JOINT NATURE CONSERVATION COMMITTEE

**JNCC Report**

**No. 414**

# Surveillance of winter and spring aggregations of seaducks, divers and grebes in UK inshore areas: Aerial surveys and shore-based counts 2006/07

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# Summary

From January to March 2007, the Joint Nature Conservation Committee (JNCC) conducted aerial surveys of wintering aggregations of seaducks, divers and grebes within a number of Scottish inshore areas. The aim of the surveys was to collect data on the wintering (November to March) numbers and distribution of inshore waterbirds in areas of the UK known to be important for this group of species. The surveys were carried out as part of the JNCC annual programme of surveillance of non-breeding populations of inshore waterbirds in the UK. Due to logistical problems, no surveys were carried out before January 2007. An additional survey of Aberdeen Bay was carried out in April 2007 to record spring aggregations in this area.

The areas surveyed by aircraft were: Aberdeen Bay, the Moray and Dornoch Firths, northern Orkney, the west coast of the Outer Hebrides, Coll, Tiree and the Sound of Mull, the Sound of Gigha and outer West Loch Tarbert, and the Firth of Clyde, including Loch Ryan and Luce Bay. Surveys were conducted from light aircraft, following a line-transect method designed to collect data that are suitable for both distance sampling (to estimate total numbers of birds by correcting for a decrease in detectability with increased distance from the transect line) and geostatistical modelling (to identify areas with the highest densities of birds).

Ten species of inshore waterbirds were recorded comprising red-throated diver, black-throated diver, great northern diver, greater scaup, common eider, common scoter, velvet scoter, long-tailed duck, common goldeneye, and red-breasted merganser. In addition, birds that could be identified only as diver species were recorded.

In contrast to previous winter surveys, no little gulls were observed. No red-necked, great crested or Slavonian grebes were observed, despite surveying areas with known concentrations of these species. It is not known whether these species are overlooked during surveys, or whether their behaviour renders them difficult to observe from the air. Bottlenose dolphins and harbour porpoises were recorded incidentally but are not discussed in this report.

Great northern divers were recorded mainly in the north and west, with the highest densities being in Orkney, the Outer Hebrides, and the sound of Gigha. Red-throated divers were recorded in the highest numbers in Aberdeen Bay in spring, with high numbers in Luce Bay in March. Eiders were numerous throughout, but were recorded in the highest numbers in Orkney, the Moray Firth, and the firth of Clyde. Common scoters and velvet scoters occurred in large numbers in the Moray Firth. The most long-tailed ducks were recorded in Orkney and the Moray Firth, and the only greater scaup were recorded in the Loch Ryan transects in the Firth of Clyde.

In addition to aerial surveys, monthly shore-based counts were conducted within the Aberdeen Bay area from June 2006 to May 2007 to provide additional information on inshore waterbird numbers. These counts are included in this report. Shore-based counts were also conducted between December and February within parts of the upper Firth of Clyde and Scapa Flow. Counts from these two sites are not included in this report.

# 1. Introduction

During the winter and spring of 2006/07, the JNCC Seabirds at Sea Team (SAST) conducted aerial surveys of wintering aggregations of sea ducks *Anatidae,* divers *Gaviidae* and grebes *Podicepididae*, hereafter referred to as inshore waterbirds. The surveys were conducted as part of the JNCC annual winter survey programme, which aims to collect data on non-breeding numbers and distributions of these species within UK coastal areas known to be important for inshore waterbirds.

The survey programme, in conjunction with similar aerial surveys by the Wildfowl and Wetlands Trust (WWT), supports two international instruments: the African-Eurasian Migratory Waterbird Agreement (AEWA; established under the Convention on the Conservation of Migratory Species of Wild Animals – also known as CMS or Bonn Convention (CMS 1999) and the European Union Birds Directive (EEC 1979). In support of the first of these, the survey programme aims to address the UK's obligations to monitor important populations of inshore waterbirds. In support of the second, the data collected during these surveys will be used to inform the process of identifying inshore areas as potential marine Special Protection Areas (SPAs) (Johnston *et al.,* 2002; Stroud *et al.,* 2001).

The aerial survey method used during the 2006/07 surveys has previously been used by both JNCC and WWT for dedicated surveys of coastal waters for aggregations of inshore waterbirds (Cranswick *et al.,* 2003, Dean *et al.,* 2003; Dean *et al.,* 2004a; Dean *et al.,* 2004b, Wilson *et al.,* 2006; Söhle *et al.,* 2006). It is a line-transect sampling method, based on that developed by the National Environmental Research Institute (NERI) in Denmark (Kahlert *et al.,* 2000), but with minor modification. In winter 2006/07, the surveys conducted by JNCC were carried out in Scottish inshore waters only, while WWT conducted surveys in the inshore waters of England and Northern Ireland (WWT Consulting 2007).

In the areas surveyed, the method proved to be time and cost effective for surveying large coastal areas for aggregations of some species of inshore waterbirds. The method permits the collection of spatially precise and accurate data on the distribution of inshore waterbirds along sample line-transects. These data may be used to estimate population sizes and to model the density distribution or presence/absence of recorded species using analytical techniques such as distance sampling (Buckland *et al.,* 2001) and geostatistical interpolation (Cressie 1991). Examples of these types of analyses can be found in McSorley *et al.,* (2005), Webb *et al.,* (2004), Webb *et al.,* (2006a) and Webb *et al.,* (2006b).

Using aerial survey methods there is the potential to miss some species, e.g. species that show avoidance behaviour to aircraft, or species that are close inshore and are missed by observers while the aircraft is banking at the coastline. Shore-based counts can potentially include some species that might be missed by aerial surveys, although the offshore extent of such counts can be limited. In addition to aerial surveys, the JNCC winter survey programme included shore-based counts of inshore waterbirds within the Aberdeen Bay area, the upper Firth of Clyde and Scapa Flow. These counts collected additional data on the numbers and distribution of inshore waterbirds and attempted to count the total numbers of birds present within the survey area.

This report outlines the methods used during the 2006/07 winter and spring aerial surveys of selected Scottish inshore water areas and shore-based counts of Aberdeen Bay, and presents the recorded numbers and diurnal distributions of the species observed in each survey area.

# 2. Methods

## 2.1 Target Species

The target species for aerial and shore-based count surveys were those inshore waterbirds that winter within coastal areas of the UK and are listed in Table 1 of the AEWA Action Plan (Convention of Migratory Species 1999), or in Annex I of the EC Birds Directive (79/409/EEC), or are migratory species that occur regularly in the UK. These species are red-throated diver *Gavia stellata*, black-throated diver *G. arctica*, great northern diver *G. immer*, red-necked grebe *Podiceps grisegena,* great crested grebe *P. cristatus*, Slavonian grebe *P. auritus*, greater scaup *Aythya marila*, common eider *Somateria mollissima*, common scoter *Melanitta nigra*, velvet scoter *M. fusca*, long-tailed duck *Clangula hyemalis*, common goldeneye *Bucephala clangula*, goosander *Mergus merganser* and red-breasted merganser *M. serrator*. In addition, cetaceans were recorded.

## 2.2 Aerial survey

### 2.2.1 Survey locations

Aerial surveys were conducted from January to May 2007 of the following areas:

- Aberdeen Bay
- Moray and Dornoch Firths
- North of Mainland Orkney
- West coast of the Outer Hebrides: Traigh Luskentyre, Sounds of Taransay and Harris, west coast of Uists & Barra
- The waters around Coll, Tiree and west Mull
- Sound of Gigha and outer West Loch Tarbert
- The Firth of Clyde and Loch Ryan
- Luce Bay

### 2.2.2 Survey time and total transect length

A total of 11 completed surveys were carried out over 16 days. All areas were surveyed once, apart from Luce Bay, and the Firth of Clyde, which were both surveyed twice.

Surveys taking place over two or more days were due to limited hours of daylight (trip 1, Luce Bay and trip 6, Moray Firth), fuel limitations (trip 12, Outer Hebrides) or poor conditions. A survey of the Sound of Gigha was attempted during January, but had to be abandoned as sea conditions were poor. All incomplete surveys were completed as soon as possible after the original survey date.

The approximate length of total transect lines surveyed during the 2006/07 aerial surveys was 4,501 km. The survey locations, date and time, and total lengths of the transect lines flown during each survey of each area are shown in Table 1. The locations of each survey area are shown in Figure 1.

**Table 1:** Survey trip number, area, date, times and total transect length within each area surveyed from January to April 2007. Start and end times do not include travel times to and from the survey sites.

| Trip no. | Area | Date | Start time (GMT) | End time (GMT) | No. transects flown | Total transect length (Km) |
|---|---|---|---|---|---|---|
| 1 | Luce Bay | 22/01/2007 | 14:15:59 | 16:17:17 | 14 | 170.71 |
| 2 | Luce Bay | 23/01/2007 | 10:37:12 | 11:40:34 | 15 | 158.15 |
| 3 | Firth of Clyde | 23/01/2007 | 12:03:14 | 13:28:17 | 9 | 195.47 |
| 4 | Firth of Clyde | 25/01/2007 | 09:38:05 | 14:01:15 | 20 | 322.15 |
| 5 | Dornoch Firth | 03/02/2007 | 10:00:04 | 12:31:49 | 18 | 428.58 |
| 6 | Moray Firth | 03/02/2007 | 14:33:14 | 15:40:18 | 10 | 171.68 |
| 7 | North Orkney | 18/02/2007 | 09:43:37 | 11:20:16 | 18 | 240.49 |
| 8 | Moray Firth | 18/02/2007 | 13:01:41 | 14:00:47 | 9 | 189.22 |
| 9 | Sound of Gigha | 23/03/2007 | 09:01:23 | 11:14:10 | 32 | 324.92 |
| 10 | Sound of Mull | 23/03/2007 | 13:50:29 | 16:14:13 | 21 | 305.45 |
| 11 | Coll and Tiree | 24/03/2007 | 09:28:57 | 16:24:58 | 24 | 378.74 |
| 12 | Outer Hebrides | 25/03/2007 | 12:11:40 | 15:37:21 | 33 | 331.96 |
| 13 | Outer Hebrides | 26/03/2007 | 09:12:31 | 10:27:34 | 5 | 339.77 |
| 14 | Luce Bay | 26/03/2007 | 13:59:09 | 16:33:04 | 12 | 339.82 |
| 15 | Firth of Clyde | 27/03/2007 | 09:45:32 | 14:59:22 | 35 | 227.29 |
| 16 | Aberdeen Bay | 26/04/2007 | 15:12:48 | 16:42:00 | 18 | 218.64 |

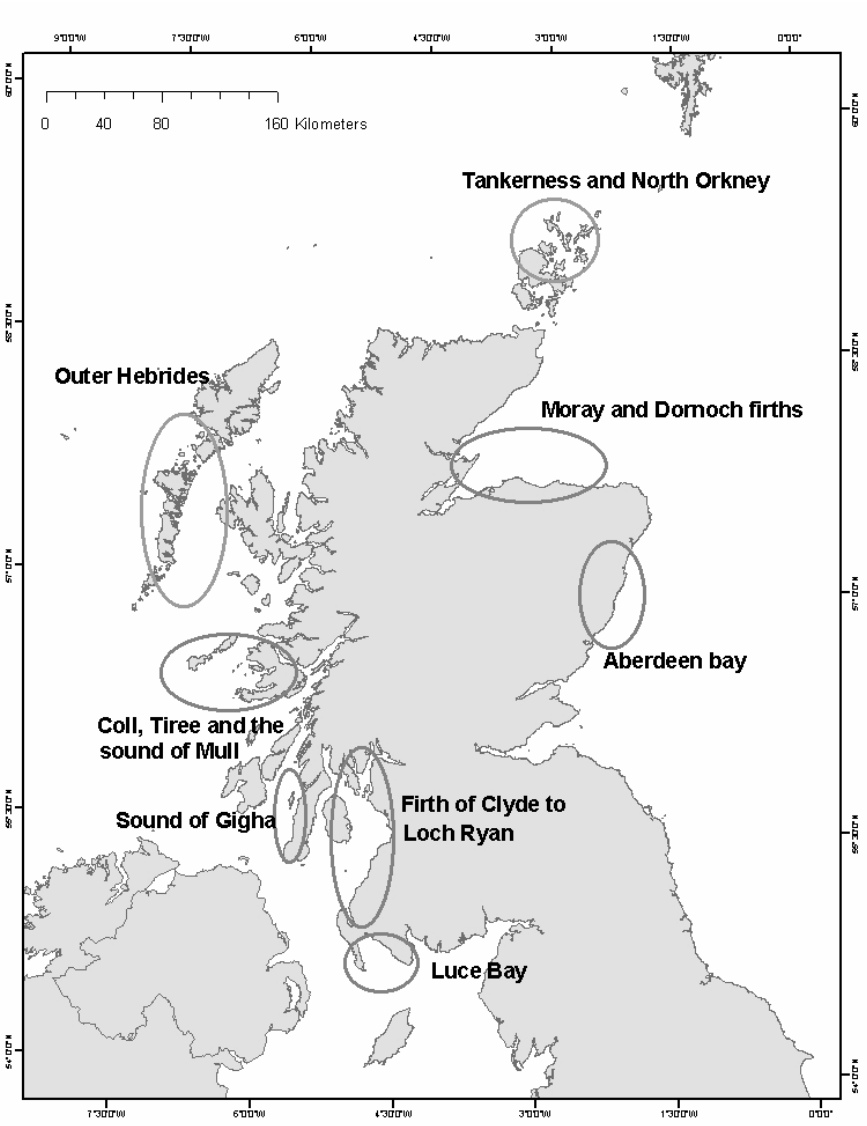


**Figure 1.** Locations of inshore areas surveyed by the JNCC during 2006/07 aerial survey season.

## 2.2.3 Survey method

Winter surveys were originally planned for November 2006 to March 2007. However, due to logistical reasons (weather conditions or aircraft availability), no surveys were carried out before January 2007.

The line-transect survey method applied during the 2006/07 surveys was developed in Denmark by the NERI (Kahlert *et al.*, 2000) to collect data suitable for analysis using distance sampling (Buckland *et al.*, 2001). Distance sampling provides a statistically robust method of estimating the numbers of birds that go undetected at various

perpendicular distances from the transect line, hereby allowing total population size to be estimated, with confidence limits.

Within each survey area, a regular grid of evenly spaced, parallel transect lines was defined, as described in Dean *et al.,* (2004a). East-west transect lines were spaced at 1.85km (1` latitude), except along the west coast of the Outer Hebrides and Coll and Tiree, where transects were spaced at 3.7km (2` latitude) apart. North-south transect lines were spaced at 2km (2` longitude). North-south or east-west transects were selected on the basis of running approximately perpendicular to the coastline of the survey area.

In some survey areas, a further transect was flown parallel to the coast (approximately 1 km offshore), to collect additional data to aid future spatial analyses. The data for these parallel transects are not included in this report.

Previous deployment of the line-transect sampling method (Dean *et al.,* 2003; Dean *et al.,* 2004a; Dean *et al.,* 2004b; Wilson *et al.,* 2006; Söhle *et al.,* 2006) has proven to be successful in providing data suitable for both distance sampling and geostatistical analyses (McSorley *et al.,* 2005; Webb *et al.,* 2004; Webb *et al.,*2006a; Webb *et al.,* 2006b). The data presented in this report are the raw data. This report does not include any distance sampling or geostatistical analyses of these data.

### 2.2.4 Aircraft

Surveys were conducted from either a Partenavia (PN-68), or a Britten-Norman Islander (BN2A) aircraft. Both aircraft have a high-winged design, allowing observers an unobstructed view of the sea. Both aircraft are capable of relatively low cruising speeds, thus maximising observation time, and are twin-engined, so satisfying legal and safety requirements. Neither aircraft was fitted with bubble windows. Any birds present within the strip of water directly below the aircraft could not be recorded; at the target altitude of 76m this strip extended approximately 44m port and starboard of the transect line.

The target altitude and cruising speed were standardised at 76m (250 feet) and 185km $h^{-1}$ (100 knots) respectively to minimise the flushing of birds from the water by the approaching aircraft (Kahlert *et al.,* 2000).

### 2.2.5 Weather conditions

Survey flights were undertaken between 07:00hrs and 18:00hrs GMT. Optimal conditions for survey flights were: excellent visibility (to the horizon), calm seas of sea state 3 or less (wind ≤ 10 knots, swell ≤ 0.6 m), high altitude light cloud cover and little or no precipitation. Some surveys were conducted in sub-optimal conditions, but never in sea state exceeding 4 (wind > 16 knots) or in low cloud (below 500 ft).

### 2.2.6 Data recording

During each survey flight, time and navigation data (including the aircraft's position, altitude and speed) were automatically recorded by two Global Positioning Systems (GPS) at a precision of 10 m or better. Data recorded with a Garmin GPSMap 276C

GPS was stored on a datalogger (DGPS-XM4-ALT), which was connected using a serial lap link. A back-up arrangement logged track data using a Garmin eTrex Legend C GPS. The pilot used either the onboard GPS (in the PN-68) or the handheld Garmin GPSMap 276C (in the BN2A) to maintain the aircraft's position along the transect line. Transect routes were pre-loaded into the GPS prior to the survey. The aircraft was generally flown within 50m of the intended transect line, except where ships or offshore platforms necessitated small detours.

Observations were made simultaneously by one port observer and one starboard observer, each of whom recorded data directly onto a cassette voice recorder, using the protocols described in Dean *et al.,* (2004a). In summary, observers recorded the start and end times of each transect (to the nearest second) directly onto the voice recorder. Observers also recorded the species, number and perpendicular distance (assigned in bands) of all inshore waterbirds from the transect line. Observed cetaceans were recorded in the same way. The time recorded was to the nearest second that the bird/flock passed abeam (at right angles to the length of the aircraft). The perpendicular distance of each observation from the transect line was recorded by assigning observations to one of four distance bands: band A = 44-162m; band B = 163-282m; band C = 283-426m and band D ≥ 427m. Observers determined these distances using fixed angles of declination from the visual horizon. In addition, visibility, cloud cover and wind speed were recorded at the beginning and at the end of each transect.

### 2.2.7 Data analysis

Observation data were entered into a Microsoft Access table, and navigation data uploaded from the GPS, into a Microsoft Access database table. The two tables were then linked using common time and date fields. The position of the aircraft, during small gaps in the navigation data (caused by poor GPS signal in some areas) was calculated by interpolation within the Access database, using a database routine written in Visual Basic for Applications (VBA) code. The total length of transects covered during each survey (Table 1), were calculated from the time and position data in the navigation database tables using VBA code.

Using the common time field in the Access database, each observation was assigned a location corresponding to the location of the aircraft at the time (to the nearest second) that the observation was recorded abeam. The database containing the navigation and observation data was linked to a Geographical Information System (ESRI ArcMap v.8.2 GIS), to generate the transect maps and distribution maps (Figures 3-36) presented in section 3.1.5.

## 2.3 Shore-based count survey

### 2.3.1 Survey area

Nine shore-based counts of the target species were conducted by SAST between June 2006 and May 2007 in Aberdeen Bay. Within 10 sub-sections, counts were made at 23 count points from Slains Castle (NK101 361) in the north to New Doonies Yawns (NJ9680 0370) in the south (Figure 2). In addition, shore-based counts were

conducted in Scapa Flow and in the Clyde, by external contractors. The methods and results of those counts will be reported elsewhere.

## 2.3.2 Count method

The locations of count points were chosen on the basis of accessibility, sufficient elevation, and uninterrupted line of sight to give an optimal all-round view of the coastline to the north and south. Generally, each section was counted from two count points and the observers used landmarks along the coast to determine the boundary of the count area. In some cases (sections 2 and 10), count points were placed close together because of the nature of the coastline.

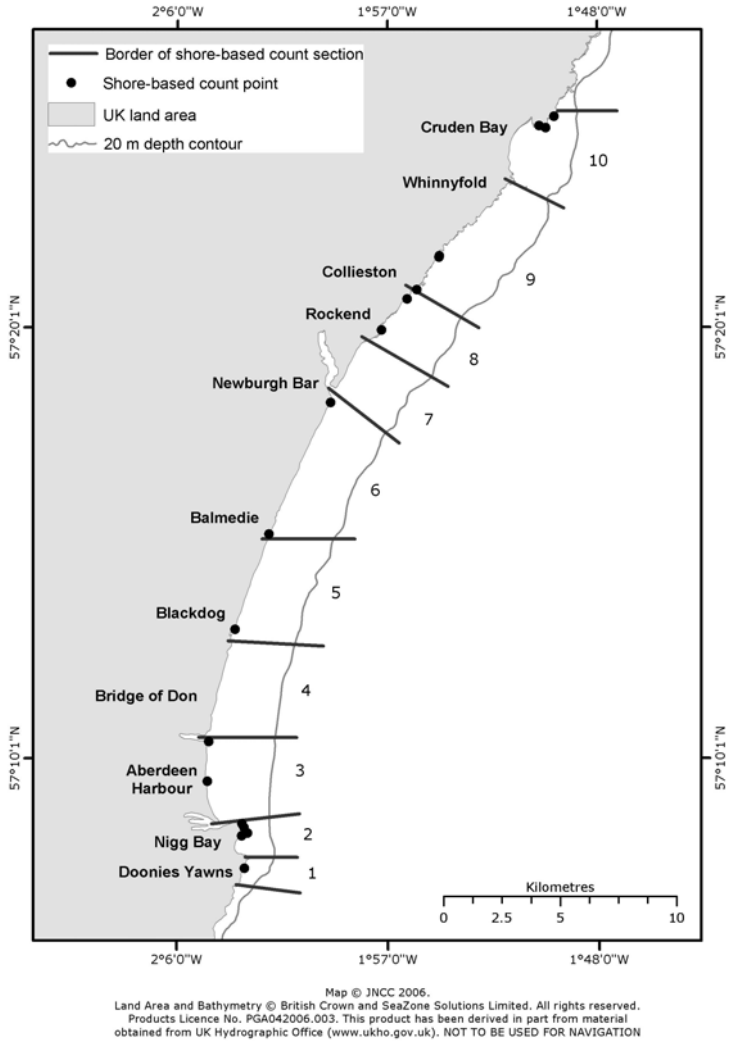


**Figure 2.** Locations of count points and count sub-sections for shore-based counts conducted within Aberdeen Bay, June 2006 – May 2007.

## 2.3.3 Weather conditions

Counts were undertaken only during daylight hours and in suitable weather conditions, which were defined as good to excellent visibility (little or no glare, haze,

or precipitation), calm seas (Beaufort Scale 3 or less, wind ≤ 10 knots), and high altitude, light cloud cover.

### 2.3.4 Data recording

Shore-based counts were carried out where possible on a single day during each month from June 2006 to May 2007 (Table 2). During winter, there was often insufficient daylight to cover the survey area in one day, in which case counts were made over two consecutive days where possible. Counts were made from each of the 23 count points using a tripod-mounted telescope with a 20-60x zoom, or 30x fixed eyepiece, generally working from north to south. The maximum distance from the shore within which birds could be counted was estimated to be approximately 2km in optimal conditions.

All target species observed on the water were counted and recorded. To avoid double counting, flying birds were excluded from calculations.

Details of the shore based counts carried out in Aberdeen Bay are given in Table 2.

**Table 2.** Survey details of shore based counts carried out in Aberdeen Bay, June 2006 to May 2007.

| Survey | Date | Start Time (GMT) | End Time (GMT) | Total survey hours |
|---|---|---|---|---|
| 1 | 27/06/2006 | 09:10 | 18:10 | 09:00 |
| 2 | 26/07/2006 | 09:10 | 15:00 | 05:50 |
| 3 | 30/08/2006 | 10:30 | 16:00 | 05:30 |
| 4 | 29/09/2006 | 09:30 | 18:25 | 08:55 |
| 5 | 03/11/2006 | 08:40 | 15:35 | 06:55 |
| 6 | 05/12/2006 | 10:25 | 12:25 | 02:00 |
| 6 | 06/12/2006 | 10:05 | 15:00 | 07:05 |
| 7 | 13/02/2007 | 14:10 | 15:40 | 01:30 |
| 7 | 14/02/2007 | 09:40 | 15:40 | 07:30 |
| 8 | 12/04/2007 | 07:50 | 14:45 | 06:55 |
| 8 | 13/04/2007 | 13:20 | 13:45 | 07:20 |
| 9 | 22/05/2007 | 07:55 | 15:50 | 07:55 |

# 3. Results/Discussion

## 3.1 Aerial survey

### 3.1.1 Species recorded

Ten of the 14 target species were recorded at least once during the 2006/07 aerial surveys (Table 3). These comprised red-throated diver, black-throated diver, great northern diver, greater scaup, common eider, common scoter, velvet scoter, long-tailed duck, common goldeneye and red-breasted merganser. In addition, some birds were recorded that could be identified only as diver species. No little gulls were seen during the surveys. Bottlenose dolphins and harbour porpoises were also recorded but are not further discussed in this report.

**Table 3**. Numbers of each species recorded on each aerial survey, January to March 2007.

| DATE | Area Name | Greater scaup | Common eider | Common scoter | Velvet scoter | Common goldeneye | Long-tailed duck | Red-breasted merganser | Red-throated diver | Black-throated diver | Great northern diver | Unidentified diver |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20070123 | Firth of Clyde | 232 | 185 | 83 | | 2 | 4 | 13 | 21 | | 10 | |
| 20070123 | Luce Bay | | 36 | 177 | | | 2 | | 3 | | 17 | 1 |
| 20070125 | Firth of Clyde | | 583 | | | | 5 | 3 | 25 | | 9 | |
| 20070125 | Scapa and N Orkney | | 83 | 37 | | | 9 | 1 | 2 | | 17 | 9 |
| 20070203 | Moray Extended Area | | 791 | 684 | 84 | | 250 | | 21 | | 31 | 10 |
| 20070218 | Scapa and N Orkney | | 789 | 35 | | | 393 | 39 | 7 | | 115 | |
| 20070218 | Sound of Mull | | 138 | | | | 77 | | 5 | | 23 | 5 |
| 20070323 | Sound of Gigha | | 226 | 19 | 5 | | 2 | 14 | | | 171 | 1 |
| 20070323 | Sound of Mull | | 10 | | | | | 11 | | | 12 | |
| 20070325 | Outer Hebrides | | 526 | | | | 41 | 31 | | | 128 | |
| 20070326 | Luce Bay | | 31 | 104 | 1 | 7 | | 2 | 37 | 1 | 40 | 3 |
| 20070326 | Outer Hebrides | | 130 | 7 | | | 1 | 1 | | | 24 | |
| 20070327 | Firth of Clyde | 132 | 829 | 15 | | | 7 | 17 | 47 | 7 | 10 | 4 |
| 20070426 | Aberdeen Bay | | 174 | 115 | | | 2 | 4 | 50 | | | |

Figures 3-36 show the distributions of the birds recorded during aerial surveys of each area. Most inshore waterbird species observed during aerial surveys were recorded inshore of the 20m depth contour, this depth being the maximum typical diving depth suggested for these species (Cramp & Simmons 1977). This corresponds with data collected by JNCC in previous years (Dean *et al.,* 2003, 2004a and 2004b, Wilson *et al.,* 2006, Söhle *et al.,* 2006).

### 3.1.2 Positional accuracy of observations

In considering the distribution maps (Figures 3-36) it is important to note that there is a degree of error associated with the positions assigned to each observation. An assessment of the accuracy of the locations assigned to bird observations was made using a method described by Dean *et al.,* (2004a). In summary it resulted in the following conclusions:

1. Most observations were assigned a position along the transect line within 257m of their actual position.

2. For the purposes of distribution mapping herein, all observations are assumed to be on the transect line and are therefore at least 44m and at most approximately 925–1000m from their true position either side of the transect line.

### 3.1.3 Interpreting the raw data

In considering these numbers it is also important to note that:

1. The data are samples (recorded along line-transects) of the total numbers present within each survey area. In order to produce total population estimates they should be analysed using distance sampling methods (Buckland *et al.,* 2001).

2. Comparison of absolute numbers of birds between different survey areas should be avoided due to differences in the size of survey areas and sampling intensity.

### 3.1.4 Distribution of bird observations

#### 3.1.4.1 Aberdeen Bay (Figures 3-5)

Aberdeen Bay was surveyed on 24 April 2007. Aberdeen Bay has been surveyed many times in previous years, but this is only the second spring aerial survey that has been completed (the other being on 10 May 2006). The main species recorded in this area were red-throated diver, common scoter, common eider, long-tailed duck and red-breasted merganser.

Distributions of birds in 2007 were similar to that in 2006. The largest concentrations of red-throated divers were around the Newburgh bar and along the shallow sandy bays to the south. Common eider were also present here, but were also found along

the more rocky coastlines to the north and the south. Small flocks of common scoter were observed north of Newburgh bar and off Blackdog.

**3.1.4.2 Firth of Clyde and Loch Ryan** (Figures 6-13)

The survey of the Firth of Clyde and Loch Ryan was completed on 23/25 January and on 27 March 2007. In January, eight species were recorded. Low numbers of common scoter, common eider, common goldeneye, long-tailed duck, red-breasted merganser, great northern diver and red-throated diver were observed, and nationally important numbers of greater scaup were present in Loch Ryan.

During the survey on 27 March 2007, seven species were recorded. Common eider, common scoter, long-tailed duck, red-breasted merganser and great northern diver were counted in small numbers, along with nationally important numbers of greater scaup. A raw count of 47 red-throated divers was recorded during the March survey.

**3.1.4.3 Coll and Tiree** (Figures 14-15)

The Coll and Tiree survey was carried out on 24 March 2007. Only two species were recorded, common eider and great northern diver. Both species were recorded in low numbers.

This is the fourth year that Coll and Tiree have been surveyed, and the fifth complete survey. Numbers of birds and diversity of species recorded have decreased since aerial surveys started in 2003/04. In the past, red-throated diver, long-tailed duck and red-breasted merganser were recorded in low numbers.

Recorded numbers of common eiders have remained constant throughout the four years of survey, occurring mainly in shallow waters north of the coasts of Tiree.

Great northern divers have been recorded in significant numbers in each of the four years the area has been surveyed, but recorded numbers have shown a general decline. This pattern has also been noted in the adjacent survey area in the Sound of Mull.

**3.1.4.4 Sound of Gigha** (Figures 16-18)

The sound of Gigha survey was carried out on 23 March 2007. Six species were recorded. Great northern divers were recorded throughout the survey area in nationally important numbers, with a raw count of 171 birds.

The other species recorded were common scoter, common eider, long-tailed duck, red-breasted merganser, and velvet scoter. These species occurred mainly between the Isle of Gigha and the Mull of Kintyre, and West Loch Tarbert. Most of these seaducks were recorded in low numbers, apart from common eider.

This is the third winter that the sound of Gigha has been surveyed, and the third year that significant numbers of great northern divers have been recorded.

**3.1.4.5 Outer Hebrides** (Figures 19-21)

The survey of the Outer Hebrides was carried out on 25 and 26 March 2007. Of the five species recorded, only great northern divers were present in significant numbers, being recorded throughout the west coasts of the Uists, Benbecula and Barra,

The other species recorded were common eider, common scoter, red-breasted merganser and long-tailed duck. Common eiders were recorded throughout the whole survey area. The small numbers of other seaducks recorded were mainly in sheltered areas such as the sound of Harris.

**3.1.4.6 Luce Bay** (Figures 22-25)

The Luce Bay surveys were carried out on 22/23 January 2007 and 26 March 2007. Eight species were recorded during two surveys, five in January, and seven in March.

In January, common scoter, common eider, long-tailed duck, red-throated diver and great northern diver were recorded. A greater number of great northern divers was recorded compared with previous years. A raw count of 37 red-throated divers was recorded (cf. 3 in January) and one black-throated diver was recorded (cf. none in January). These divers were mainly found in the centre of the bay.

Also recorded in March were common scoter, common eider, red-breasted merganser and velvet scoter. Main numbers of common eiders were found along the eastern coast of the Mull of Galloway, while common scoter flocks were mainly recorded in the north of the bay.

**3.1.4.7 Moray and Dornoch Firths** (Figures 26-30)

The Moray and Dornoch Firths were surveyed once over the 3 and 18 February 2007. The main species recorded were great northern diver, velvet scoter, and long-tailed duck.

Most of these birds occurred along the Moray coast, especially the large numbers of seaduck, with Spey Bay being particularly important.

**3.1.4.8 Sound of Mull** (Figures 31-32)

The Sound of Mull survey was carried out on 23 March 2007. Low numbers of only three species were recorded; 12 great northern divers, 10 were common eiders, and 11 red-breasted mergansers. Birds were recorded throughout the survey area, with high numbers around the island of Ulva.

This is the fourth year that the Sound of Mull has been surveyed, with consistently sparse populations of divers and seaducks being recorded.

**3.1.4.9 North Orkney** (Figures 33-36)

The survey of northern Orkney was completed on 18 February 2007. Of the six species recorded, three were present in nationally important numbers. A raw count of

115 great northern divers was recorded. Lower numbers of red-breasted merganser, common scoter and red-throated diver were recorded.

This survey was the first to be carried out over North Orkney (previous surveys have concentrated on Scapa Flow), so no comparisons with those surveys can be made. However, both the diversity of species and the numbers recorded reflect similarities with previous Scapa Flow surveys.

## 3.1.5. Distribution of observation maps

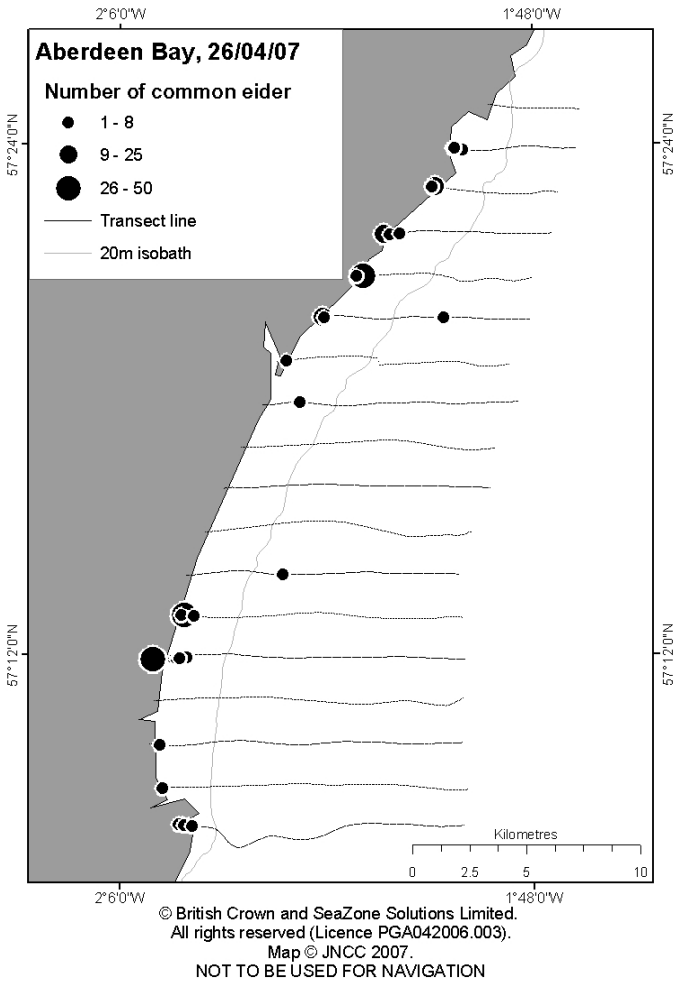


**Figure 3.** Distribution of common eider in Aberdeen bay, 26 April 2007

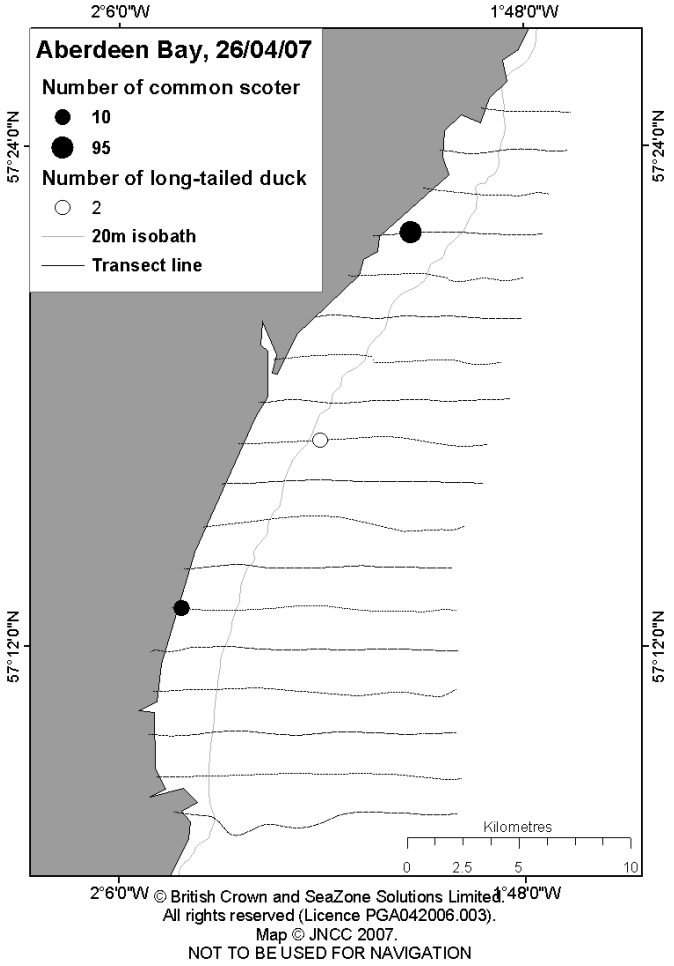


**Figure 4.** Distribution of common scoter and long tailed duck in Aberdeen bay, 26 April 2007

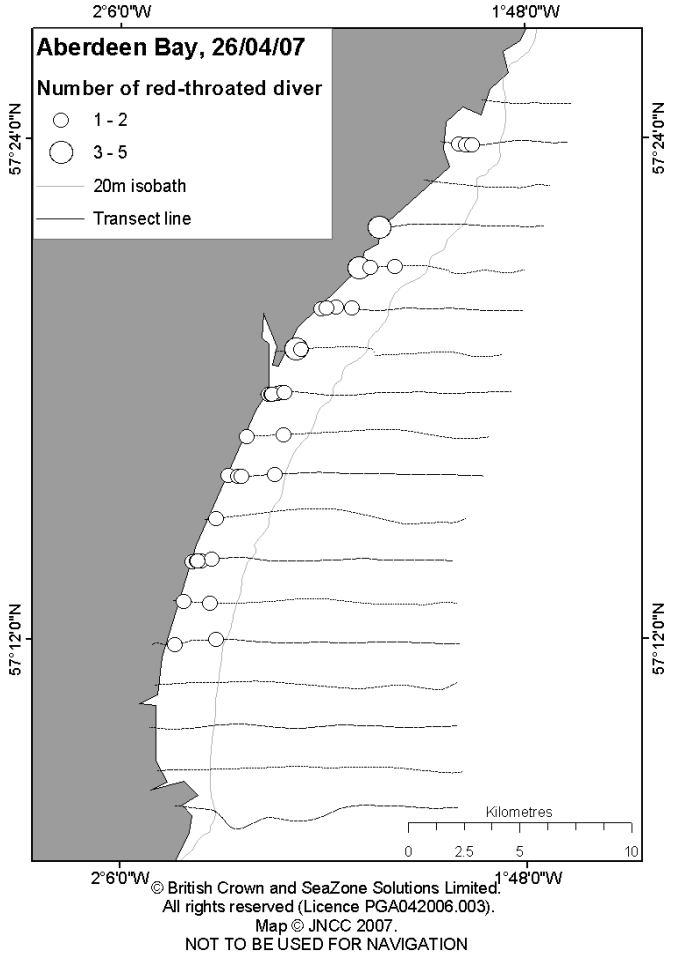


**Figure 5.** Distribution of red-throated diver in Aberdeen bay, 26 April 2007

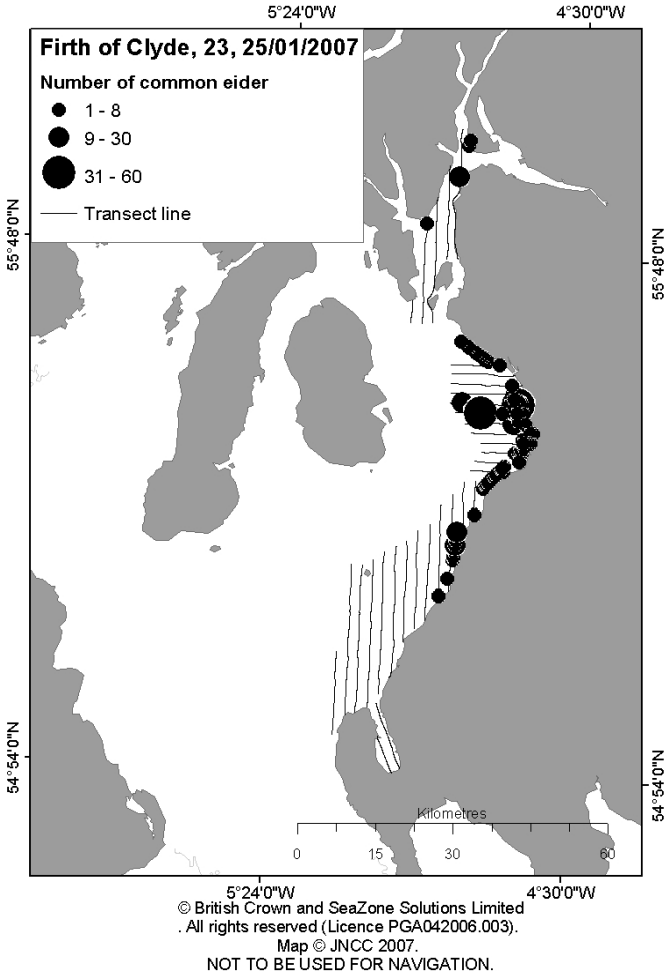


**Figure 6.** Distribution of common eider in the Firth of Clyde, 23 and 25 January 2007

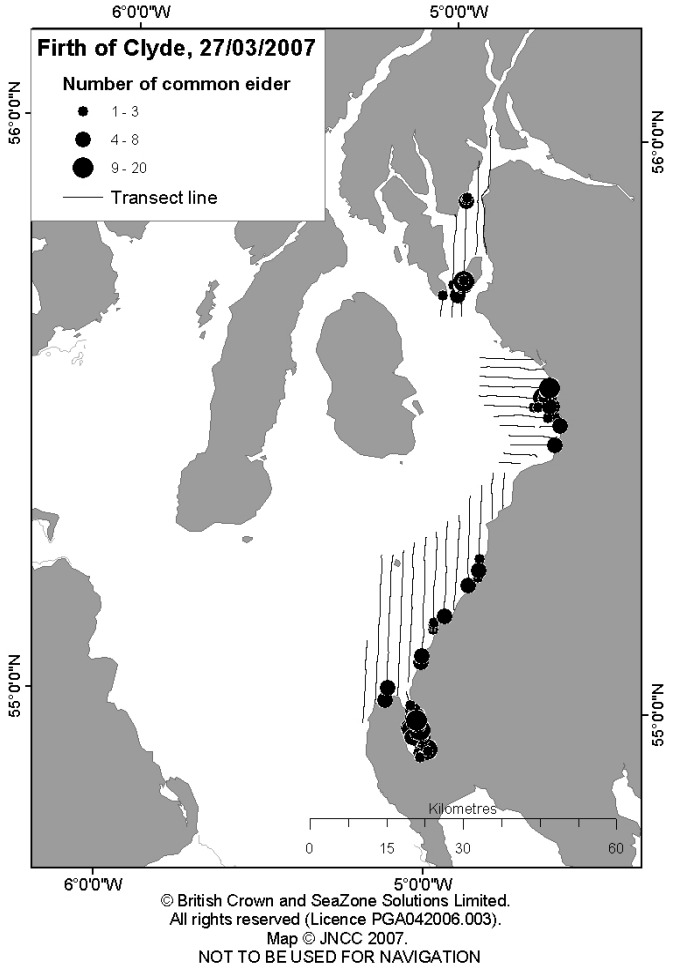


**Figure 7.** Distribution of common eider in the Firth of Clyde, 27 March 2007

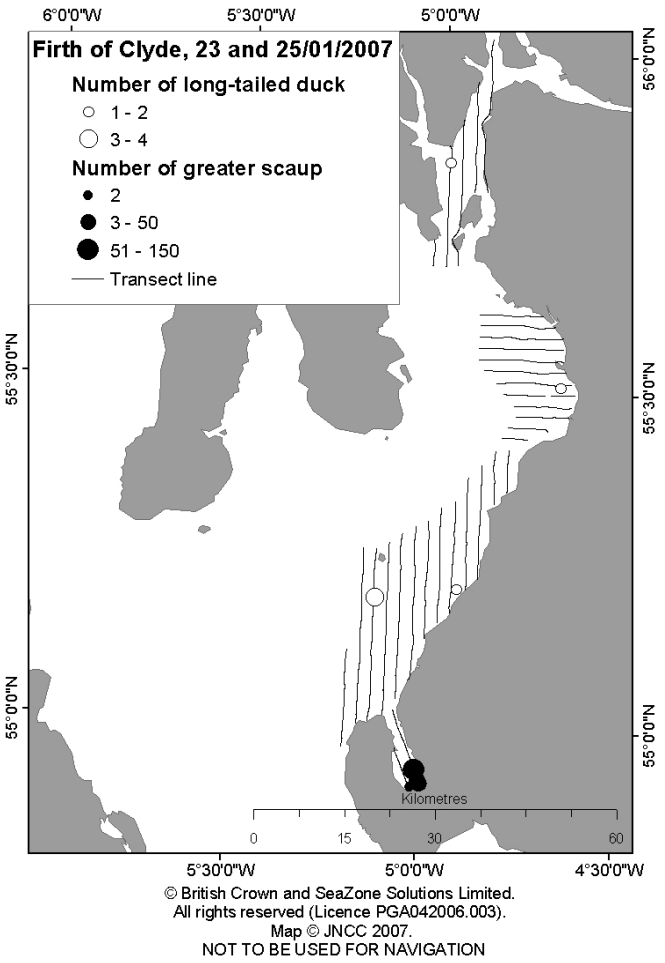


**Figure 8.** Distribution of long-tailed duck and greater scaup in the Firth of Clyde, 23 and 25 January 2007

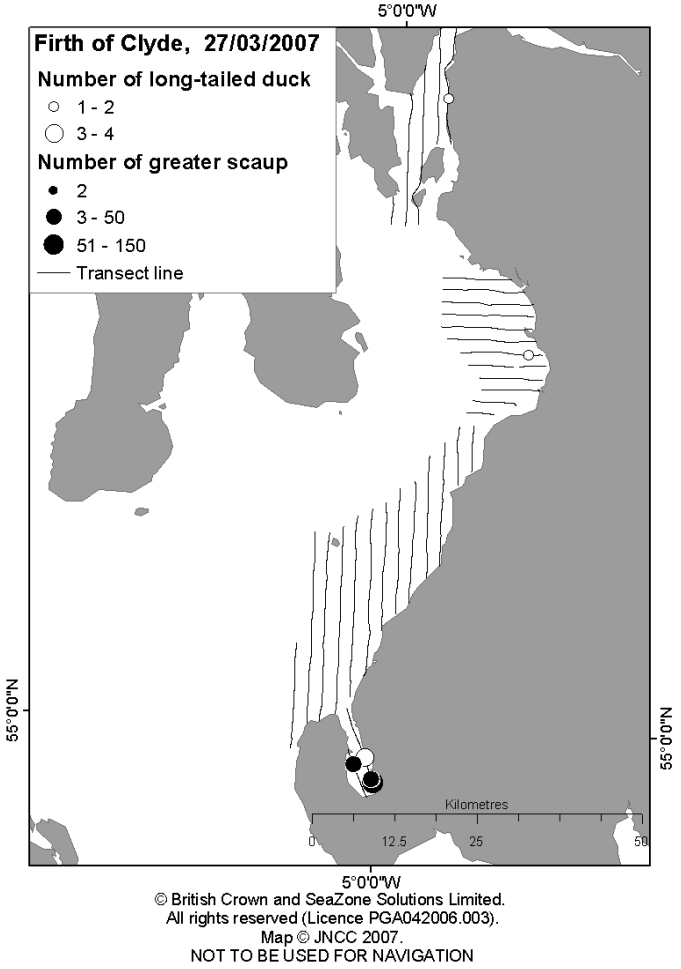


**Figure 9.** Distribution of long-tailed duck and greater scaup in the Firth of Clyde, 27 March 2007

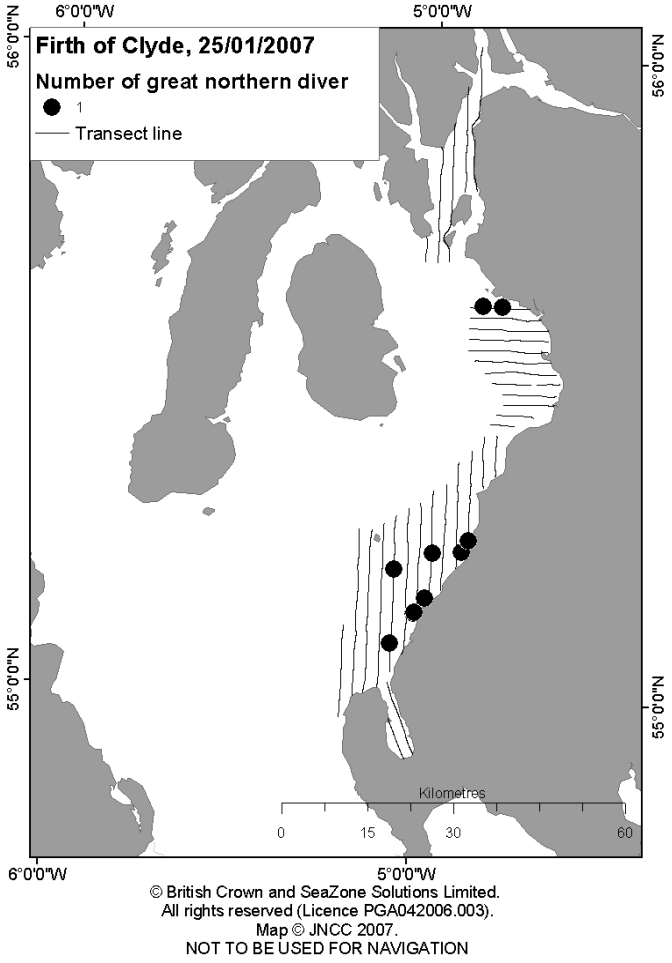


**Figure 10.** Distribution of great northern diver in the Firth of Clyde, 23 and 25 January 2007

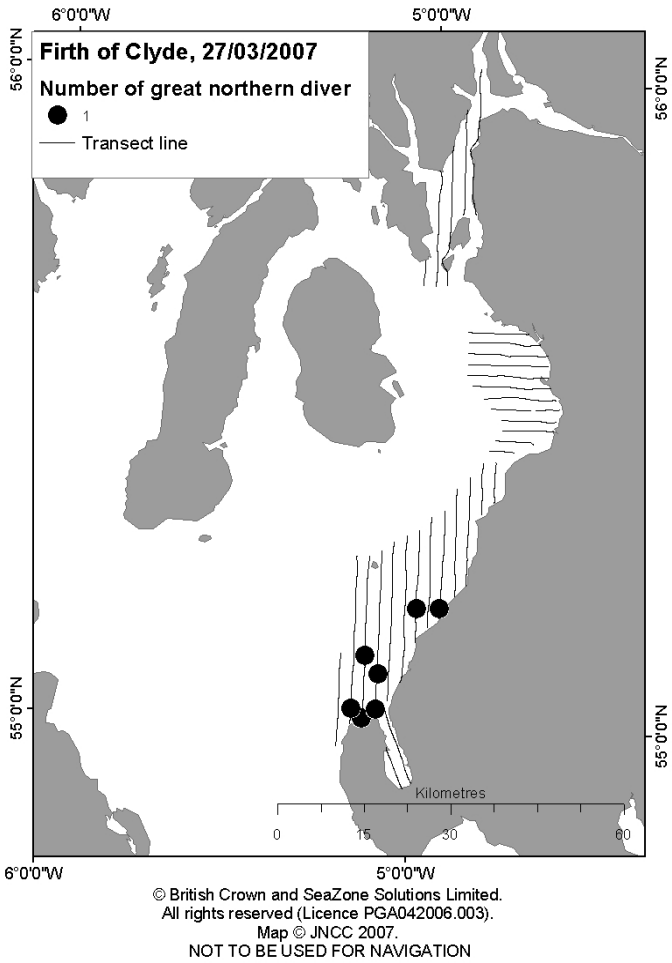


**Figure 11.** Distribution of great northern diver in the Firth of Clyde, 27 March 2007

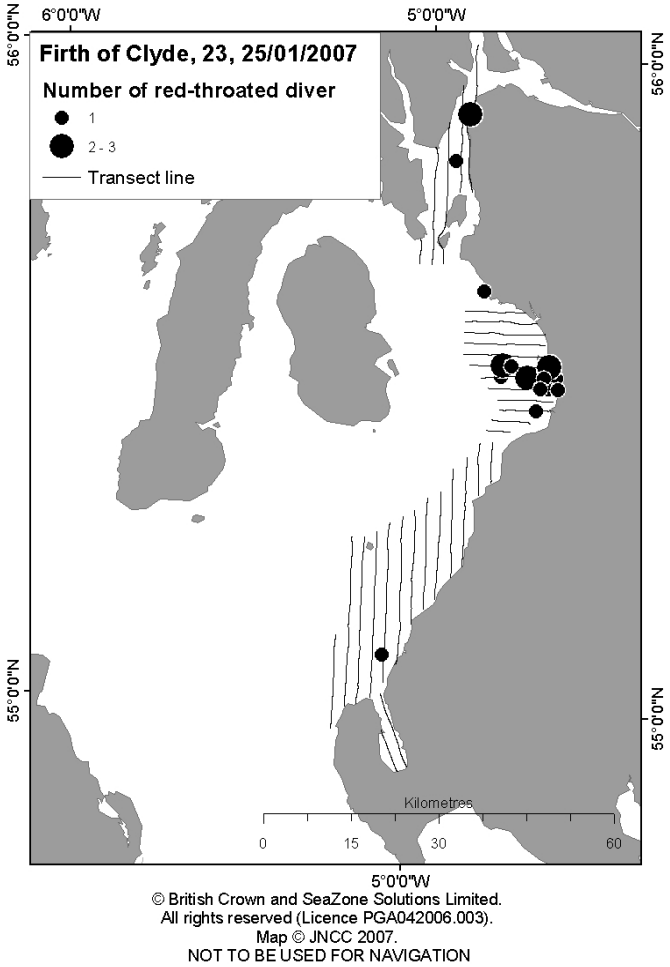


**Figure 12.** Distribution of red-throated divers in the Firth of Clyde, 23 and 25 January 2007

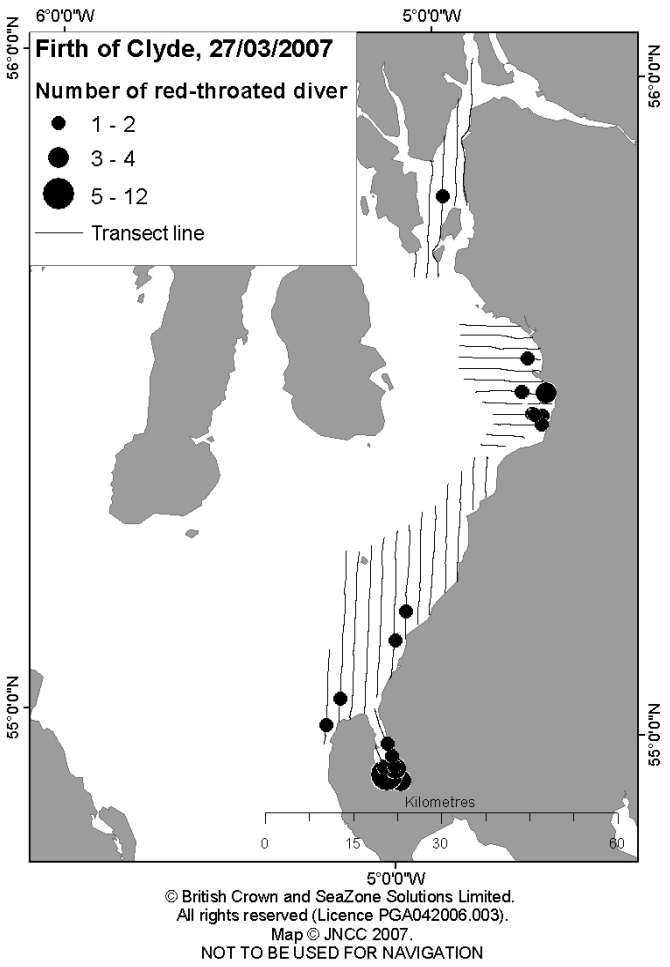


**Figure 13.** Distribution of red-throated divers in the Firth of Clyde, 27 March 2007

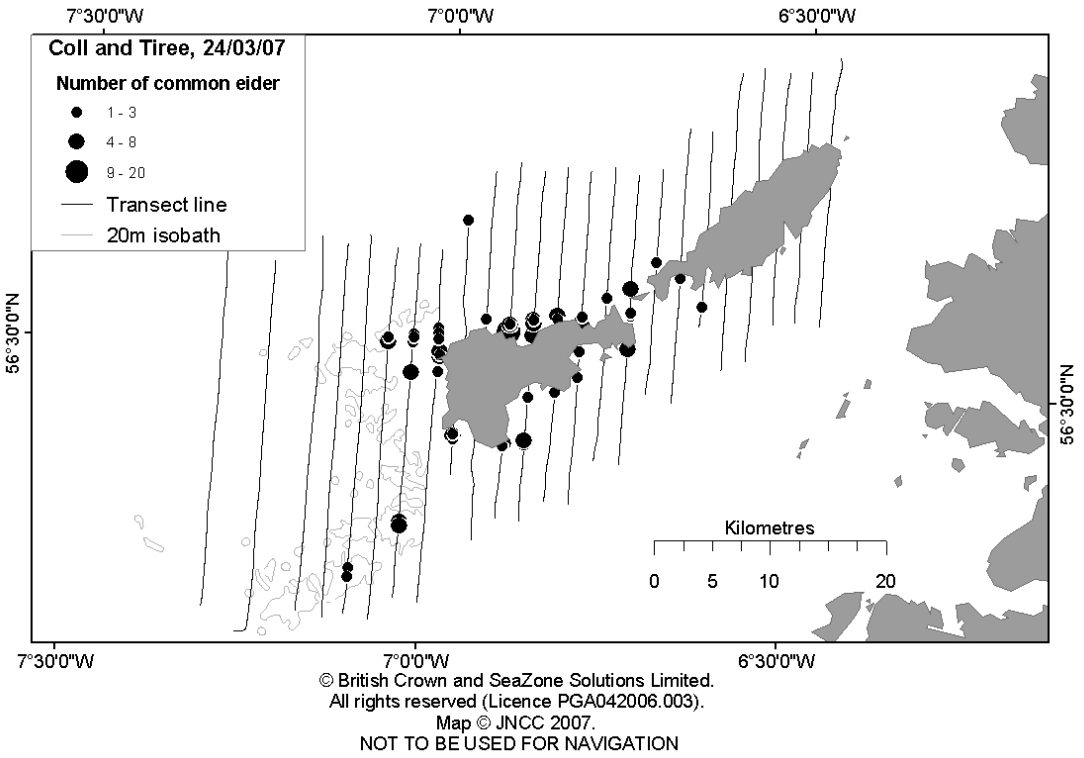


**Figure 14.** Distribution of common eider, Coll and Tiree, 24 March 2007

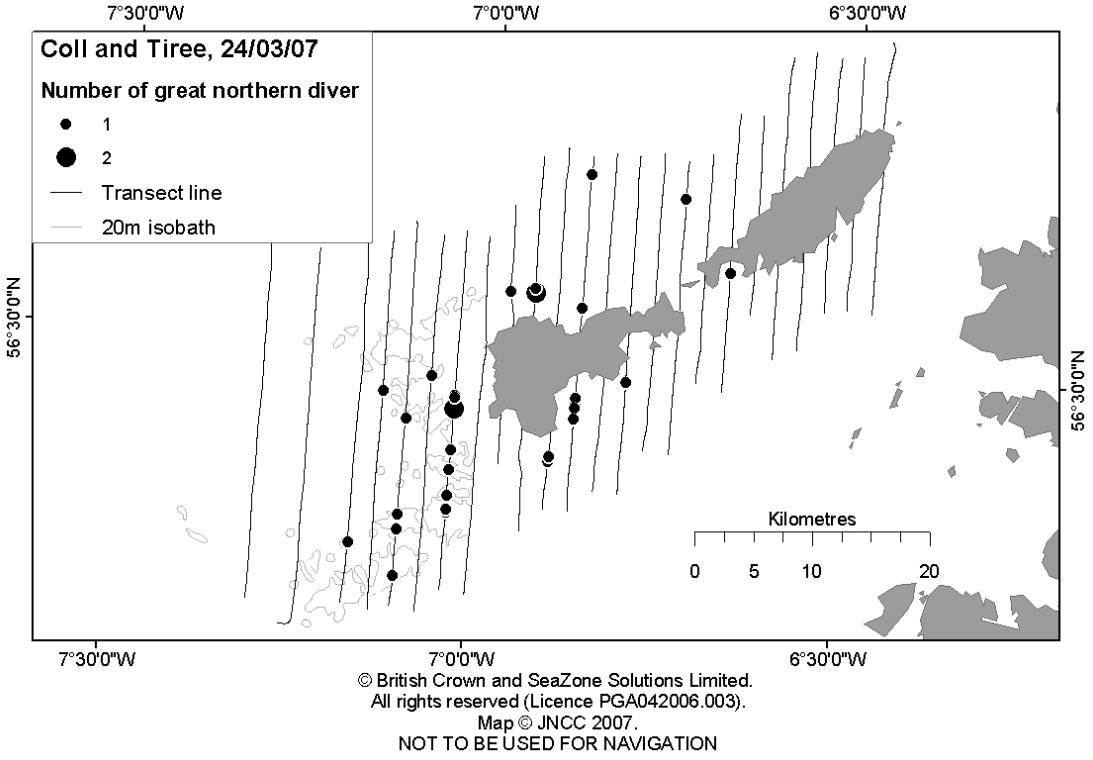


**Figure 15.** Distribution of great northern diver, Coll and Tiree, 24 March 2007

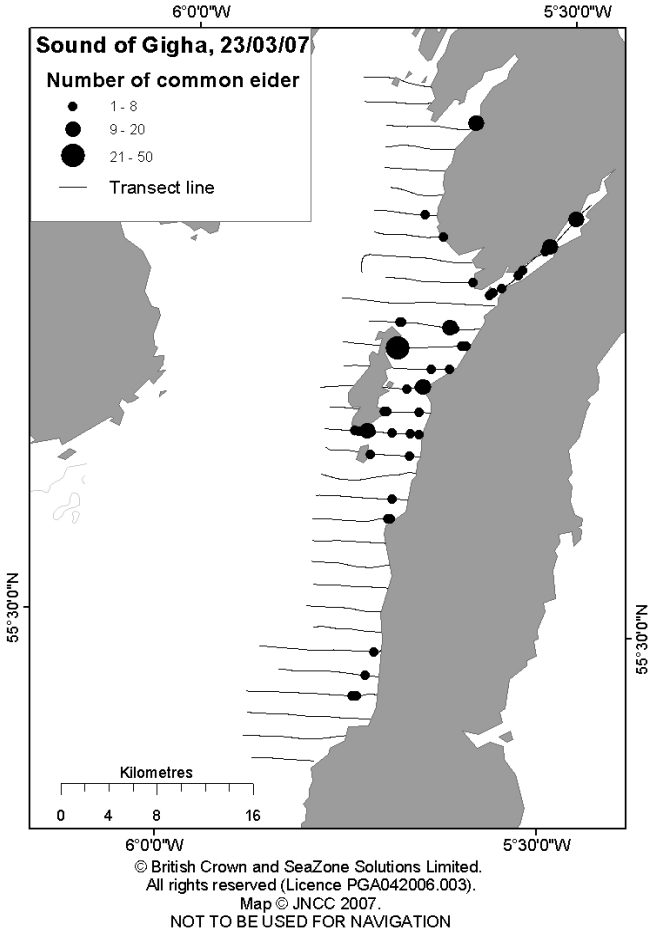


**Figure 16.** Distribution of common eider, Sound of Gigha, 23 March 2007

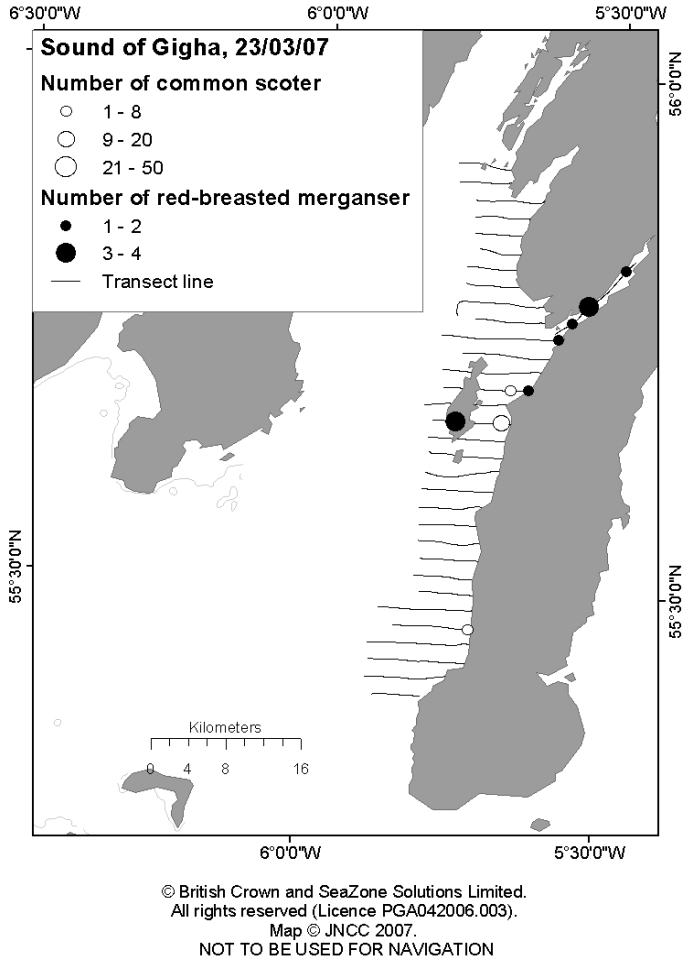


**Figure 17.** Distribution of common scoter and red-breasted merganser, Sound of Gigha, 23 March 2007

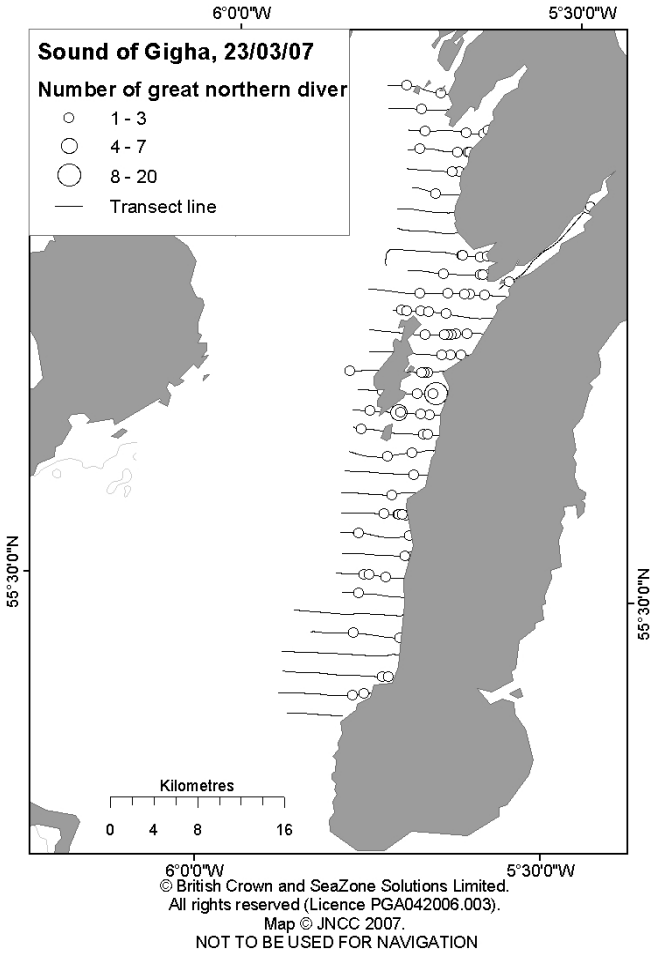


**Figure 18.** Distribution of great northern diver, Sound of Gigha, March 2007

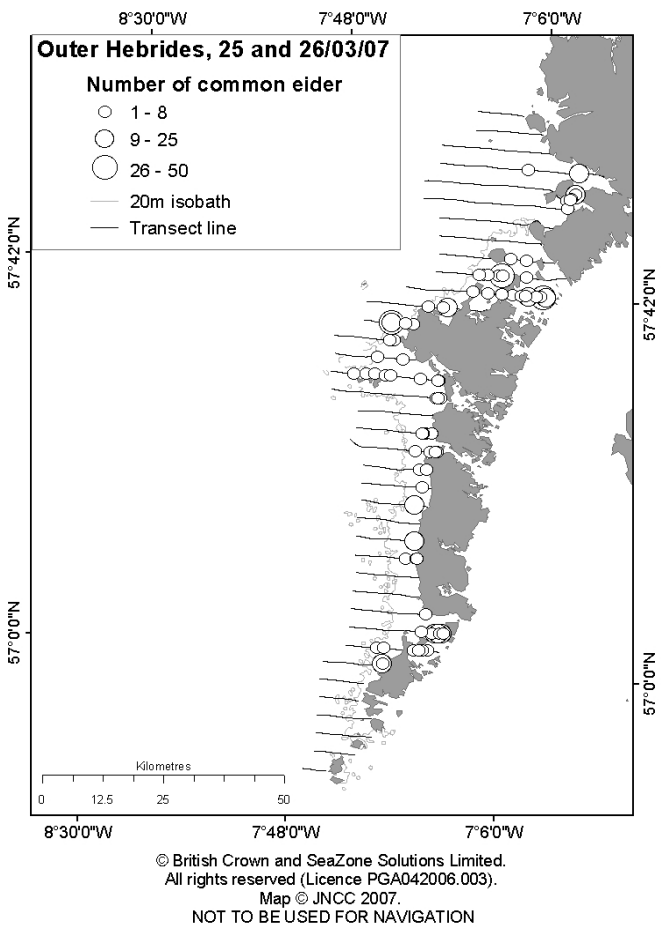


**Figure 19.** Distribution of common eider, Outer Hebrides, 25 and 26 March 2007

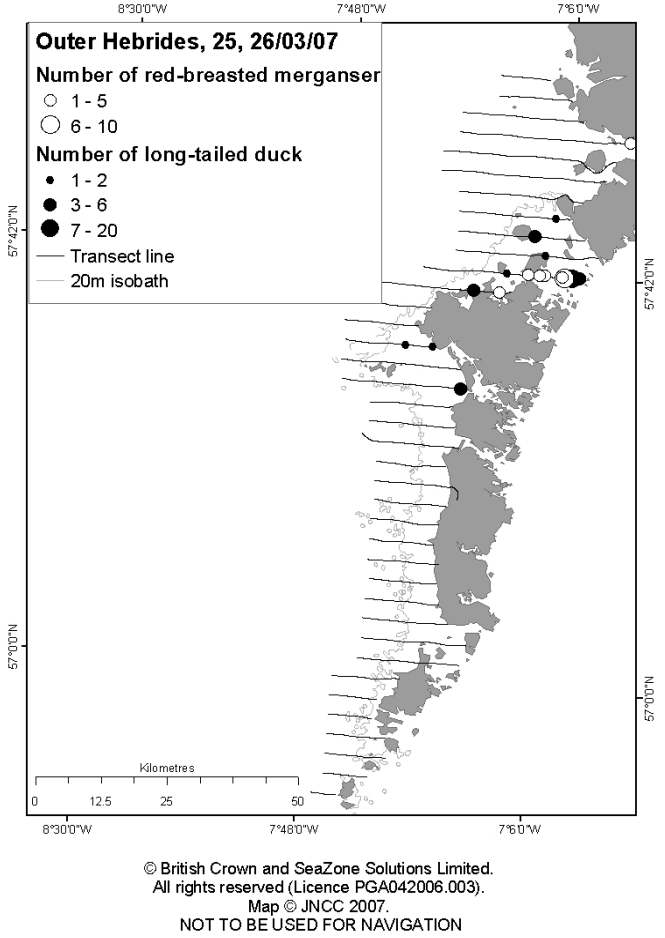


**Figure 20.** Distribution of red-breasted merganser and long-tailed duck, Outer Hebrides, March 2007

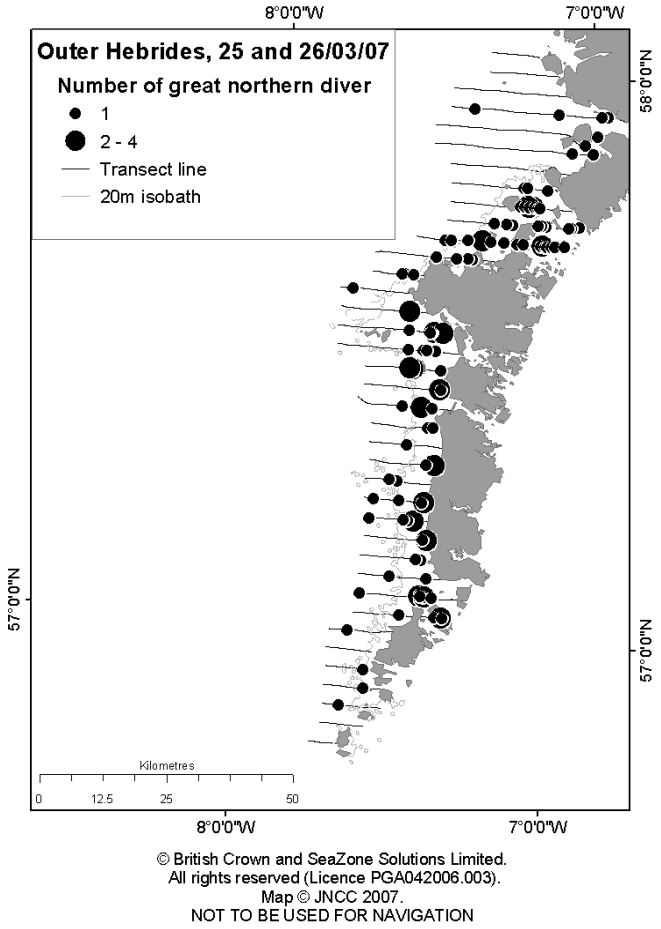


**Figure 21.** Distribution of great northern divers, Outer Hebrides, 25 and 26 March 2007

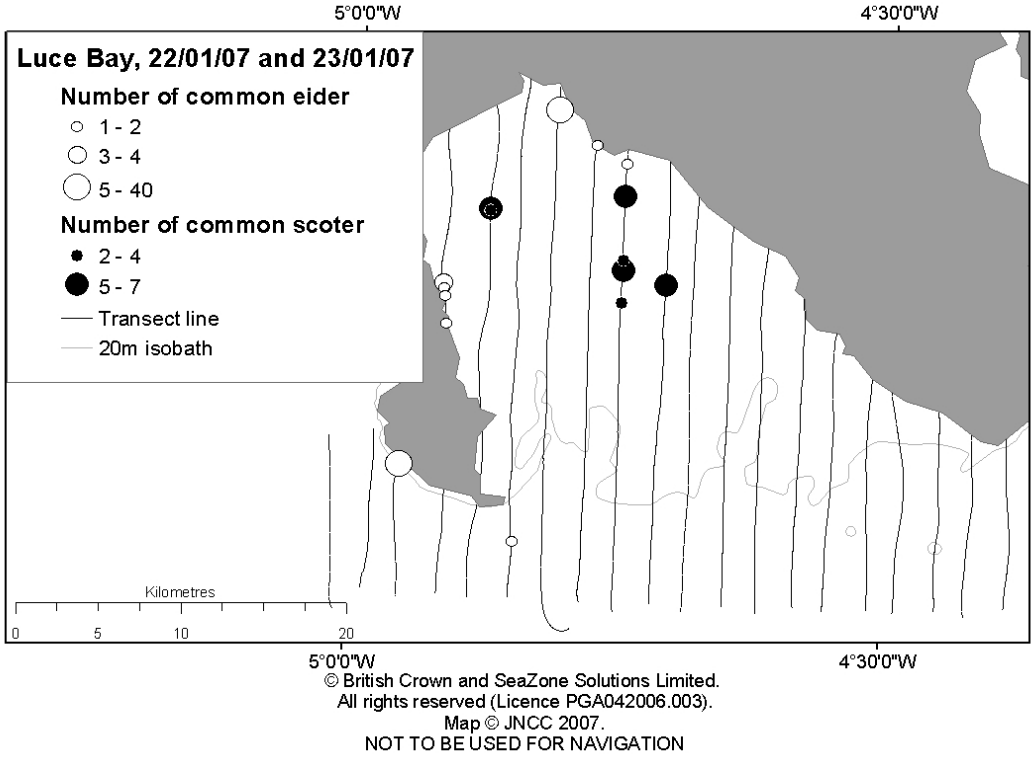


**Figure 22.** Distribution of common eider and common scoter in Luce Bay, 22 and 23 January 2007

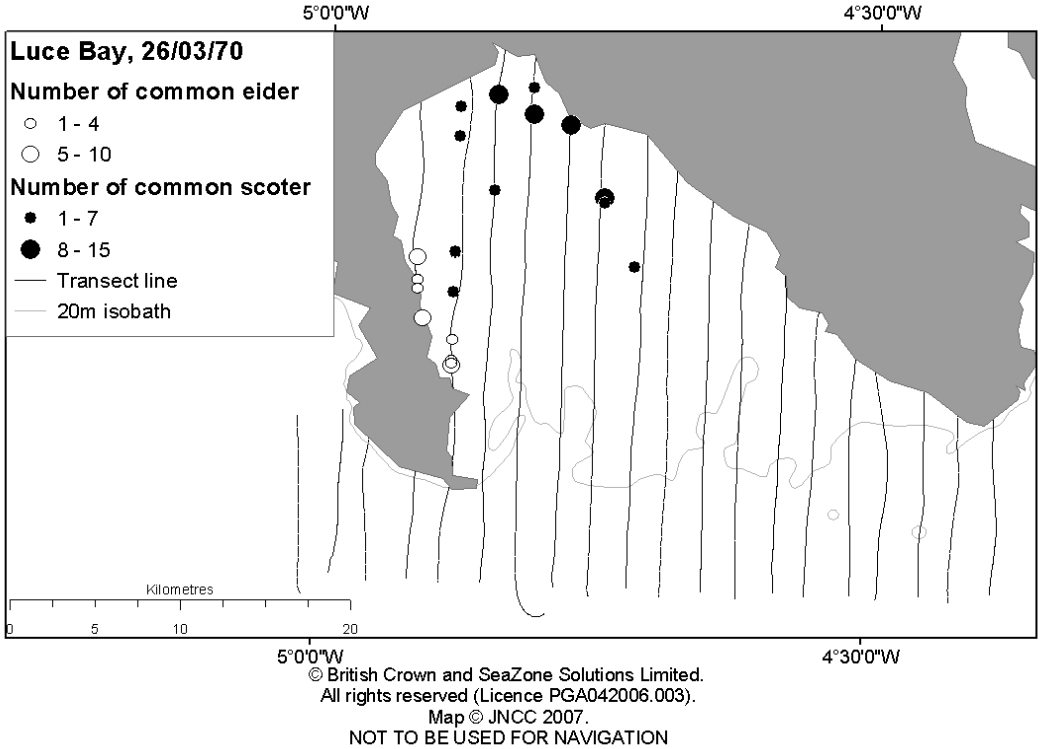


**Figure 23.** Distribution of common eider and common scoter in Luce Bay, 26 March 2007

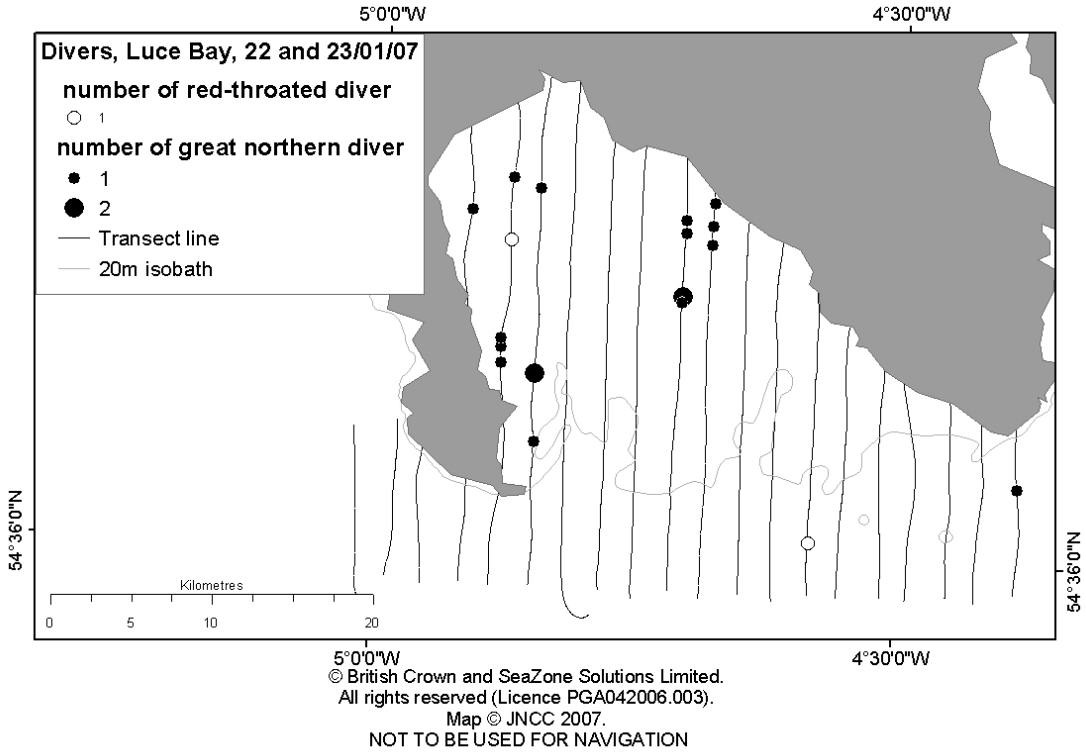


**Figure 24.** Distribution of divers in Luce Bay, 22 and 23 January 2007

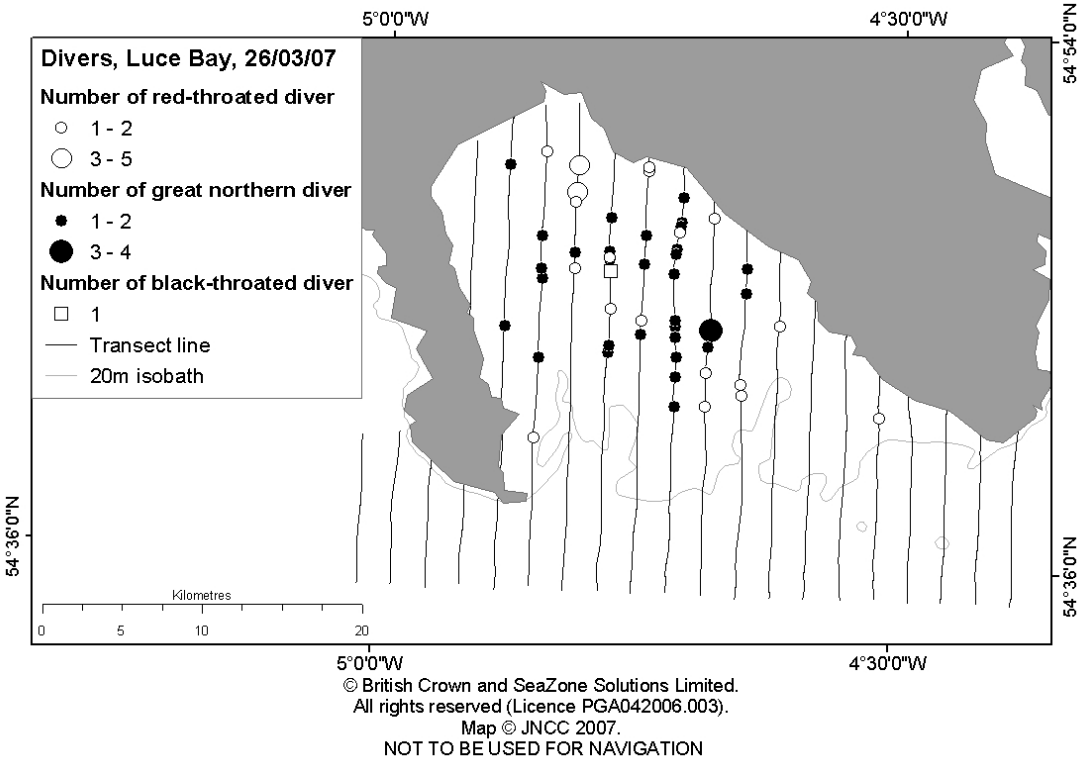


**Figure 25.** Distribution of divers in Luce Bay, 26 March 2007

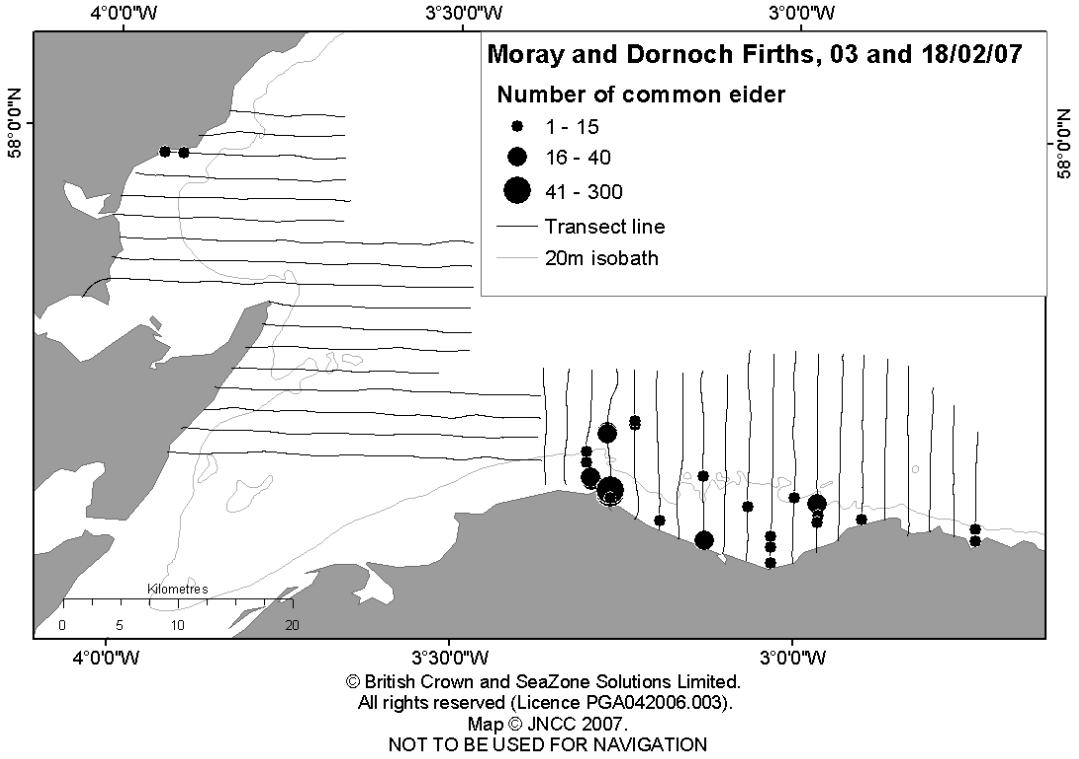


**Figure 26.** Distribution of common eider in the Moray and Dornoch Firths, 03 and 18 February 2007

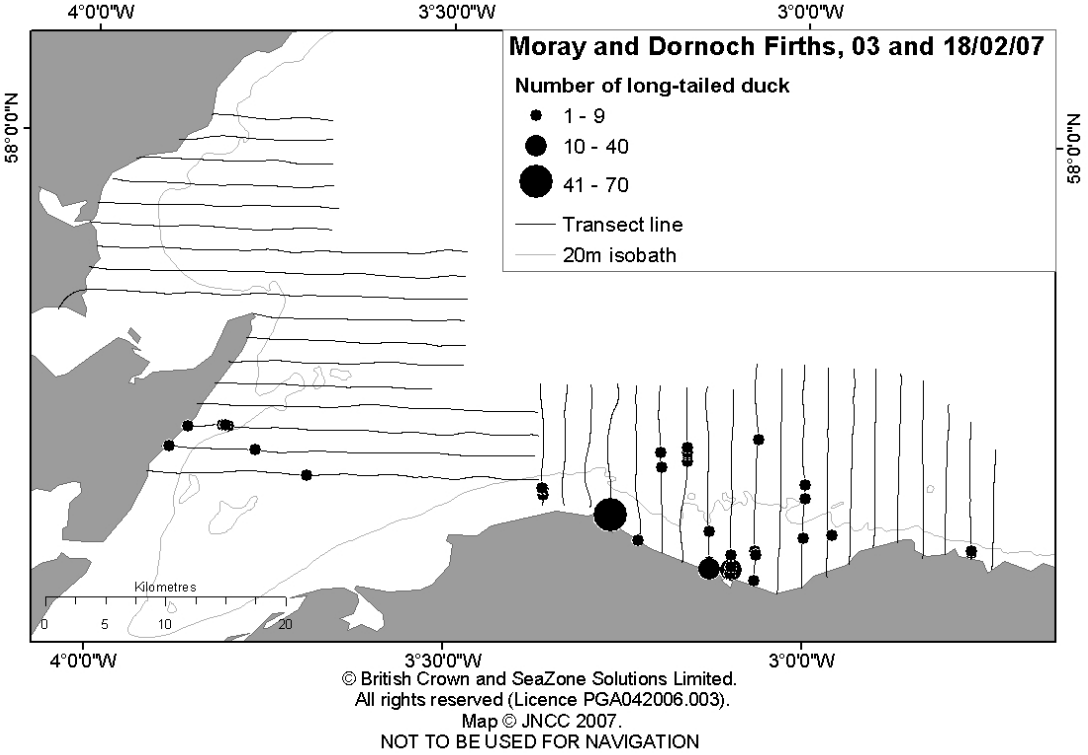


**Figure 27.** Distribution of long-tailed duck in the Moray and Dornoch Firths, 03 and 18 February 2007

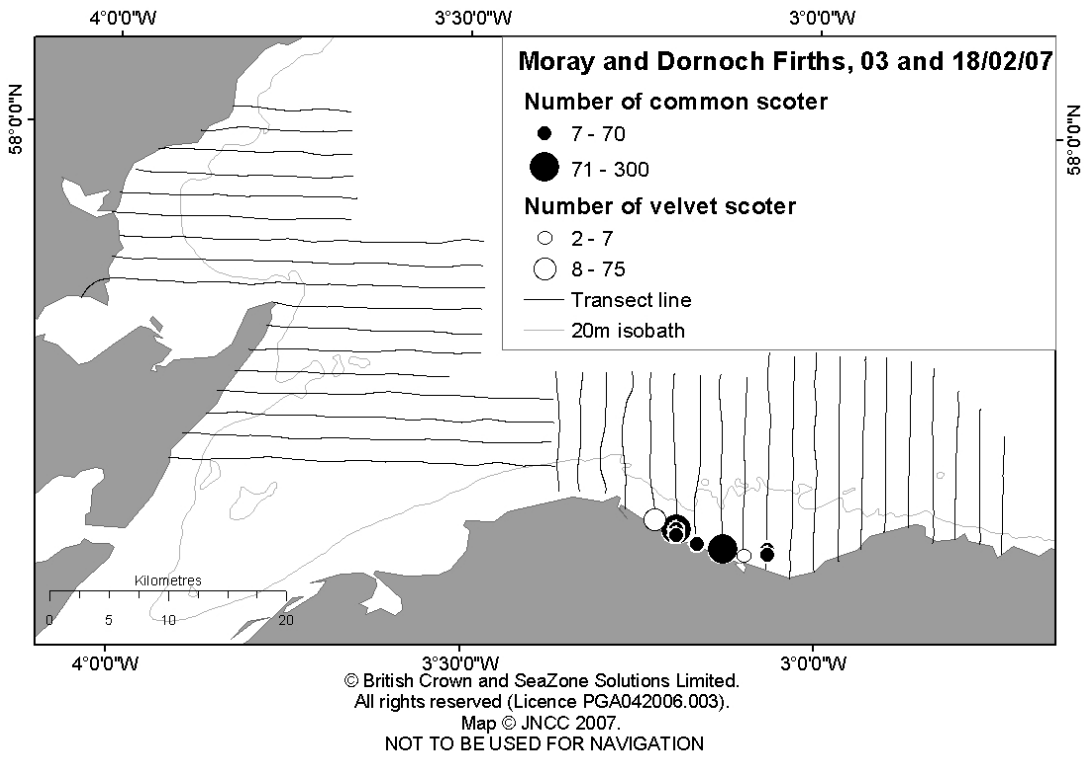


**Figure 28.** Distribution of common and velvet scoter in the Moray and Dornoch Firths, 03 and 18 February 2007

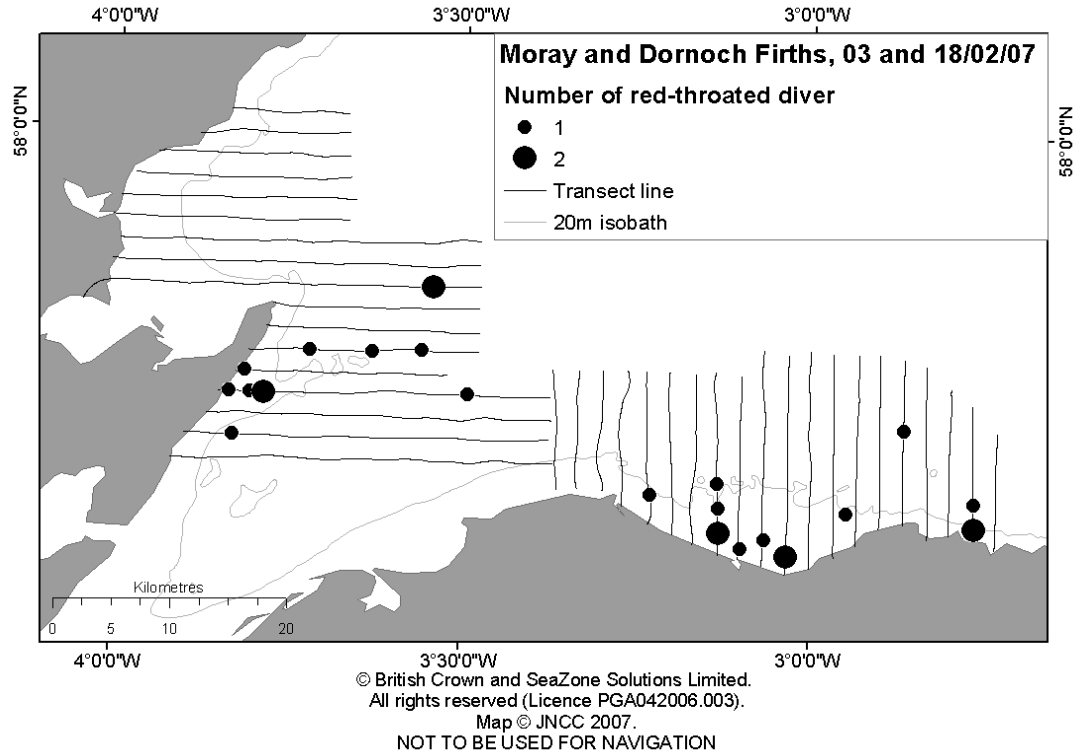


**Figure 29.** Distribution of red-throated diver in the Moray and Dornoch Firths, 03 and 18 February 2007

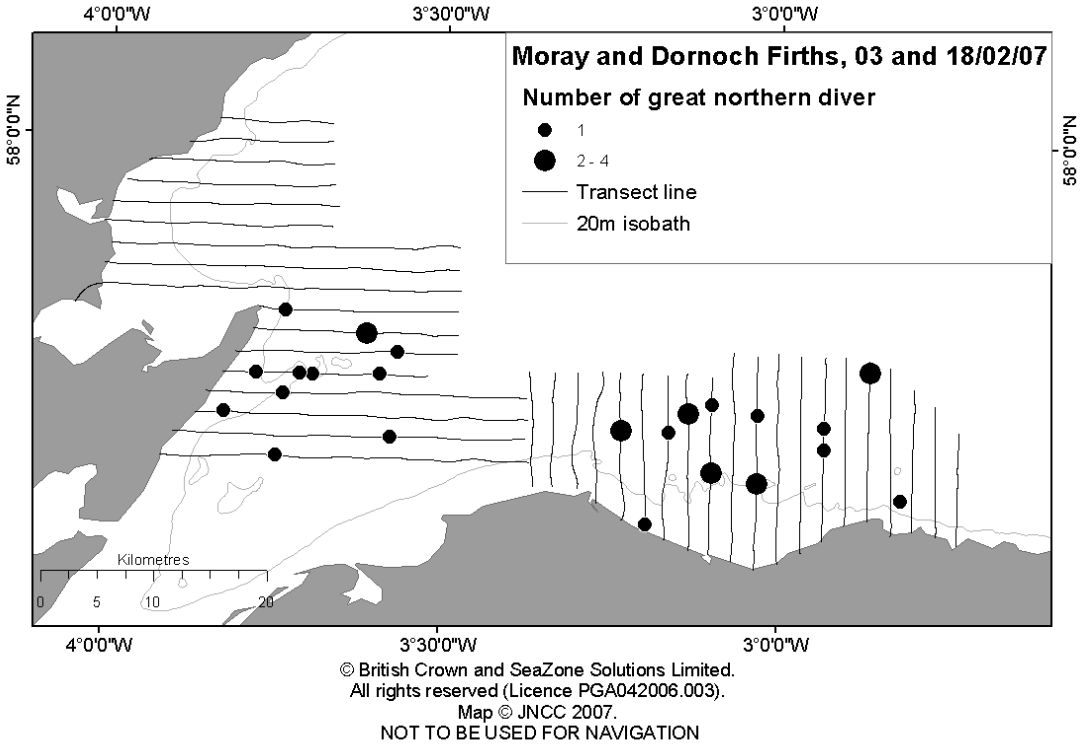


**Figure 30.** Distribution of great northern diver in the Moray and Dornoch Firths, 03 and 18 February 2007

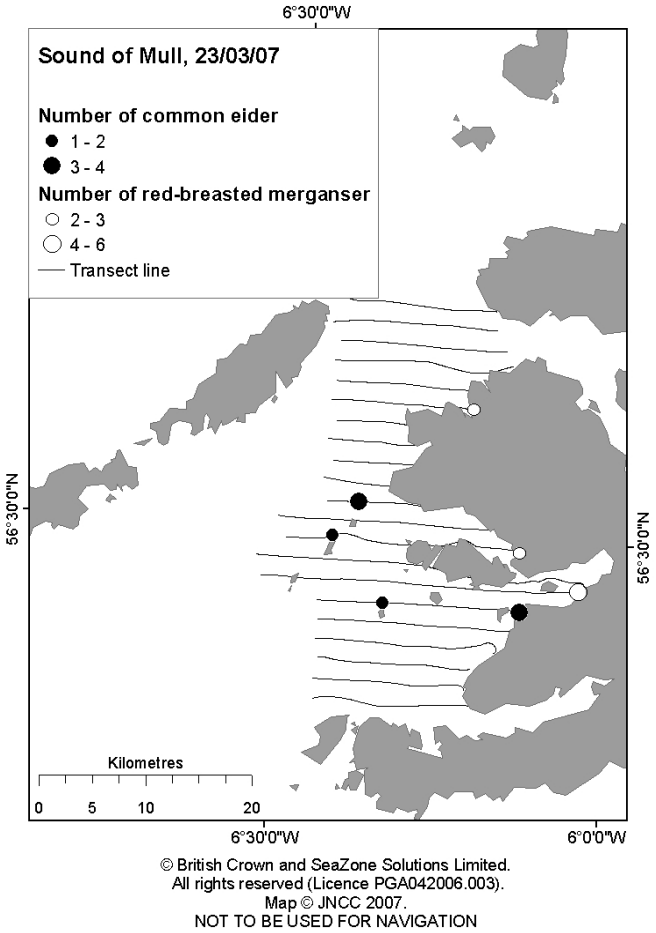


**Figure 31.** Distribution of common eider and red-breasted merganser, Sound of Mull, 23 March 2007

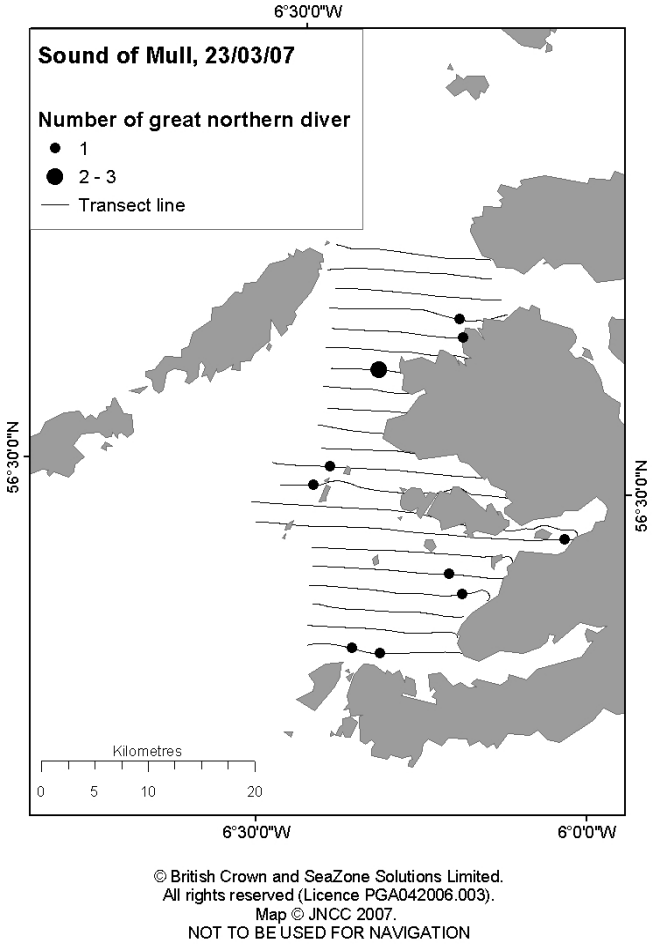


**Figure 32.** Distribution of great northern diver, Sound of Mull, 23 March 2007

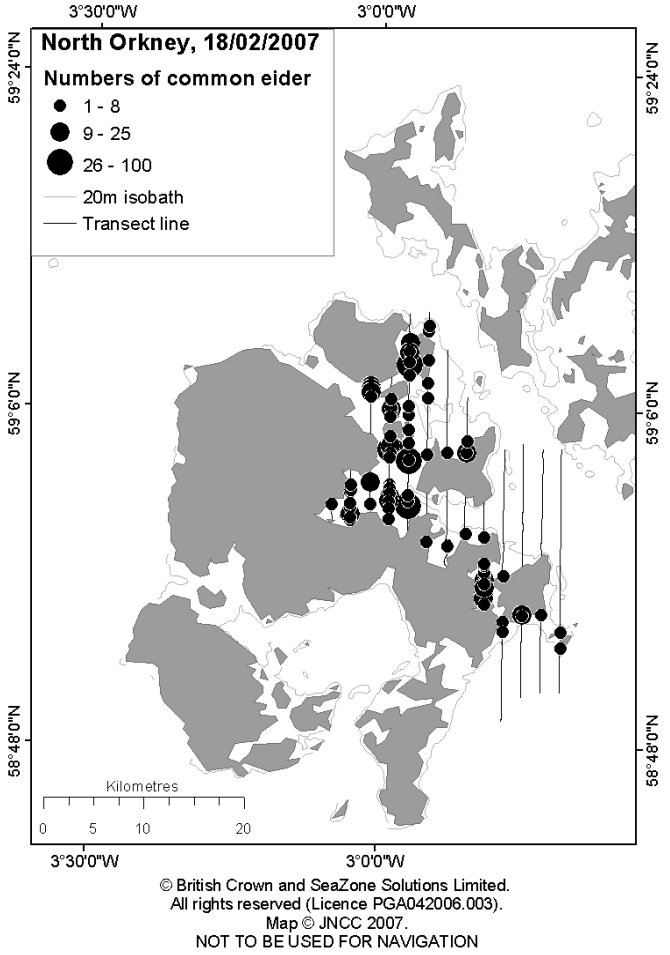


**Figure 33.** Distribution of common eider, North Orkney, 18 February 2007

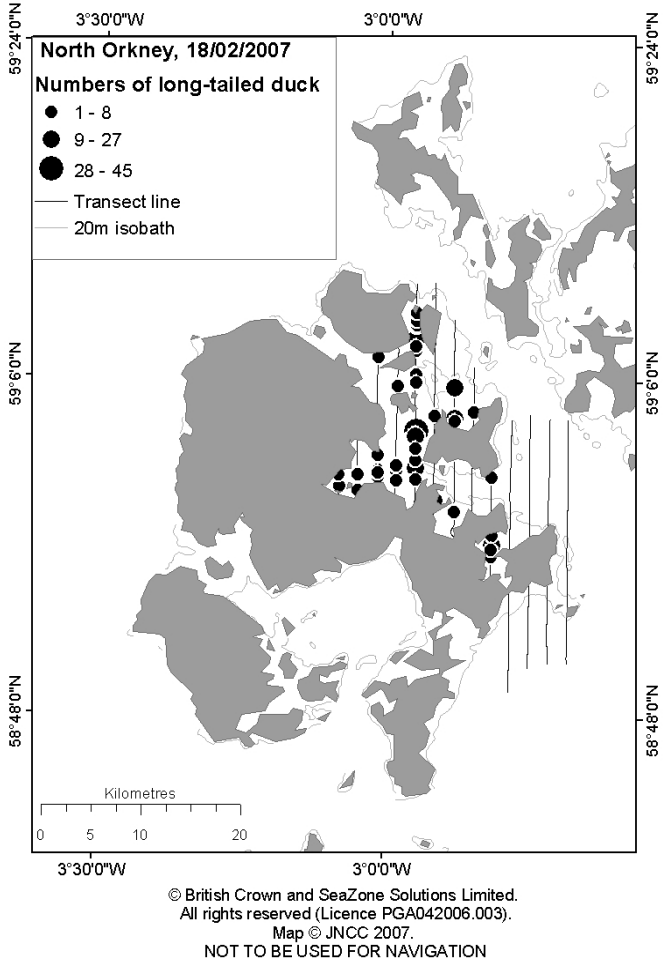


**Figure 34.** Distribution of long-tailed duck, North Orkney, 18 February 2007

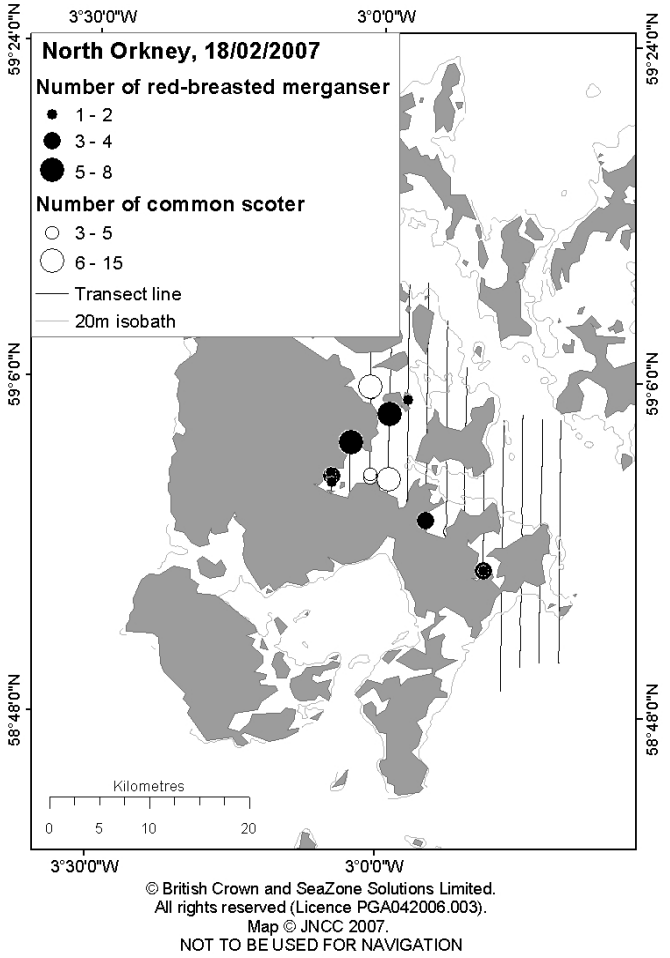


**Figure 35.** Distribution of common scoter and red-breasted merganser, North Orkney, 18 February 2007

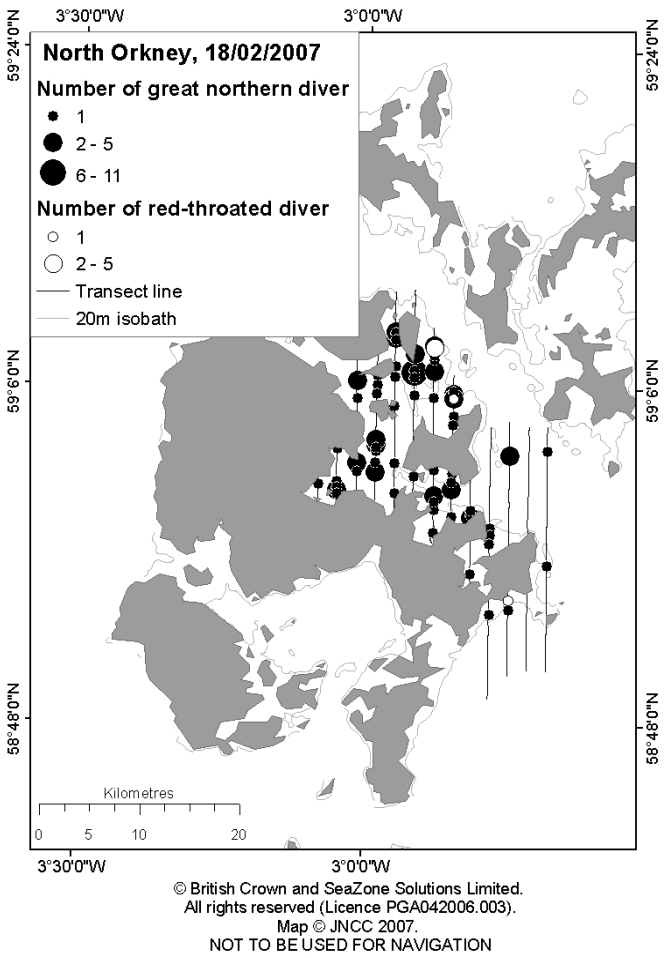


**Figure 36.** Distribution of red-throated and great northern divers, North Orkney, 18 February 2007

### 3.1.6 Species not adequately surveyed

The following target species were not recorded during these, and previous line transect surveys: red-necked grebe, great crested grebe, and Slavonian grebe (Dean *et al.,* 2003; 2004a and 2004b, Wilson *et al.,* 2006, Sohle *et al.,* 2006) Information from shore-based surveys would suggest that red-necked grebes might have been expected in Scapa Flow, and Slavonian grebes might have been expected in both Scapa Flow and the Moray Firth (Pollitt *et al.,* 2003).

It is likely that grebes were not recorded because they are not easily detected on aerial surveys; grebes tend to be distributed close to the shore, where they may be missed as the aircraft turns at the beginning and end of transects. In addition, the small wintering numbers of these species in the UK (Stone *et al.,* 1997) reduces the likelihood of grebes being recorded on aerial surveys. Land based counts or boat based surveys may be the most suitable methods for surveying or monitoring these species (Dean *et al.,* 2003; 2004a and 2004b, Wilson *et al.,* 2005, Sohle *et al.,* 2006).

This was the second winter since 2000/2001 that greater scaup were recorded on aerial surveys. Previously they have been recorded in each of the 2005/06 surveys in Loch Ryan, during surveys of the Firth of Clyde. In land based surveys, greater scaup are usually recorded in single, very dense flocks within 50m of the shore (A. Webb *pers. obs* .; Dean *et al.,* 2003). The probability of missing such flocks is likely to be quite high, and consideration should be given to other survey methods for surveying greater scaup populations, such as shore based surveys.

It is vital that alternative methods of monitoring of those species and types of area, for which line transect and/or aerial survey methods are unsuitable, be included in any comprehensive inshore waterbird monitoring programme.

### 3.1.7 Further analyses

The line transect sample count for data for the 2006/07 aerial surveys (the totals of which are presented in Table 2) are suitable for distance sampling analyses (Buckland *et al.,* 2001) aimed at estimating total population sizes in each survey area.

The distribution data collected during the aerial surveys (figures 3-36) offer a good initial representation of the local diurnal distributions of the important species recorded in each survey area. In addition, these data have a high spatial precision, and may be suitable for geostatistical interpolation (Cressie 1991), depending on their spatial (autocorrelative) structure. Geostatisical interpolation is capable of building fine scale models of density (hence providing further estimates of population size) or presence/absence distributions (McSorely *et al.,* 2005; Webb *et al.,* 2004; Webb *et al.,* 2005; Webb *et al.,* 2006a, 2006b).

## 3.2 Shore-based counts

Eleven of the 14 target species were recorded on the water during shore-based counts of the Aberdeen bay area (Table 4). These comprised red-throated diver, black-throated diver, great crested grebe, black necked grebe, greater scaup, common eider, common scoter, velvet scoter, long-tailed duck, common goldeneye and red-breasted merganser.

In contrast to the sample counts obtained from aerial surveys, shore based counts aim to record total numbers of birds present within the survey area. However, it is possible that a small proportion of the total numbers of some species present within the survey area were not detected during counts because they were in locations obscured by the coastline. In addition, the maximum offshore extent of the survey area was limited by the maximum distance at which birds can be seen, which is approximately 2km.

The following sections describe in detail the numbers and distributions of the five most common species (common eider, long-tailed duck, common scoter, red-breasted merganser and red-throated diver). Tables 5-8 give detailed counts for each section, for these five species during counts conducted between November and February. (See Figure 2 for locations of count areas and count points used during Aberdeen Bay shore based counts.)

**Table 4.** Total numbers of target species recorded on the water during shore based counts in Aberdeen Bay, June 2006 to May 2007.

| Survey Date | Scaup | Eider | King eider | Long-tailed duck | Common scoter | Velvet scoter | Goldeneye | Red-breasted merganser | Red-throated diver | Black-throated diver | Great-crested grebe | Black-necked grebe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27/06/2006 | 0 | 2926 | 0 | 1 | 785 | 0 | 0 | 18 | 36 | 0 | 0 | 0 |
| 26/07/2006 | 2 | 2724 | 1 | 0 | 586 | 28 | 0 | 18 | 13 | 0 | 0 | 0 |
| 30/08/2006 | 0 | 6269 | 0 | 0 | 309 | 0 | 0 | 44 | 51 | 0 | 0 | 0 |
| 29/09/2006 | 0 | 2413 | 0 | 7 | 1175 | 3 | 0 | 1 | 175 | 0 | 0 | 0 |
| 03/11/2006 | 0 | 262 | 0 | 0 | 879 | 0 | 3 | 12 | 72 | 0 | 0 | 0 |
| 05/12/2006 | 0 | 116 | 0 | 10 | 629 | 0 | 0 | 9 | 26 | 0 | 0 | 0 |
| 06/12/2006 | 0 | 117 | 0 | 0 | 0 | 0 | 0 | 2 | 19 | 0 | 0 | 0 |
| 13/02/2007 | 0 | 272 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 0 | 0 | 0 |
| 14/02/2007 | 0 | 170 | 0 | 25 | 193 | 0 | 0 | 4 | 44 | 0 | 0 | 0 |
| 12/04/2007 | 0 | 858 | 0 | 26 | 227 | 0 | 0 | 9 | 110 | 1 | 0 | 2 |
| 13/04/2007 | 0 | 147 | 0 | 2 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 |
| 22/05/2007 | 0 | 1898 | 0 | 0 | 1525 | 0 | 0 | 0 | 98 | 0 | 0 | 0 |

**Table 5.** Numbers of the five most common species recorded during shore based counts in Aberdeen Bay on 03 November 2006, by count area.

| | Count Areas | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Common eider | 0 | 85 | 14 | 29 | 8 | 14 | 43 | 16 | 44 | 9 |
| Long-tailed duck | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Common scoter | 0 | 0 | 0 | 350 | 0 | 2 | 0 | 0 | 527 | 0 |
| Red-breasted merganser | 0 | 0 | 0 | 1 | 0 | 4 | 4 | 0 | 2 | 0 |
| Red-throated diver | 0 | 2 | 15 | 4 | 7 | 16 | 5 | 13 | 9 | 1 |

**Table 6.** Numbers of the five most common species recorded during shore based counts in Aberdeen Bay on 05 and 06 December 2006, by count area.

| | Count Areas | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Common eider | 15 | 77 | 23 | 13 | 0 | 1 | 5 | 45 | 45 | 11 |
| Long-tailed duck | 0 | 0 | 0 | 8 | 2 | 0 | 0 | 0 | 0 | 0 |
| Common scoter | 0 | 0 | 0 | 130 | 63 | 0 | 0 | 0 | 323 | 0 |
| Red-breasted merganser | 0 | 0 | 0 | 3 | 2 | 6 | 0 | 0 | 0 | 0 |
| Red-throated diver | 0 | 11 | 6 | 6 | 9 | 6 | 2 | 1 | 3 | 1 |

**Table 7.** Numbers of the five most common species recorded during shore based counts in Aberdeen Bay on 13 and 14 February 2007, by count area.

| | Count Areas | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Common eider | 0 | 201 | 72 | 18 | 7 | 0 | 2 | 24 | 76 | 27 |
| Long-tailed duck | 0 | 0 | 0 | 17 | 0 | 0 | 0 | 0 | 0 | 8 |
| Common scoter | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 182 | 0 |
| Red-breasted merganser | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 1 | 0 | 0 |
| Red-throated diver | 0 | 2 | 6 | 13 | 5 | 5 | 11 | 0 | 5 | 3 |

### 3.2.1 Common eider

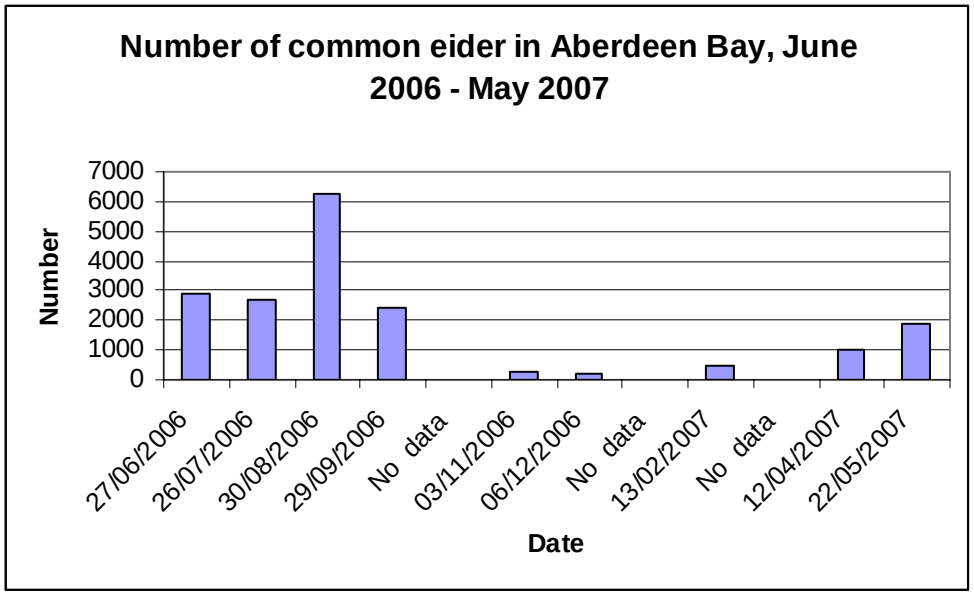


**Figure 37.** Numbers of common eider in Aberdeen Bay from shore based counts, June 2006 to May 2007

Common eider occurred along the coast of Aberdeen Bay, with some flocks numbering hundreds of individuals. The largest numbers of birds were recorded off the sandy beach to the south of the breeding colony at Forvie, off Blackdog bar and Murcar Golf Course, around Girdle ness, and off Old Slains castle. The August peak of 6,269 birds (Figure 37) coincided with the fledging of young birds from the Sands of Forvie colony and elsewhere along the east coast. The distribution patterns of common eider observed on shore based counts were similar to those observed on aerial surveys

### 3.2.2 Long-tailed duck

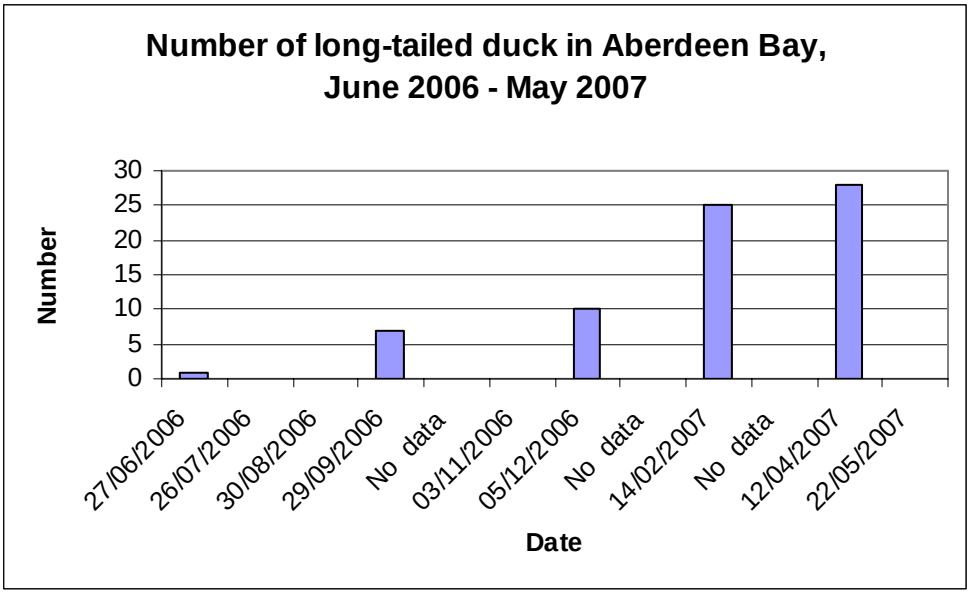


**Figure 38.** Numbers of long-tailed duck in Aberdeen Bay from shore based counts, June 2006 to May 2007.

Small numbers of long-tailed duck were recorded over-wintering in Cruden Bay, around the Ythan estuary, and south to Girdle ness. Numbers of birds increased during the spring as birds passed through Aberdeen Bay on their way to northern breeding sites (Figure 38). The distribution patterns of long-tailed ducks counted on shore based counts were similar to those observed on aerial surveys.

### 3.2.3 Common scoter

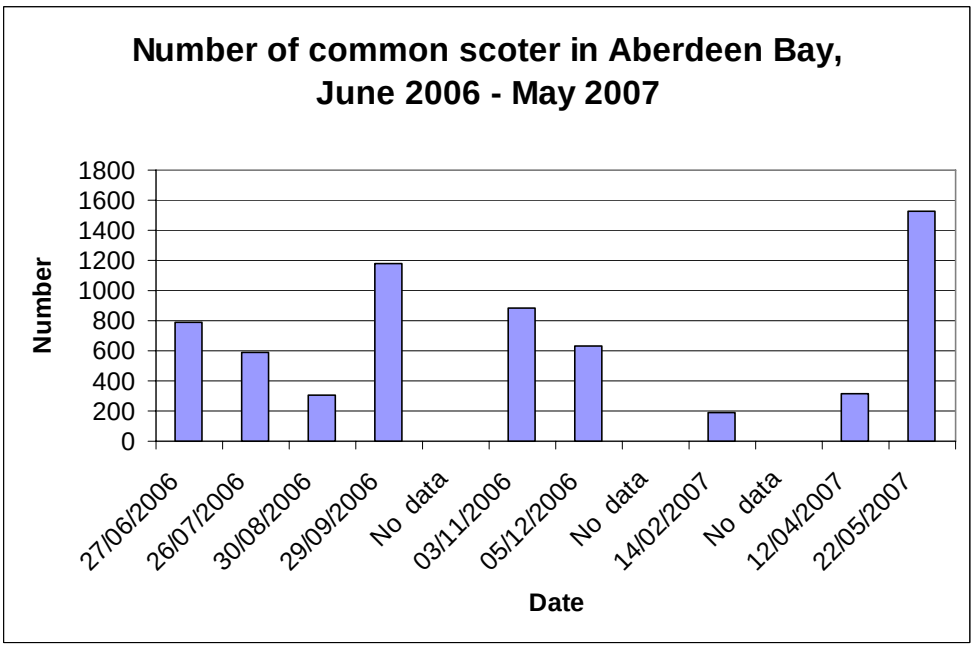


**Figure 39.** Numbers of common scoter in Aberdeen Bay from shore based counts, June 2006 to May 2007.

Common scoters were recorded throughout the year in Aberdeen Bay, with numbers increasing during spring and summer when birds gather to moult before and after the breeding season (Figure 39). The pattern of distribution of common scoter observed on shore based counts is very similar to that observed on aerial surveys. The highest numbers of common scoters were found off Blackdog, Murcar and the Donmouth, where individual flocks could number in the thousands. During winter low numbers of common scoters remained in these areas, and are also regular in Cruden Bay.

### 3.2.4 Red-breasted merganser

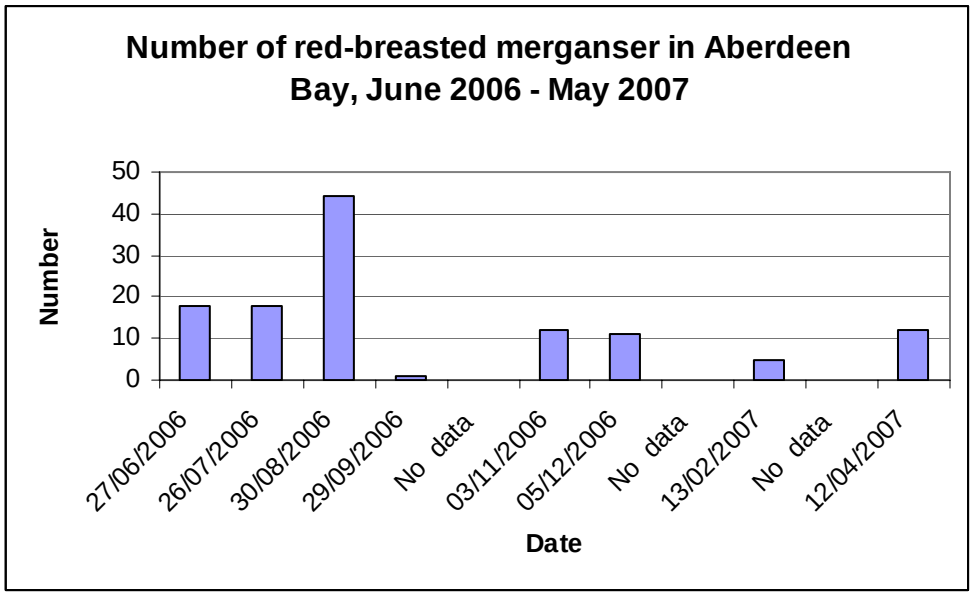


**Figure 40.** Numbers of red-breasted merganser in Aberdeen Bay from shore based counts, June 2006 to May 2007.

Red-breasted mergansers were recorded in small numbers throughout the year in Aberdeen Bay (Figure 40). The peak number of red-breasted mergansers recorded in August indicated post breeding dispersal of birds. The distribution patterns of red-breasted mergansers recorded on shore based counts were similar to those observed on aerial surveys. Red breasted mergansers were mainly recorded in small groups along the shallow bay to the south of Collieston, in Cruden Bay and in the Girdle ness/Nigg Bay area.

### 3.2.5 Red-throated diver

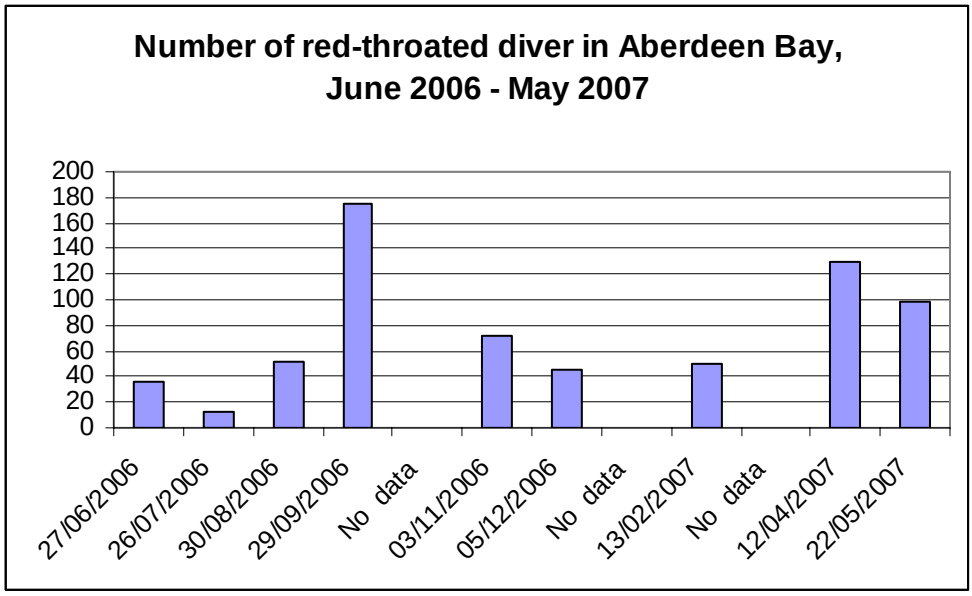


**Figure 41.** Numbers of red-throated diver in Aberdeen Bay from shore based counts, June 2006 to May 2007.

Red throated divers were recorded throughout the year in Aberdeen Bay, with numbers increasing in April/May and September (Figure 41) as birds made use of the area for stopping during passage to and from their breeding grounds further north. In September, birds passing through Aberdeen Bay will also include young birds of the year. The numbers of divers recorded in Aberdeen Bay were lowest during July, during the breeding season

## 3.3 Important areas in Aberdeen Bay

Three areas in Aberdeen bay appeared to be favoured by seaduck and divers at specific times of the year.

(1) The area between the Donmouth and Balmedie (count areas four and five) held particularly large numbers of common scoter and common eider in the summer and autumn, and large numbers of red-throated divers during the spring. This area was also most productive for some other species, recorded in much lower numbers, such as velvet scoter and red-breasted merganser;

(2) Count areas one and two, around Girdle ness, held relatively high numbers of common eider throughout the year, but had much lower numbers of the other target species; and

(3) The area to the north of Collieston, up to and including Cruden Bay also regularly held good numbers of common eider, and had large numbers of common scoter during the winter months.

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