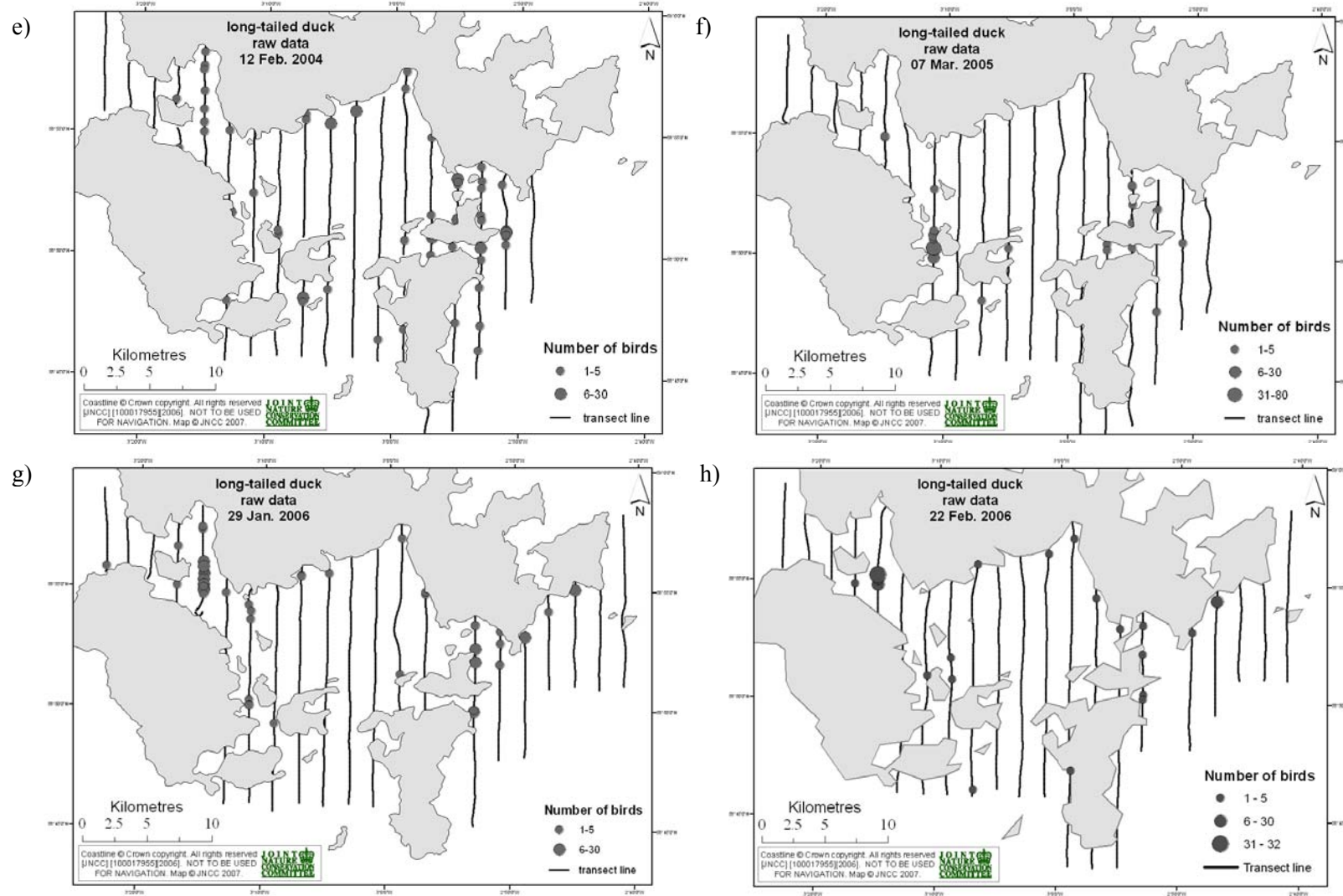
**Figure A1 cont.** Distribution of common eider in Scapa Flow recorded during line-transect aerial surveys conducted on e) 12 February 2004 f) 7 March 2005 g) 29 January 2006 and h) 22 February 2006.



**Figure A2.** Distribution of long-tailed duck in Scapa Flow recorded during land and boat-based counts conducted in a) November 1998, b) November 2000, c) January/February 2007 and recorded during line-transect aerial survey conducted on d) 12 December 2002.

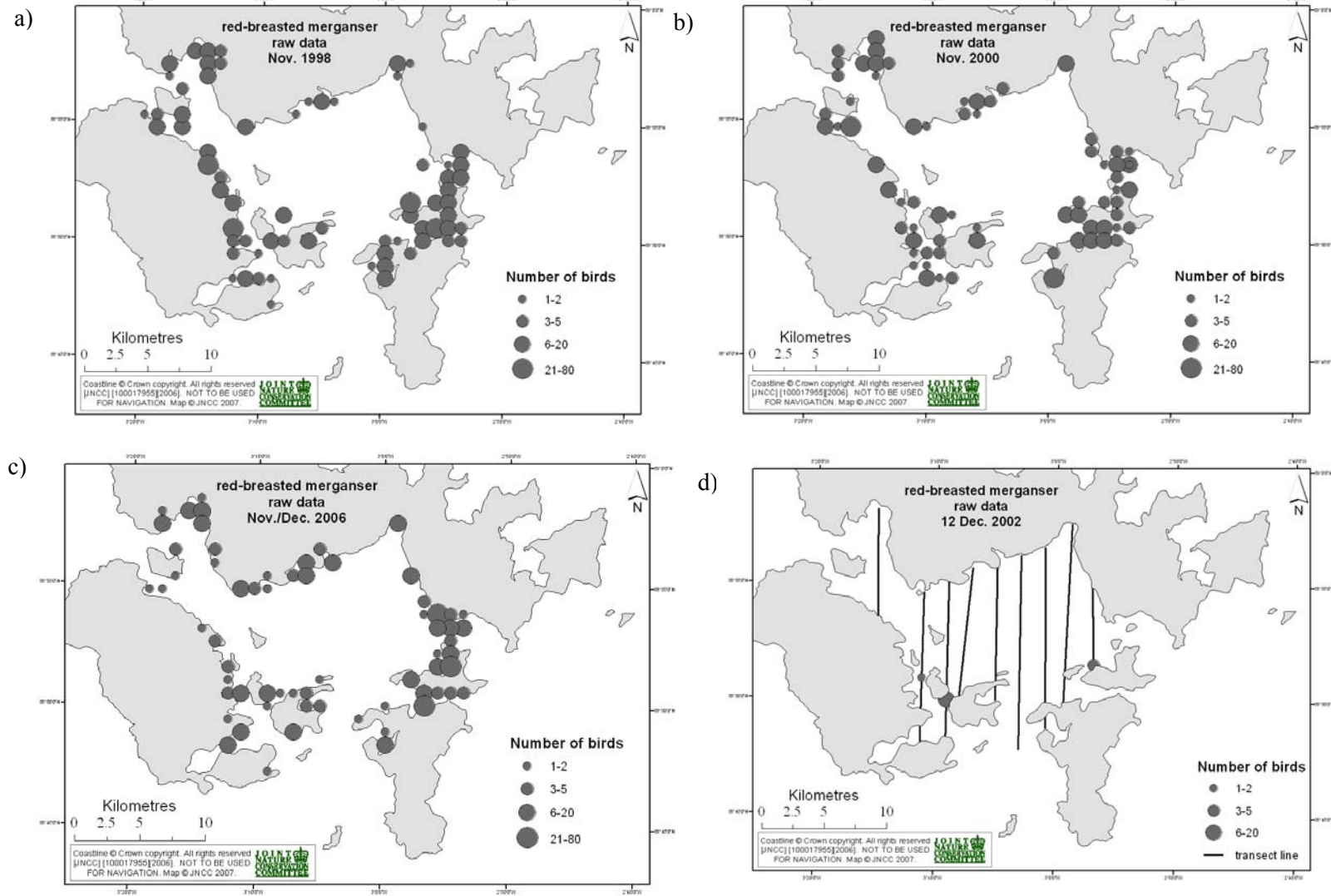


**Figure A2 cont.** Distribution of long-tailed duck in Scapa Flow recorded during line-transect aerial surveys conducted on e) 12 February 2004 f) 7 March 2005 g) 29 January 2006 and h) 22 February 2006.

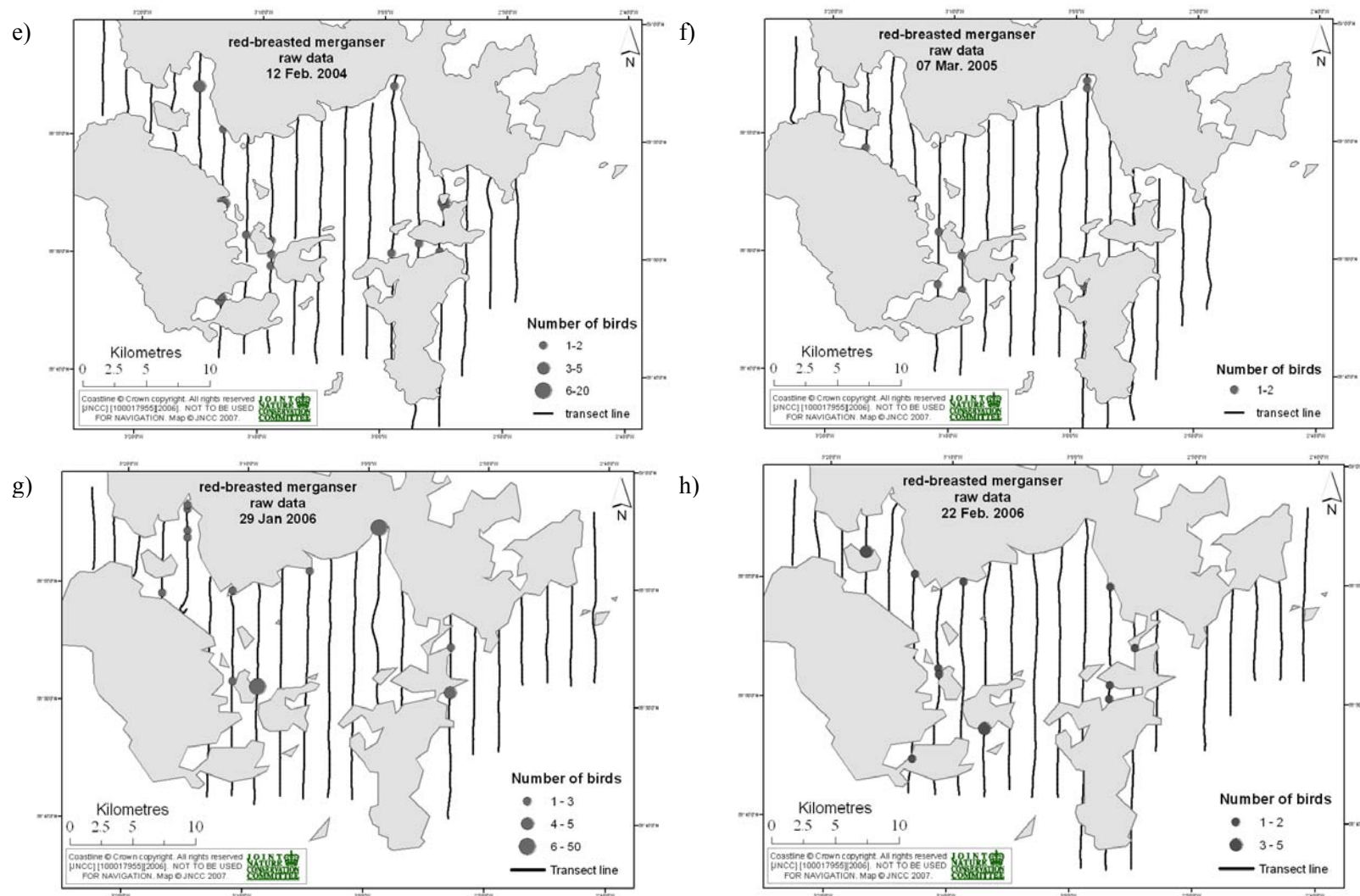




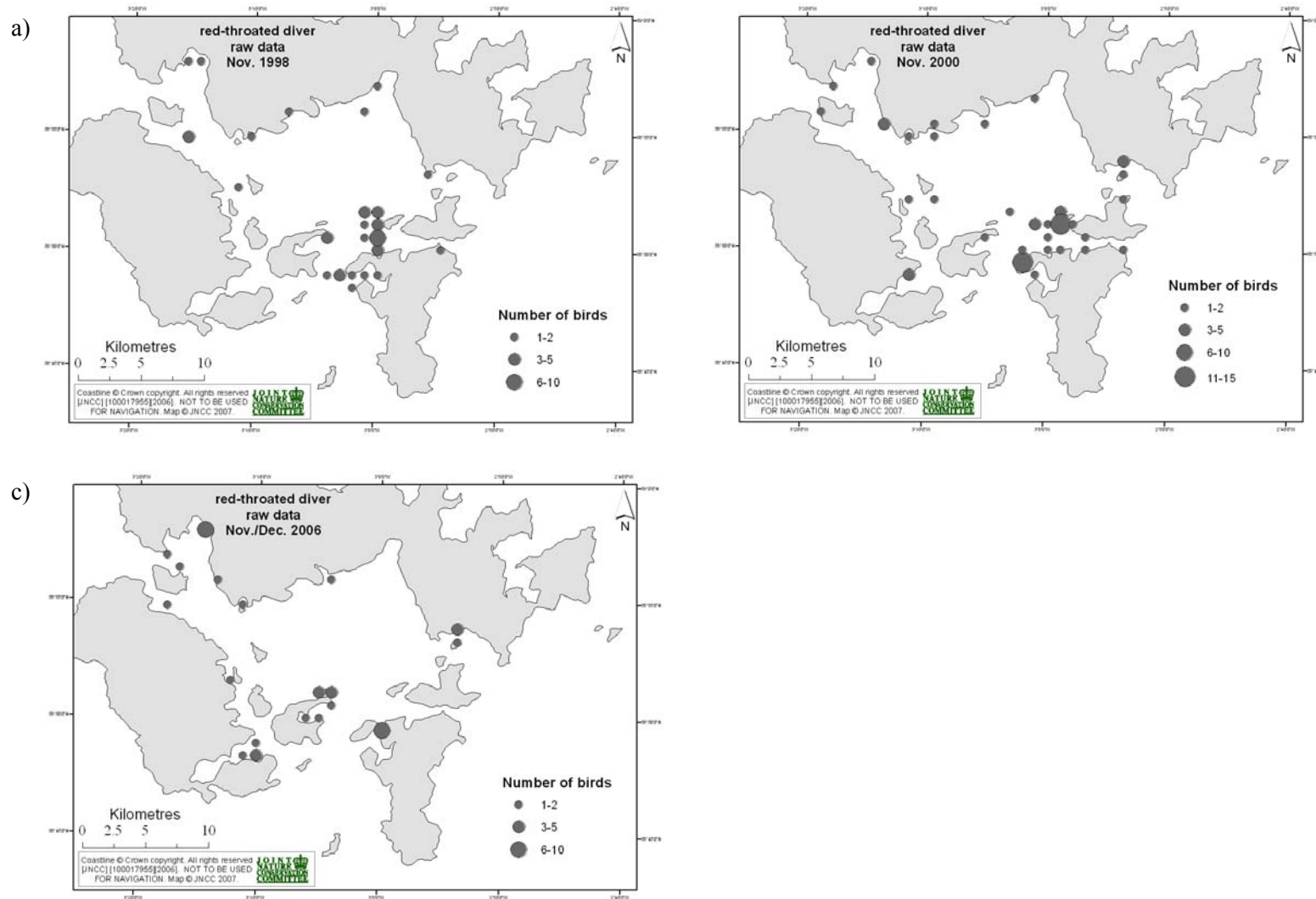
**Figure A3.** Distribution of red-breasted merganser in Scapa Flow recorded during land and boat-based counts conducted in a) November 1998, b) November 2000, c) January/February 2007 and recorded during line-transect aerial survey conducted on d) 12 December 2002.



**Figure A3 cont.** Distribution of red-breasted merganser in Scapa Flow recorded during line-transect aerial surveys conducted on e) 12 February 2004 f) 7 March 2005 g) 29 January 2006 and h) 22 February 2006.

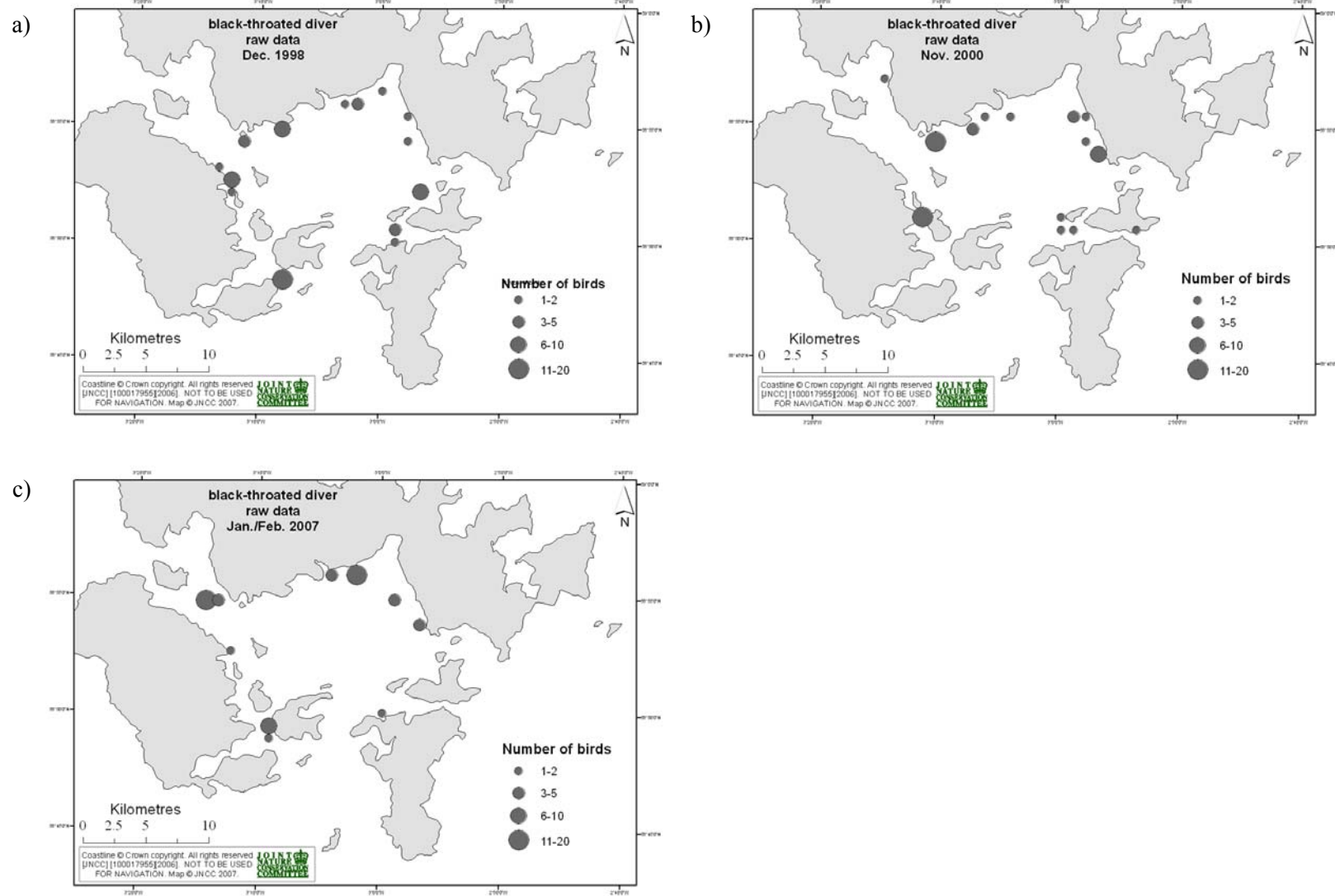


**Figure A4.** Distribution of red-throated divers in Scapa Flow recorded during land and boat-based counts conducted in a) November 1998, b) November 2000 and c) November/December 2006.

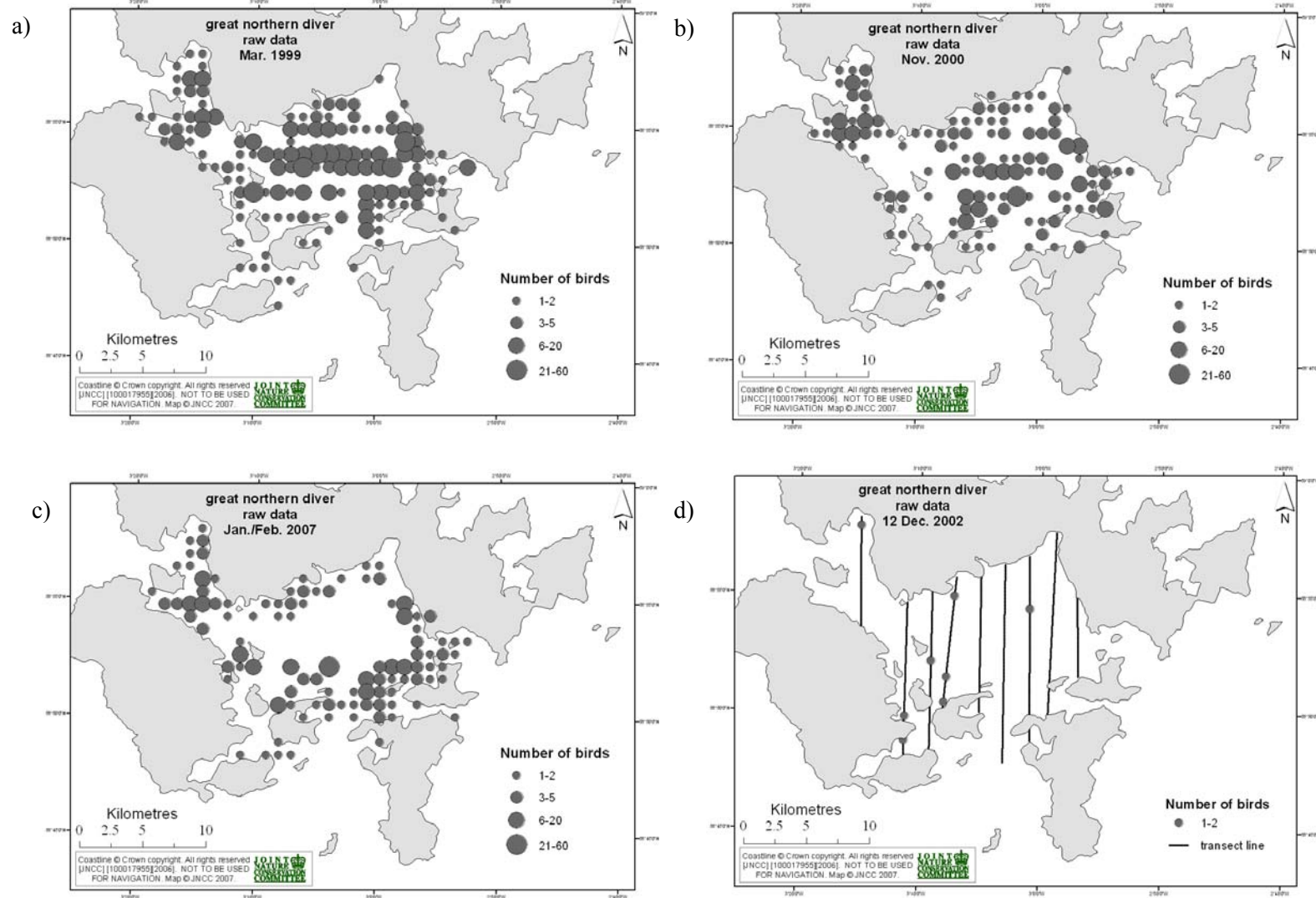




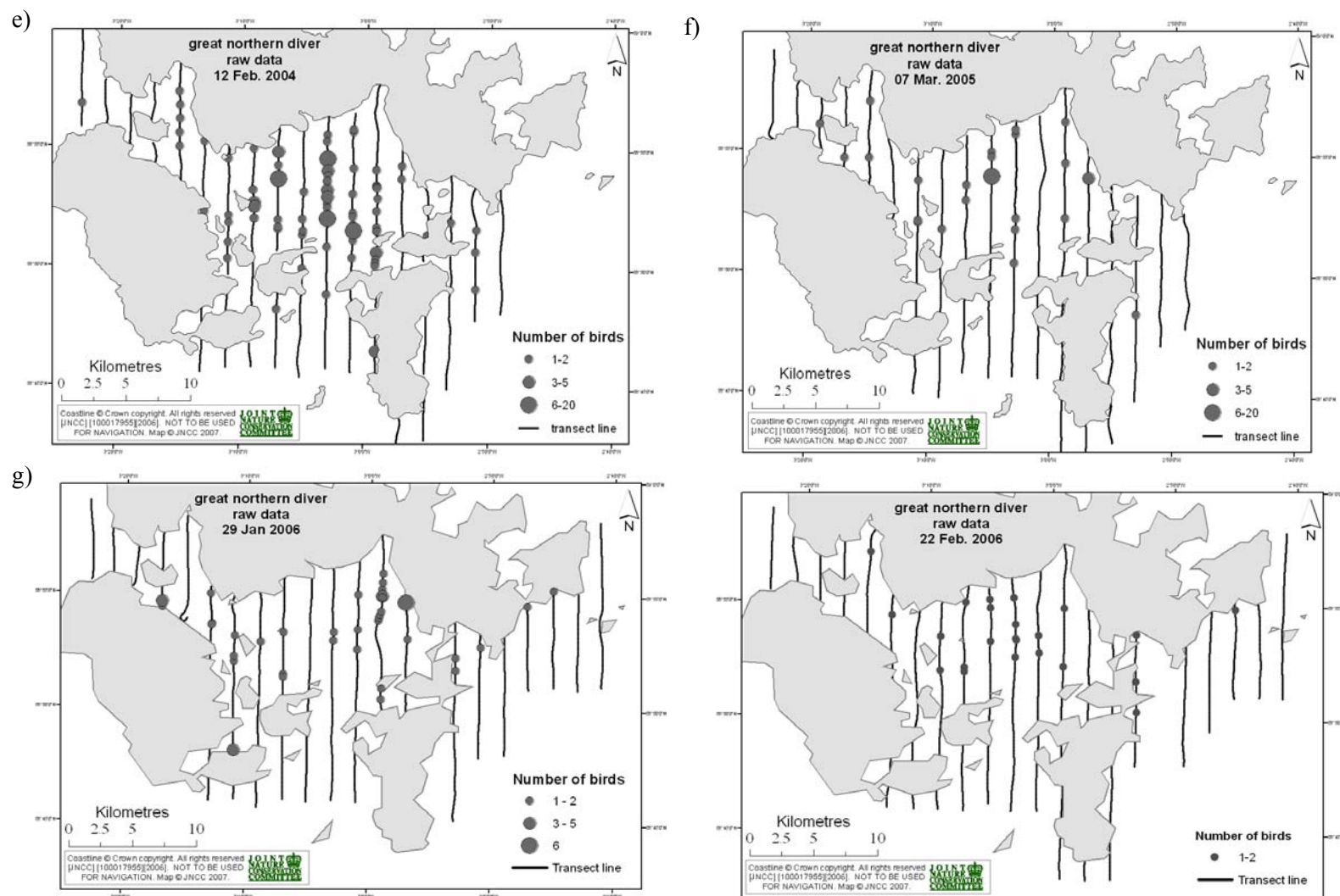
**Figure A5.** Distribution of black-throated divers in Scapa Flow recorded during land and boat-based counts conducted in a) December 1998, b) November 2000 and c) January/February 2007.



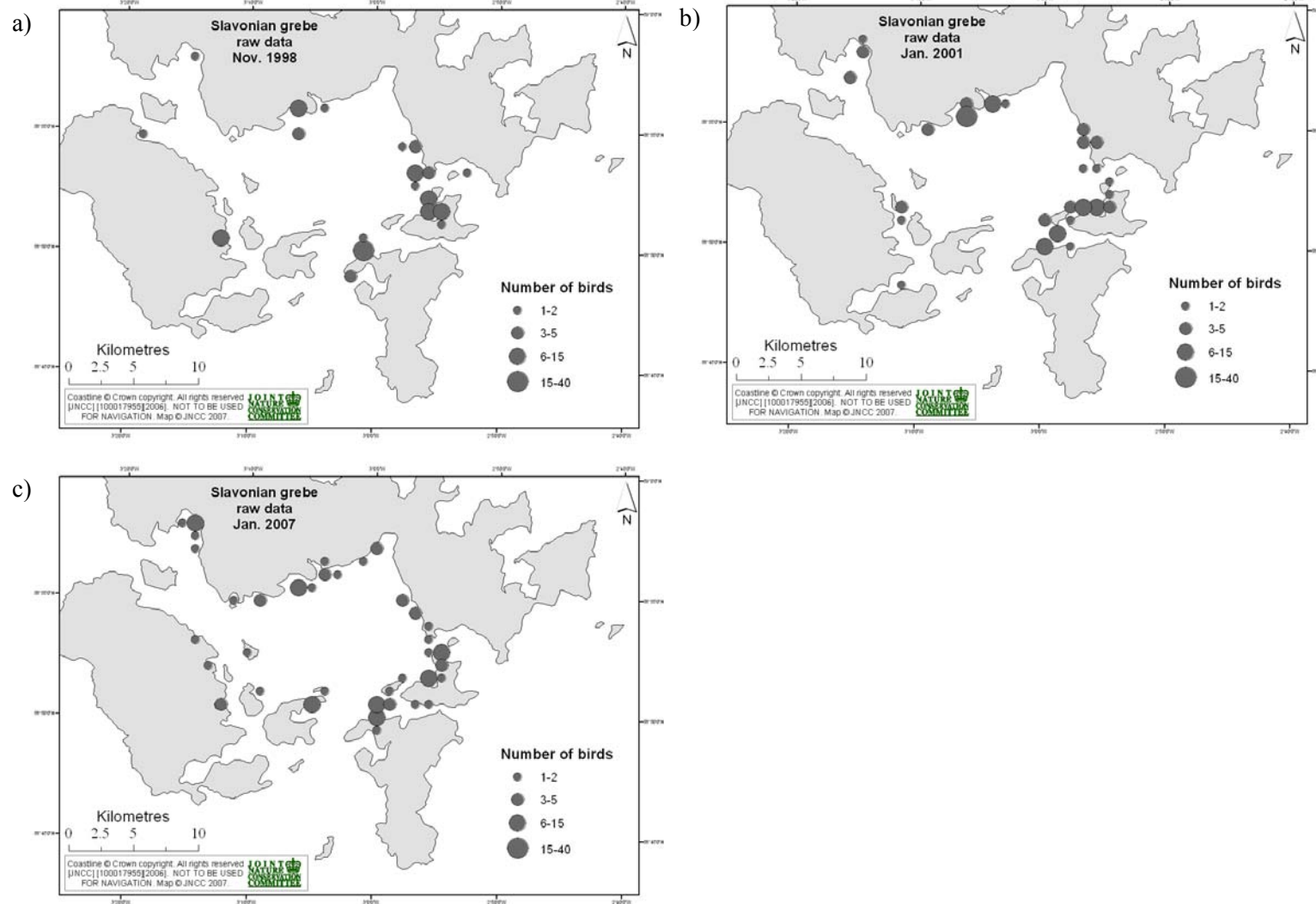
**Figure A6.** Distribution of great northern diver in Scapa Flow recorded during land and boat-based counts conducted in a) March 1999, b) November 2000, c) January/February 2007 and recorded during line-transect aerial survey conducted on d) 12 December 2002.



**Figure A6 cont.** Distribution of great northern diver in Scapa Flow recorded during line-transect aerial surveys conducted on e) 12 February 2004 f) 7 March 2005 g) 29 January 2006 and h) 22 February 2006.



**Figure A7.** Distribution of Slavonian grebe in Scapa Flow recorded during land and boat-based counts conducted in a) November 1998, b) January 2001 and c) January/February 2007.



## Appendix 2. Peak seasonal population estimates for waterbird assemblage

**Table B1** Peak seasonal population estimates for waterbird assemblages in the Scapa Flow for land/boat-based counts from 1998/99, 2000/01 and 2006/07 (light grey) and aerial survey estimates from 2002/03 to 2005/06 (white). The number in bold show the peak population estimates per season and are summarised in Table 15. Species for which population estimates were calculated are shown in dark grey (see section 3.1.1).

Species	Nov 98	Dec 98	Jan 99	Mar 99	Nov 00	Jan 01	Mar 01	Dec 02	Feb 04	Mar 05	Jan 06	Feb 06	Nov 06	Feb 07
Mute Swan	4	4	8	13	0	5	8 -		-	-	-	-	8	2
Greylag Goose	1	0	0	0	5	35	0 -		-	-	-	-	1	50
Common shelduck	2	20	42	72	0	46	96 -		-	-	-	-	2	57
Eurasian wigeon	2862	3715	3895	1171	2991	4823	1468 -		-	-	-	-	3118	2037
Gadwall	3	0	0	0	0	0	0 -		-	-	-	-	0	0
Common teal	730	776	1322	123	456	1291	216 -		-	-	-	-	172	243
Mallard	1038	1010	1127	154	847	1079	267 -		-	-	-	-	440	323
Pintail	0	2	0	0	0	0	0 -		-	-	-	-	0	0
Northern shoveler	0	3	0	0	0	2	5 -		-	-	-	-	0	0
Common eider	2308	1792	1680	2038	1980	1809	1635	721	2555	1659	1335	1097	1441	1693
Long-tailed duck	1224	1433	1582	1246	1184	1474	993	96	614	450	828	511	834	1122
Common scoter	3	0	2	2	7	3	6	26	413	0	0	32	3	6
Velvet scoter	7	9	19	7	11	9	6	0	0	0	0	0	5	10
Common goldeneye	71	248	282	231	40	254	199	0	0	0	0	38	38	121
Red-breasted merganser	628	477	477	324	488	388	292	49	123	46	134	72	501	437
Goosander	1	0	3	1	0	0	0	-	-	-	-	-	0	0
Red -throated diver	59	26	29	38	82	22	20	0	8	32	7	20	56	15
Black-throated diver	49	57	47	42	58	54	18	0	0	0	0	0	25	57
Great Northern diver	540	644	145	781	438	411	359	40	269	165	275	121	288	298
Little grebe	7	10	8	2	5	6	4	0	0	0	0	0	2	7
Red-necked grebe	3	4	21	23	10	3	1	0	0	0	0	0	0	2
Slavonian grebe	102	91	124	74	74	141	59	0	0	0	0	0	83	139
Cormorant	92	50	55	32	87	68	8 -		-	-	-	-	52	31
European shag	3393	2276	2154	744	3161	1593	629	-	-	-	-	-	2233	706
<b>Total</b>	<b>13127</b>	12647	13022	7118	11924	<b>13516</b>	6289	<b>932</b>	<b>3982</b>	<b>2352</b>	<b>2579</b>	1891	<b>9302</b>	7356

### Appendix 3. Detailed population estimates

**Table C1:** Density and population estimates for **common eider** from aerial surveys carried out from 2002 to 2006 in Scapa Flow. Estimates were derived from distance sampling, except for those marked with an asterisk (\*), which were derived from extrapolation of raw counts. 95% confidence intervals (CI) are empirical (<sup>e</sup>) or bootstrap (<sup>b</sup>) estimates.

Survey date	No. transects	No. observed	No. flocks	Survey area (km <sup>2</sup> )	Density [birds/ km <sup>2</sup> ] (CI)	Total number of birds (CI)
<b>Season 2002/03</b>						
12 Dec 2002	9	304 77		217.59	3.31 (1.50-7.31)	721 (327-1591) <sup>e</sup>
<b>Season 2003/04</b>						
12 Feb 2004	18	832 116		424.53	6.02 (3.93-9.23)	2555 (1666-3918) <sup>b</sup>
<b>Season 2004/05</b>						
07 Mar 2005	18	599 113		429.37	4.55 (2.70-7.65)	1659 <sup>+</sup> (1160-3285) <sup>e</sup>
<b>Season 2005/06</b>						
29 Jan 2006	21	356 93		462.38	2.88 (1.59-5.23)	1335 (884-2351) <sup>b</sup>
22 Feb 2006	21	614 54		462.38	1.61 (0.93-2.80)	1097 <sup>+</sup> (390-1226) <sup>b</sup>

**Table C2:** Density and population estimates for **long-tailed duck** from aerial surveys carried out from 2002 to 2006 in Scapa Flow. Estimates were derived from distance sampling, except for those marked with an asterisk (\*), which were derived from extrapolation of raw counts. 95% confidence intervals (CI) are empirical (<sup>e</sup>) or bootstrap (<sup>b</sup>) estimates.

Survey date	No. transects	No. observed	No. flocks	Survey area (km <sup>2</sup> )	Density [birds/ km <sup>2</sup> ] (CI)	Total number of birds (CI)
<b>Season 2002/03</b>						
12 Dec 2002	9	99 29		217.59	0.88 (0.45-1.73)	222 <sup>+</sup> (98-376) <sup>e</sup>
<b>Season 2003/04</b>						
12 Feb 2004	18	210 55		424.53	1.31 (0.76-2.26)	614 <sup>+</sup> (447-1269) <sup>b</sup>
<b>Season 2004/05</b>						
07 Mar 2005	18	146 22		429.37	0.85 (0.36-2.00)	450 <sup>+</sup> (155-860) <sup>e</sup>
<b>Season 2005/06</b>						
29 Jan 2006	21	192 44		462.38	1.65 (0.80-3.39)	828 <sup>+</sup> (302-1517) <sup>b</sup>
22 Feb 2006	21	125 20		462.38	0.91	511 <sup>+</sup> (230-1137) <sup>e</sup>

**Table C3:** Density and population estimates for **red-breasted merganser** from aerial surveys carried out from 2002 to 2006 in Scapa Flow. Estimates were derived from distance sampling, except for those marked with an asterisk (\*), which were derived from extrapolation of raw counts. 95% confidence intervals (CI) are empirical (<sup>e</sup>) or bootstrap (<sup>b</sup>) estimates.

Survey date	No. transects	No. observed	No. flocks	Survey area (km <sup>2</sup> )	Density [birds/ km <sup>2</sup> ] (CI)	Total number of birds (CI)
<b>Season 2002/03</b>						
12 Dec 2002	9	16 5		217.59	0.33*	71*
<b>Season 2003/04</b>						
12 Feb 2004	18	29 15		424.53	0.29 (0.14-0.59)	123 (46-227) <sup>e</sup>
<b>Season 2004/05</b>						
07 Mar 2005	18	11 8		429.37	0.05*	45*
<b>Season 2005/06</b>						
29 Jan 2006	21	35 12		462.38	0.29*	134*
22 Feb 2006	21	24 11		462.38	0.23 (0.10-0.52) 72	*

**Table C4:** Density and population estimates for **red-throated diver** from aerial surveys carried out from 2002 to 2006 in Scapa Flow. Estimates were derived from distance sampling, except for those marked with an asterisk (\*), which were derived from extrapolation of raw counts. 95% confidence intervals (CI) are empirical (<sup>e</sup>) or bootstrap (<sup>b</sup>) estimates.

Survey date	No. transects	No. observed	No. flocks	Survey area (km <sup>2</sup> )	Density [birds/ km <sup>2</sup> ] (CI)	Total number of birds (CI)
<b>Season 2002/03</b>						
12 Dec 2002	9	0	0 217.	59	0	0
<b>Season 2003/04</b>						
12 Feb 2004	18	2 2		424.53	0.02*	8*
<b>Season 2004/05</b>						
07 Mar 2005	18	4 2		429.37	0.04*	32*
<b>Season 2005/06</b>						
29 Jan 2006	21	1 1		462.38	0.09*	7*
22 Feb 2006	21	6 4		462.38	0.04*	20*

**Table C5:** Density and population estimates for great northern diver from aerial surveys carried out from 2002 to 2006 in Scapa Flow. Estimates were derived from distance sampling, except for those marked with an asterisk (\*), which were derived from extrapolation of raw counts. 95% confidence intervals (CI) are empirical (<sup>e</sup>) or bootstrap (<sup>b</sup>) estimates.

Survey date	No. transects	No. observed	No. flocks	Survey area (km <sup>2</sup> )	Density [birds/ km <sup>2</sup> ] (CI)	Total number of birds (CI)
<b>Season 2002/03</b>						
12 Dec 2002	9	18 16		217.59	0.37 (0.14-1.02)	81 (30-157) <sup>b</sup>
<b>Season 2003/04</b>						
12 Feb 2004	18	156 78		424.53	0.55 (0.28-1.07)	269 <sup>+</sup> (142-536) <sup>e</sup>
<b>Season 2004/05</b>						
07 Mar 2005	18	33 23		429.37	0.38 (0.23-0.65)	165 (74-245) <sup>b</sup>
<b>Season 2005/06</b>						
29 Jan 2006	21	56 39		462.38	0.59 (0.31-1.16)	275 (135-462) <sup>b</sup>
22 Feb 2006	21	28 23		462.38	0.26 (0.15-0.45)	121 (62-195) <sup>b</sup>