JOINT NATURE CONSERVATION COMMITTEE

JNCC Report
No. 416

The numbers of inshore waterbirds using the waters of Mull, Coll and Tiree during the non-breeding season; an assessment of the area's potential for qualification as a marine SPA

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August 2009

ISSN 0963 8091

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This report should be cited as:

Söhle, I., O'Brien, S.H., Dean, B.J., Wilson, L.J., Webb, A. & Reid, J.B. 2009. The numbers of inshore waterbirds using the waters of Mull, Coll and Tiree during the non-breeding season; an assessment of the area's potential for qualification as a marine SPA. *JNCC Report* No. 416.

Contents

1 Summary

JNCC conducted line transect aerial surveys to collect data on inshore waterbirds in the waters around Mull, Coll, and Tiree during the non-breeding season. Four surveys were completed of the west coast of the Isle of Mull over three winters (2004/05-2006/07). Five surveys were completed of the waters around the islands of Coll and Tiree over five winters (2003/04-2007/08).

The species recorded were: greater scaup *Aythya marila*, common eider *Somateria mollissima*, long-tailed duck *Clangula hyemalis,* red-breasted merganser *Mergus serrator*, red-throated diver *Gavia stellata* and great northern diver *Gavia immer.*

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 in order to determine whether the areas, or part of them might meet the selection requirements under Stage 1 of the UK Site Selection Guidelines, as a Special Protection Area under the EC Birds Directive.

The means of peak estimates of great northern diver numbers were 54 for the waters west of Mull, and 492 in the waters around Coll and Tiree. Peak estimated numbers of great northern divers in the Mull area exceeded the appropriate Stage 1 threshold (currently 50 individuals) for SPA qualification under the UK SPA Selection Guidelines in only one out of three winter seasons, although the mean of peak estimates did exceed the Stage 1 threshold. Peak estimated numbers of great northern divers in the waters around Coll and Tiree exceeded the appropriate Stage 1 threshold under the UK SPA Site Selection Guidelines in each of five winter seasons.

Peak estimated numbers of greater scaup, common eider, long-tailed duck, red-breasted mergansers and red-throated divers did not exceed the appropriate Stage 1 threshold under the UK SPA Selection Guidelines in any season in the waters around Coll and Tiree, or west of Mull, nor did the mean of peak estimates across all surveys exceed qualifying thresholds for these species in either area.

Based on the available data, only 220 individual waterbirds regularly use the inshore waters west of Mull during the non-breeding season, whereas 2,102 individual waterbirds regularly use the inshore waters of Coll and Tiree. These estimates do not exceed the appropriate Stage 1 threshold for SPA qualifications on the strength of an assemblage of non-breeding waterfowl (20,000 individuals).

Based on these analyses:

- the waters around Coll and Tiree meet UK SPA Selection Guidelines for qualification as a possible marine SPA for great northern diver at Stage 1.1;

- the waters around Coll and Tiree do not currently appear to meet UK SPA Selection Guidelines for any species other than great northern diver at Stage 1.1 or 1.2;

- the waters around Coll and Tiree do not currently appear to meet UK SPA Selection Guidelines for an assemblage at Stage 1.3; and

- the waters west of Mull do not currently meet the UK SPA Selection Guidelines at Stages 1.1., 1.2. or 1.3. However, when the complete suite of marine SPAs, including those for inshore areas, has been determined then the inshore areas of Mull, (or parts thereof) could possibly be further considered for inclusion at stage 1.4 for great northern divers based on the mean of peak estimates.

Species distributions using raw count data are presented here for information. Detailed spatial analyses of bird distributions and possible SPA boundary location options will be presented in a separate report if required.

The numbers of great northern divers estimated for the Coll and Tiree area are of interest from a national population context. Distance sampling analysis of one survey of Coll and Tiree (18 February 2004) estimated 1,273 great northern divers to be present in the survey area. This estimate is at least 42% of the current GB wintering population estimate (2,500-3,000). The mean peak estimate of 492 individuals takes into account variation across survey years, but is still approximately 16% of the current GB wintering population estimate. A review of the wintering population estimate for great northern divers is required.

2 Introduction

2.1 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 for 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 SPA 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 (e.g. seaduck, divers and grebes) outwith the breeding season (e.g. Webb *et al.* 2006, Dawson *et al.* 2007, Sohle *et al.* 2007);
3. Offshore areas used by wide-ranging seabirds, for feeding and other activities; (Kober *et al.* 2009); and other types of SPA.

The aim of this report is to determine whether the inshore areas of Mull, or Coll and Tiree (the two are treated separately), or parts thereof, meet UK SPA Selection Guidelines (see below) in respect of the numbers of inshore waterbirds outwith the breeding season (Strout *et al*. 2001).

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

2.2 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 thresholds, 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 biogeographic 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 (e.g. by contributing significantly to the species' population viability, e.g. 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); for regularly occurring migratory species, the appropriate population for comparison is the biogeographic 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* (Ramsar, Iran, 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'.

2.3 Inshore areas of the Isle of Mull

The Isle of Mull is the second largest island of the Inner Hebrides, off the west coast of Scotland. Mull is the fourth largest Scottish island and is also the fourth largest island in Great Britain.

The Mull study area encompasses the inshore areas stretching northwest from the Point of Ardnamurchan to the Isle of Iona in the southwest and eastwards into Loch Scridain (Figure 1).

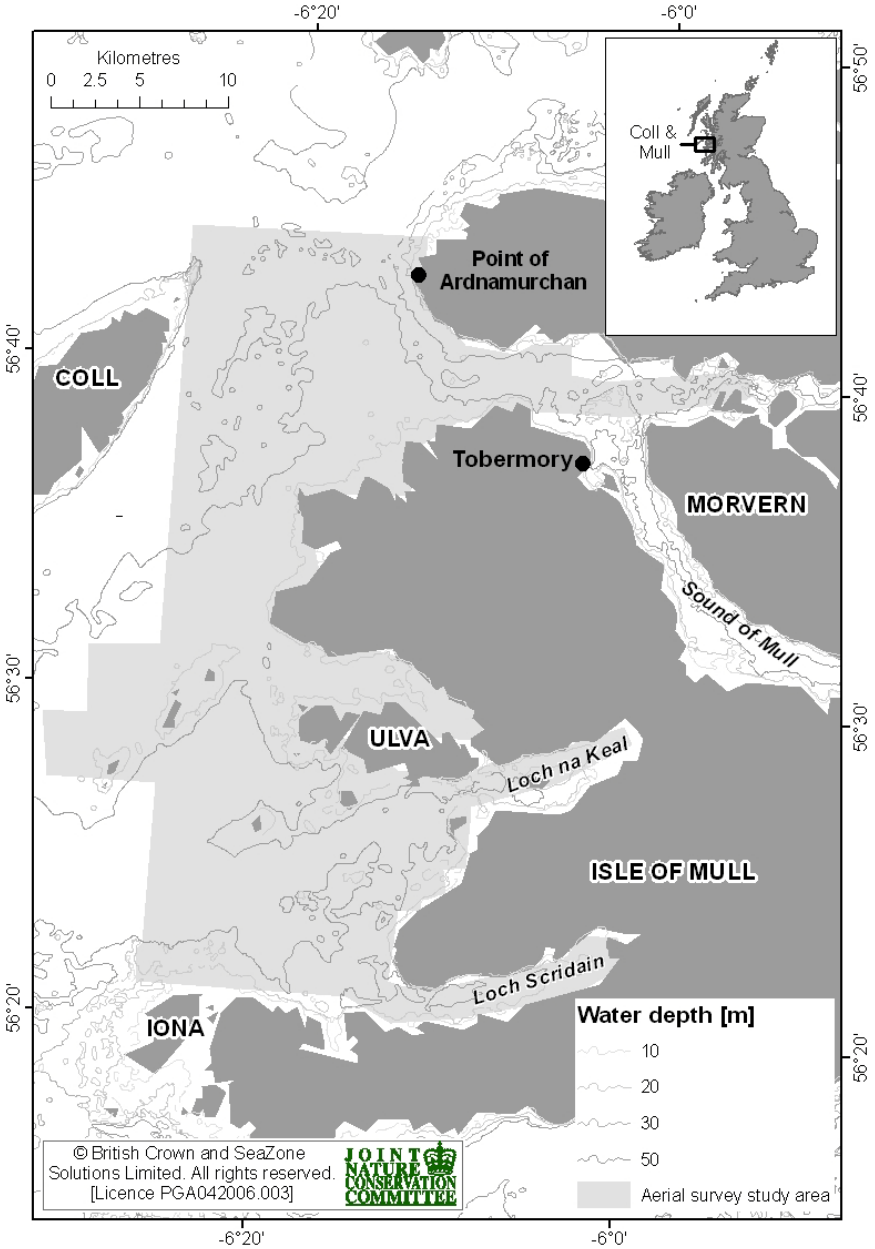

Figure 1. The Isle of Mull, showing the bathymetry and extent of the study area.

One terrestrial SPA, and four Special Areas of Conservation (SACs) designated under the Habitats Directive (92/43/EEC) are located on Mull.

2.4 Inshore areas of the islands of Coll and Tiree

The study area of Coll and Tiree includes the inshore areas stretching from north east of Coll to south west of Tiree (Figure 2). These Inner Hebridean islands are located west of Mull. Both islands are surrounded by shallow (0– 0m deep) inshore areas, although the island of Coll features areas of deeper water (to 200m) in the south-east.

The waters around Coll and Tiree host large numbers of birds outwith the existing SPAs (Wilson *et al.* 2006, Söhle *et al.* 2006, Lewis *et al.* 2008), particularly outside the breeding season.

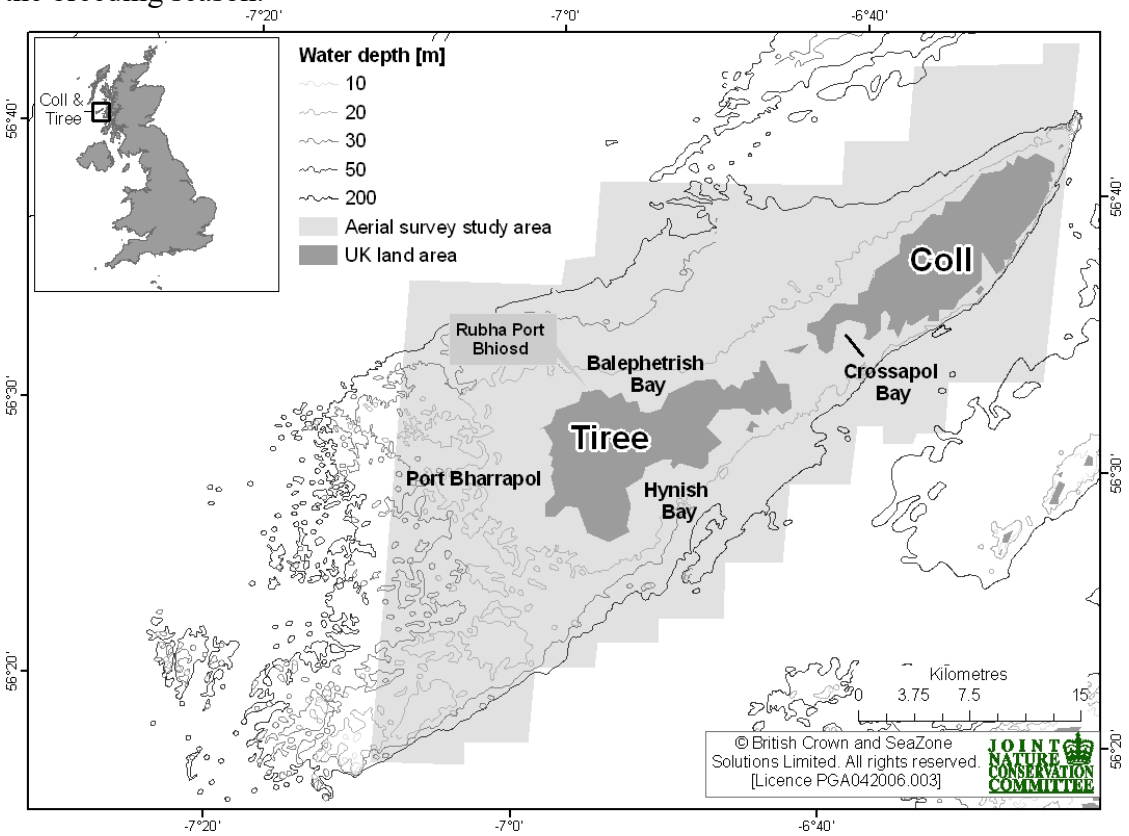

Figure 2. The islands of Coll and Tiree, showing the bathymetry and extent of the study area.

The north eastern part of the island of Coll is classified as a Ramsar site (2322ha), a Wetland Site of International Importance, and as an SPA under Article 4.1 of the Birds Directive (Figure 3). The latter supports 5.8% of the GB population of overwintering Greenland white-fronted goose *Anser albifrons flavirostris* and 8% of the GB population of Barnacle goose *Branta leucopsis*. The site also includes an extensive area of maritime heath, blanket mire and open water.

The slightly smaller (1939ha) Sléibhtean agus Cladach Thiriodh (Tiree Wetlands and Coast) SPA is classified under Article 4.1 for supporting 10% of the GB population of Greenland white-fronted goose and 5% of the GB population of barnacle goose which regularly overwinter in the area.

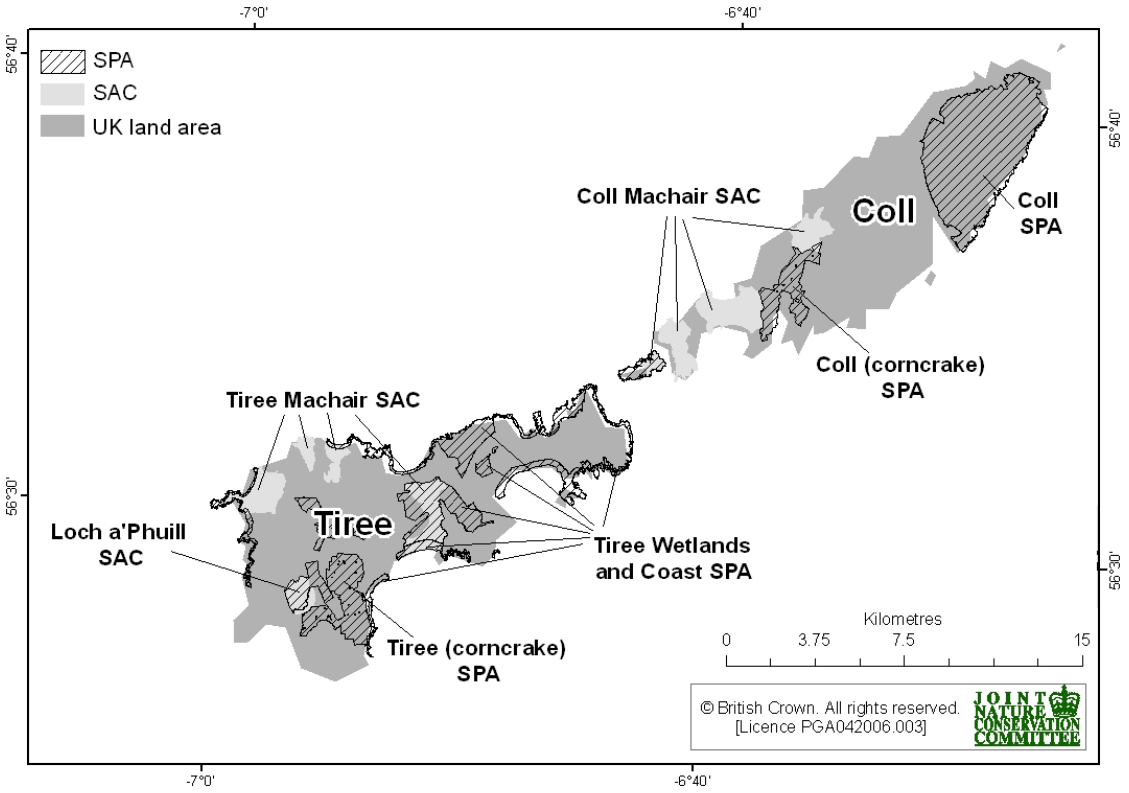

Figure 3. Overview of SPAs and SACs on Coll and Tiree.

Out of seven terrestrial Natura 2000 sites (Figure 3) only one, Tiree Wetlands and Coast SPA, features non-breeding coastal waterbirds and none addresses the conservation requirements of non-breeding inshore waterbirds at sea.

3 Methods

JNCC conducted line transect aerial surveys of the waters west of Mull and the waters surrounding Coll and Tiree over three and five winters respectively, between 2003/04 and 2007/08. Surveys were carried out between November and March to enable population estimates of wintering inshore waterbirds to be made.

3.1 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.cms.int/species/aewa/aew_tabl.htm 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, common eider, long-tailed duck, common scoter *Melanitta nigra*, velvet scoter *M. fusca*, common goldeneye *Bucephala clangula*, red-breasted merganser, goosander *Mergus merganser*, red-throated diver, black-throated diver *Gavia arctica*, great northern diver, little grebe *Tachybaptus ruficollis*, great crested grebe *Podiceps cristatus*, red-necked grebe *P. grisegena,* Slavonian grebe *P. auritus* and black-necked grebe *P. nigricollis*.

In the case of the great northern diver the threshold for such assessment is 50 individuals. The current GB winter population estimate is 2,500-3,000 individuals (Baker *et al.* 2006). However, Stroud *et al* (2001) recommend that the SPA qualification threshold should be 50 individuals.

The current GB winter population estimate for Slavonian grebes is 725 individuals (Baker *et al.* 2006), but again Stroud *et al* (2001) recommend the SPA qualification threshold should be 50 individuals.

3.2 Line transect aerial surveys

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).

3.3 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 were 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 (i.e. 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, i.e. 2 × (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.

3.4 Waterbird assemblage population estimation

For this analysis red-throated divers, great northern divers and unidentified divers were combined to give estimates for ‘all divers.’ These totals were added to the numbers of other species present to calculate the total number of inshore waterbirds present for each survey (Section 3.1.4.3, Table 4). Then, the peak total for each season (maximum estimate) was determined and then divided by the number of survey seasons in order to determine the mean peak estimate.

4 Results

4.1 Mull

4.1.1 Number of birds recorded

Four aerial line transect surveys were conducted of the waters around Mull between 25 March 2005 and 23 March 2007. All aerial surveys were carried out in February and March.

Five of the target species were recorded. Most data collected contained too few bird observations to enable distance sampling analysis. Therefore, extrapolation from raw counts was used to acquire estimates of numbers present for the following species: common eider, long-tailed duck, red-breasted merganser, red-throated diver and great northern diver (Table 2).

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.

Wetland Bird Survey (WeBS) core counts of the west coast of Mull present peak estimates of Slavonian grebes for 2002/03 and 2003/04 only. However, the Argyll Bird reports hold peak estimates from 2001/02 to 2006/07 for Loch na Keal. WeBS core counts of the west coast of Mull did not record any common goldeneye and black-throated diver or recorded only very low numbers of these species. These species are therefore not discussed further in this report.

4.1.2 Bird distributions

Distributions of common eider, red-breasted merganser and great northern diver off the west coast of Mull are presented in Appendix 1, Figures A1. Numbers of other species were not significant in an SPA context, and were too low to draw any meaningful conclusions on their distribution.

Common eider (Appendix 1, Figure A1 a-d)

Common eiders were recorded during all surveys and were observed mainly in water less than 20m deep and close to the shore. Higher numbers of common eider were regularly recorded around the Treshnish islands, Ulva and Staffa.

Red-breasted merganser (Appendix 1, Figure A1 a, c, d)

Red-breasted mergansers were present during three of four surveys but in very low numbers and sparsely distributed.

Great northern diver (Appendix 1, Figure A1 a-d)

Great northern divers were recorded during all surveys and were observed throughout the whole survey area. Birds were observed both close inshore and out to the offshore limits of the survey area, in areas of water down to 50m of depth.

4.1.3 Population and density estimates

Population estimates for aerial surveys reported here (Table 2) were derived from extrapolation from raw counts or distance sampling analysis (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. Here, 'all divers' population estimates were generated only for the purpose of calculating the size of waterbird assemblage (Section 3.1.4.3; Table 4). Details on estimates, including densities and confidence intervals (where possible) are provided in Appendix 3 for common eider, long-tailed duck, red-breasted merganser, red-throated diver and great northern diver. Though they are the best estimates possible, most population estimates should be used with caution as they were based on small sample sizes.

Table 1. Total numbers (raw counts) of birds and flocks (represented in brackets) counted in inshore waters around Mull during the 2004/05 to 2006/07 survey seasons. Numbers represent the total sample counts of all birds recorded on the line transect aerial surveys

Date of survey	Common eider	Long-tailed duck	Red-breasted merganser	Red-throated diver	Great northern diver
	Season 2004/05				
25 March 2005	67 (14)	1 (1)	1 (1)	1 (1)	27 (19)
	Season 2005/06				
9 February 2006	6 (5)	-	-	-	6 (6)
20 March 2006	12 (4)	-	8 (3)	-	1 (1)
	Season 2006/07				
23 March 2007	10 (4)	-	11 (3)	-	12 (10)

Table 2. Summary of total estimated numbers of selected species in inshore waters around Mull during each line-transect survey season from 2004/05 to 2006/07. Estimates and 95% confidence intervals (represented in brackets) are derived from distance sampling, apart from those denoted with an asterisk (*), which have been extrapolated from raw counts. Numbers in bold indicate the peak seasonal total population estimates of all species for each season. Numbers in shaded cells exceed the appropriate Stage 1 thresholds under the UK SPA Site Selection Guidelines

Date of survey	Common eider	Long-tailed duck	Red-breasted merganser	Red-throated diver	Great northern diver	All divers	Assemblage of all species
SPA qualification threshold	**12,850**	**20,000**	**1,700**	**170**	**50**	**n/a**	**20,000**
	Season 2004/05						
25 March 2005	246*	8*	4*	8*	95 (48-138)	99 (48-136)	**357**
	Season 2005/06						
9 February 2006	24*	-	-	-	24*	24*	48
20 March 2006	116*	-	38*	-	10*	10*	**164**
	Season 2006/07						
23 March 2007	39*	-	43*	-	43*	43*	**125**

4.1.4 Mean of peak estimates for each species in inshore waters of Mull

Mean of peak estimate calculations for common eider, long-tailed duck, red-breasted merganser and red-throated diver are not presented here as numbers of these birds were too low to be of significance in an SPA context.

a Great northern diver

Table 3 shows the peak estimated number for great northern divers around Mull for each season.

Great northern diver was the dominant diver species present throughout the survey area. Of all divers (46) observed during line transect surveys, one was identified as red-throated diver; the remainder were recorded as great northern diver. Only one density and population estimate of great northern divers was derived by using distance sampling. The remaining estimates were derived from extrapolation of raw counts. One estimate exceeded the stage 1 threshold in one of three seasons, as did the mean of peak estimate.

Table 3. Peak estimated number of great northern diver occurring in inshore waters of Mull during each survey season from 2004/05 to 2006/07. Shaded cells exceed the Stage 1.1 UK SPA Site Selection Guidelines threshold of 50 individuals, which is based on Baker *et al.* (2006)

Season	Analysis used to derive estimate	Peak estimate	Date
SPA guidelines Stage 1 threshold = 50			
2004/05	Distance sampling	95	25 Mar 2005
2005/06	extrapolation	24	9 Feb 2006
2006/07	extrapolation	43	23 Mar 2007
Mean of peak estimate		**54**	

b Slavonian grebe

Aerial surveys rarely record grebe species, and no Slavonian grebes were observed on the JNCC aerial surveys of Mull, Coll and Tiree. Estimated numbers of Slavonian grebes from systematic land-based counts within the survey area were low. However, casual observations show that Slavoninan grebes were regularly detected in Loch na Keal, with peak roost counts ranging from 1 (23 March 2007) to 49 (14 February 2004) (Argyll bird club). None of these seasonal peak estimates exceed the stage 1 SPA qualifying threshold in any of the recent five seasons. The area of Loch na Keal was surveyed by aircraft only on 9 February 2006 and not on any of the other aerial surveys.

c Waterbird assemblage

Table 4 shows the combined peak estimated numbers of common eider, long-tailed duck, red-breasted merganser and ‘all divers’ for each season. Estimates of total

waterbird numbers from aerial surveys did not exceed of 20,000 individuals, the Stage 1.3 threshold, in any season.

Table 4. Summary of combined peak estimated numbers of selected species occurring in inshore waters of Mull during each survey season from 2004/05 to 2006/07

Season	Common eider	Long-tailed duck	Red-breasted merganser	all divers	Total of mean peak for all species
2004/05	246	8	4	99	357
2005/06	116	0	38	24	178
2006/07	39	0	43	43	125
Mean	134	3	28	55	**220**

4.2 Coll and Tiree

4.2.1 Number of birds recorded

Six aerial line transect surveys were conducted around the islands of Coll and Tiree between 18 February 2004 and 17 March 2008. All aerial surveys were conducted in February and March of each year (Table 5). One survey had to be completed over two separate days (10 and 18 February 2006).

Six of the target species were recorded on aerial surveys. Sufficient data to enable distance analysis or extrapolation from raw counts were collected for the following species: greater scaup, common eider, long-tailed duck, red-breasted merganser, red-throated diver and great northern diver (Table 5). Some divers could not be identified to species level and therefore were recorded as unidentified diver species.

Aerial surveys rarely record common goldeneye, black-throated diver or grebes (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 that may otherwise be overlooked. However, WeBS core counts of Coll and Tiree did not record common goldeneye, black-throated diver or grebes, or recorded only very low numbers of these. This is supported by results from counts conducted annually since 1983 by the Royal Society for the Protection of Birds (RSPB) staff (RSPB, unpublished data). These species appear to be very thinly distributed around Coll and Tiree and are not discussed further in this report.

Table 5. Total numbers (raw counts) of birds and flocks (represented in brackets) counted in inshore waters around Coll and Tiree during the 2003/04 to 2007/08 survey seasons. Numbers represent the total sample counts of all birds recorded on the line transect aerial surveys

Date of survey	Greater Scaup	Common eider	Long-tailed duck	Red-breasted merganser	Red-throated diver	Great northern diver	Unidentified diver
	Season 2003/04						
18 February 2004	-	496 (68)	61 (26)	11 (3)	-	175 (117)	1 (1)
	Season 2004/05						
26 March 2005	-	218 (53)	17 (6)	4 (2)	2 (2)	131 (80)	-
10 & 18 February	**Season 2005/06**						
2006	-	259 (36)	-	7 (3)	-	45 (42)	6 (6)
21 March 2006	6 (1)	138 (45)	4 (1)	3 (3)	1 (1)	28 (26)	-
	Season 2006/07						
24 March 2007	-	163 (51)	-	-	-	33 (31)	-
	Season 2007/08						
17 March 2008	-	258 (64)	-	4 (3)	1 (1)	60 (58)	-

4.2.2 Bird distributions

Distributions of common eider, long-tailed duck, red-breasted merganser, red-throated diver and great northern diver are presented in Appendix 2, Figures A2-A3. Numbers of other species were not significant in the SPA context, and were too low to draw any meaningful conclusions on their distribution.

Common eider (Appendix 2, Figure A2 a-f)

Common eiders were recorded during all surveys and were observed mainly in water less than 20m deep and very close to the shore. High numbers of common eider were regularly recorded around the island of Tiree. Here, Balephetrish Bay and the inshore waters off Rubha Port Bhiosd to Port Bharrapol on the north western side of Tiree appeared to be hotspots for common eider (Figure 2).

Long-tailed duck (Appendix 2, Figure A2 a, b, d)

Long-tailed ducks were recorded in low numbers during three of the six surveys. They were observed in shallow inshore areas out to areas of water deeper than 50m.

Red-breasted merganser (Appendix 2, Figure A3 a-d, f)

Red-breasted mergansers were present during five of the six surveys but in very low numbers. Birds occurred in shallow water less than 10m deep close to the shore, mainly in eastern bays of Tiree and western bays of Coll.

Red-throated diver (Appendix 2, Figure A3 b, d, f)

Red-throated divers were recorded in very low numbers and only during three surveys of the inshore waters of Coll and Tiree.

Great northern diver (Appendix 2, Figure A3 a-f)

Great northern divers were recorded during all surveys but were observed throughout the whole survey area in only one survey (10 & 18 February 2006). High numbers of great northern divers were regularly recorded to the west of Coll and all around Tiree. Birds were observed in shallow inshore areas out to areas of water deeper than 50m (below chart datum). On each survey birds were observed in Hynish Bay (Tiree), and on five surveys in Crossapol Bay (Coll) (Figure 2).

4.2.3 Population and density estimates

Estimates of bird numbers from aerial surveys (Table 6) were derived either by extrapolation from raw counts, or by distance sampling analysis (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. Estimates for the number of ‘all divers’ were derived only for the purpose of calculating the waterbird assemblage (Section 3.2.4.8; Table 14). Details on estimates, including densities and confidence intervals (where possible) are presented in Appendix 4 for greater scaup, common eider, long-tailed duck, red-breasted merganser, red-throated diver, great northern

diver and ‘all divers’. Though they are the best estimates possible, most population estimates should be used with caution as they were based on small sample sizes.

Table 6. Summary of total estimated numbers of selected species around the islands of Coll and Tiree during each line transect survey season from 2003/04 to 2007/08. Estimates and 95% confidence intervals (represented in brackets) are derived from distance sampling, apart from those denoted with an asterisk (*), which have been extrapolated from raw counts. Numbers in bold indicate the peak seasonal total population estimates of all species for each season. Numbers in shaded cells exceed the appropriate Stage 1 thresholds under the UK SPA site selection guidelines

Date of survey	Greater scaup	Common eider	Long-tailed duck	Red-breasted merganser	Red-throated diver	Great northern diver	all divers	Assemblage of all species
SPA qualification threshold	**3,100**	**12,850**	**20,000**	**1,700**	**170**	**50**	**n/a**	**20,000**
	Season 2003/04							
18 Feb 2004	-	3029 (1642-5587)	428 (233-784)	101*	-	1273 (939-1727)	1275 (943-1724)	**4833**
	Season 2004/05							
26 Mar 2005	-	730 (337-1347)	71*	34*	16*	560 (325-854)	547 (321-834)	**1382**
	Season 2005/06							
10 & 18 Feb 2006	-	1336 (559-2347)	-	64*	-	202 (94-346)	226 (114-367)	**1626**
21 Mar 2006	60*	597 (254-1172)	40*	15*	10*	175 (101-274)	184 (103-292)	896
	Season 2006/07							
24 Mar 2007	-	1092 (670-1778)	-	-	-	253 (140-458)	253 (140-458)	**1345**
	Season 2007/08							
17 Mar 2008	-	1043 (495-2201)	-	7*	7*	172 (95-289)	172 (95-289)	**1515**

4.2.4 Mean of peak estimates for each species around Coll and Tiree

a Greater scaup

Table 7 shows the peak estimated numbers for greater scaup around the islands of Coll and Tiree for each season.

Only one of six surveys recorded greater scaup but not in sufficient numbers to estimate density and abundance using distance sampling. An estimate was therefore derived from extrapolation of raw counts. No estimates came close to exceeding the stage 1 SPA qualifying threshold in any season.

Table 7. Peak estimated numbers of greater scaup recorded around the islands of Coll and Tiree during each survey season from 2003/04 to 2007/08

Season	Analysis used to derive estimate	Peak estimate	Date
SPA guidelines 1% threshold = 3,100			
2003/04	-	no observations	
2004/05	-	no observations	
2005/06	extrapolation	60	21 Mar 2006
2006/07	-	no observations	
2007/08	-	no observations	
Mean of peak estimate		**12**	

b Common eider

Table 8 shows the peak estimated numbers of common eider around the islands of Coll and Tiree for each season.

Common eiders were the most numerous species present in the waters around Coll and Tiree during these aerial surveys. Population estimates varied throughout the survey period. No estimates came close to exceeding the stage 1 SPA qualifying threshold in any season. The data suggest this species is widely distributed around Coll.

Table 8. Peak estimated numbers of common eider recorded around the islands of Coll and Tiree during each survey season from 2003/04 to 2007/08.

Season	Analysis used to derive estimate	Peak estimate	Date
SPA guidelines 1% threshold = 12,850			
2003/04	Distance sampling	3029	18 Feb 2004
2004/05	Distance sampling	730	26 Mar 2005
2005/06	Distance sampling	1336	10&18 Feb 2006
2005/06	Distance sampling	596	21 Mar 2006
2006/07	Distance sampling	1092	24 Mar 2007
2007/08	Distance sampling	1043	17 Mar 2008
Mean of peak estimate		**1446**	

c Long-tailed duck

Table 9 shows the peak estimated numbers of long-tailed duck around the islands of Coll and Tiree for each season.

Only one (18 February 2004) of six surveys recorded high enough numbers of long-tailed ducks to generate density and population estimates using distance sampling. The remaining estimates were extrapolated from raw counts. No estimates came close to exceeding the stage 1 SPA qualifying threshold in any season. Again the data suggest this species is widely distributed around Coll.

Table 9. Peak estimated numbers of long-tailed duck recorded around the islands of Coll and Tiree during each survey season from 2003/04 to 2007/08

Season	Analysis used to derive estimate	Peak estimate	Date
SPA guidelines 1% threshold = 20,000			
2003/04	Distance sampling	428	18 Feb 2004
2004/05	extrapolation	71	26 Mar 2005
2005/06	-	no observations	
2006/07	extrapolation	40	24 Mar 2007
2007/08	-	no observations	
Mean of peak estimate		**108**	

d Red-breasted merganser

Table 10 shows the peak estimated numbers of red-breasted merganser around the islands of Coll and Tiree for each season.

There were too few observations of red-breasted merganser during all aerial surveys to estimate density and abundance using distance analysis, so estimates were extrapolated from raw counts. No estimates came close to exceeding the stage 1 SPA qualification threshold in any season.

Table 10. Peak estimated numbers for red-breasted merganser recorded around the islands of Coll and Tiree during each survey season from 2003/04 to 2007/08

Season	Analysis used to derive estimate	Peak estimate	Date
SPA guidelines 1% threshold = 1,700			
2003/04	extrapolation	101	18 Feb 2004
2004/05	extrapolation	34	26 Mar 2005
2005/06	extrapolation	64	10&18 Feb 2006
2006/07	-	no observations	
2007/08	extrapolation	7	17 March 2008
Mean of peak estimate		**41**	

e Red-throated diver

Table 11 shows the peak estimated numbers of red-throated diver around the islands of Coll and Tiree for each season.

Only three surveys recorded red-throated divers: on 26 March 2005, 21 March 2006 and on 17 March 2008. The density and population estimates from these aerial surveys were extrapolated from raw counts. No estimates came close to exceeding the stage 1 SPA qualifying threshold in any season.

Table 11. Peak estimated numbers of red-throated divers recorded around the islands of Coll and Tiree during each survey season from 2003/04 to 2007/08

Season	Analysis used to derive estimate	Peak estimate	Date
SPA guidelines 1% threshold = 170			
2003/04	-	no observations	
2004/05	extrapolation	16	26 Mar 2005
2005/06	extrapolation	10	21 Mar 2006
2006/07	-	no observations	
2007/08	extrapolation	7	17 March 2008
Mean of peak estimate		**7**	

f Great northern diver

Table 12 shows the peak estimated numbers of great northern diver around the islands of Coll and Tiree for each season.

Great northern diver was the most abundant diver species recorded throughout the survey area. Of all divers (472) observed during line transect surveys, four were identified as red-throated divers and seven as unidentified divers; the remainder were great northern divers. All density and population estimates of great northern divers were derived from distance sampling analysis. All estimates exceed the stage 1 SPA qualifying threshold in any season.

Table 12. Peak estimated numbers of great northern diver recorded around the islands of Coll and Tiree during each survey season from 2003/04 to 2007/08. Shaded cells exceed the 1% SPA qualifying threshold (50 individuals); (Baker *et al.* 2006)

Season	Analysis used to derive estimate	Peak estimate	Date
SPA guidelines 1% threshold = 50			
2003/04	Distance sampling	1273	18 Feb 2004
2004/05	Distance sampling	560	26 Mar 2005
2005/06	Distance sampling	202	10&18 Feb 2006
2006/07	Distance sampling	253	24 Mar 2007
2007/08	Distance sampling	172	17 March 2008
Mean of peak estimate		**492**	

g All diver species

Table 13 shows the peak estimated numbers of all diver species around the islands of Coll and Tiree for each season.

Red-throated divers were recorded too infrequently during aerial surveys to derive reliable estimates of numbers based on distance sampling (Table 2). These observations, along with records of great northern divers and unidentified diver species, were used to derive 'all divers' estimates. Line-transect surveys on 24 March 2007 and 17 March 2008 resulted in either no observations, or low numbers of red-throated or unidentified divers. Consequently, the overall density and abundance estimates for 'all divers' were equal to those calculated for great northern diver.

On 26 March 2005 red-throated and great northern divers were combined to present 'all divers'. With increase in sample size the confidence limits for this estimate from distance sampling became narrower and as a result a slightly smaller population estimate was generated than for great northern diver alone.

Table 13. Peak estimated numbers of 'all divers' recorded around the islands of Coll and Tiree during each survey season from 2003/04 to 2007/08

Season	Analysis used to derive estimate	Peak estimate	Date
2003/04	Distance sampling	1275	18 Feb 2004
2004/05	Distance sampling	547	26 Mar 2005
2005/06	Distance sampling	226	10&18 Feb 2006
2006/07	Distance sampling	253	24 Mar 2007
2007/08	Distance sampling	172	17 March 2008
Mean of peak estimate		**495**	

4.2.5 Waterbird assemblage

Table 14 shows the combined peak estimated number of greater scaup, common eider, long-tailed duck, red-breasted merganser and 'all divers' for each season. Population estimates from aerial surveys did not exceed the Stage 1.3 SPA qualifying threshold of 20,000 individuals in any season.

Table 14. Summary of combined estimated number for selected species recorded around the islands of Coll and Tiree during each survey season from 2003/04 to 2007/08

Season	Greater scaup	Common eider	Long-tailed duck	Red-breasted merganser	All divers	Total of mean peak for all species
2003/04	0	3029	428	101	1275	4833
2004/05	0	730	71	34	547	1382
2005/06	60	1336	40	64	226	1726
2006/07	0	1092	0	0	253	1345
2007/08	0	1043	0	7	172	1515
Mean	12	1446	108	41	494	**2101**

5 Discussion

5.1 Distance sampling analysis for Mull, Coll and Tiree

The data for great northern divers in the inshore areas of Mull from only one survey (25 March 2005) had a sufficient sample size and did not violate the assumptions required to apply distance sampling analysis. Consequently it was possible to model a detection function only for this survey.

Sufficient data to allow distance analysis were available only for common eider and great northern diver around Coll and Tiree. It was also possible to model a detection function for one out of three long-tailed duck surveys. However, for the remainder of the long-tailed duck surveys, or for red-breasted merganser and red-throated divers, 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.

5.2 Application of Stage 1 UK SPA Selection Guidelines for Mull, Coll and Tiree

5.2.1 Greater scaup

The greater scaup 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 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 3,100 individuals (Wetlands International 2006).

Greater scaup were only recorded during one aerial survey around Coll and Tiree. Peak population estimates for each survey of greater scaup ranged from 0 to 60 individual birds, with a mean of peak counts of 12 (Table 7). Therefore, numbers of greater scaup occurred in insufficient numbers to be of significance in the SPA context. WeBS core counts and systematic recordings from RSPB support these findings.

Peak estimated numbers of greater scaup in waters around Mull, Coll and Tiree did not exceed the threshold in any of five seasons, nor did the mean of peak estimate for the five most recent seasons.

The inshore waters of Mull, Coll and Tiree do not meet the requirements of stage 1.2 of the selection guidelines for this species.

5.2.2 Common eider

The common eider 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 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).

In the inshore waters of Mull common eider did not occur regularly in numbers exceeding this threshold. Comparison with WeBS core counts indicated that data are sparse. However, up to 67 individual eider have been recorded west of Mull during a systematic seaduck count carried out by RSPB.

The estimated numbers of common eider in the inshore areas of Coll and Tiree for each survey ranged from 597 to 3,029 individual birds, with a mean of peak counts of 1,446 (Table 6). Population estimates varied across seasons.

Estimated numbers of common eider in the waters around Mull, Coll and Tiree did not exceed the 1.2 threshold in any of five seasons, nor did the mean of peak estimated numbers for the five most recent seasons.

The inshore waters of Mull, Coll and Tiree do not meet the requirements of stage 1.2 of the selection guidelines for this species.

5.2.3 Long-tailed duck

Long-tailed duck 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 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 did not occur regularly in numbers exceeding this threshold in the inshore waters of Mull. Comparison with WeBS core counts support these findings and also indicate that data are sparse.

In the inshore waters of Coll and Tiree peak estimated numbers of long-tailed ducks for each season ranged from 40 to 428, with a mean of peak counts of 135 individual birds (Table 6). The data indicated high variation in population estimates across seasons. Comparison with WeBS core counts and systematic recordings from RSPB indicated that this supports the aerial survey findings. Long-tailed ducks have also been recorded in flocks up to 61 individuals (WeBS, February 2004) in offshore waters between Mull, Coll and Tiree.

Peak estimated numbers of long-tailed duck in the waters around Mull, Coll and Tiree did not exceed the 1.2 threshold in any of five seasons, nor did the mean of peak estimated numbers for the five most recent seasons.

The inshore waters of Mull, Coll and Tiree do not meet the requirements of stage 1.2 of the selection guidelines for this species.

5.2.4 Red-breasted merganser

The red-breasted merganser 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 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).

Red breasted mergansers did not occur regularly in numbers exceeding this threshold in the inshore waters of Mull. Although data on inshore waterbirds off the west coast of Mull are sparse, these findings were supported by a comparison with WeBS core counts and systematic recordings from RSPB seaduck counts.

In the inshore waters of Coll and Tiree estimated numbers of red-breasted mergansers for each survey ranged from only 15 to 101 with a mean of peak count of 50 individual birds (Table 6). Comparison with WeBS core counts and systematic recordings from RSPB indicated that this supports our aerial survey findings.

Peak estimated numbers of red-breasted mergansers in waters around Mull, Coll and Tiree did not exceed the threshold in any of five seasons, nor did the mean of peak estimated numbers for the five most recent seasons.

The inshore waters of Mull, Coll and Tiree do not meet the requirements of stage 1.2 of the selection guidelines for this species.

5.2.5 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).

Red-throated divers did not occur regularly in numbers exceeding this threshold in the inshore waters of Mull. Based on low numbers recorded and extrapolation from two survey counts, the mean peak count for the inshore waters of Coll and Tiree is seven individual birds (Table 7). Comparison with WeBS core counts and systematic recordings from RSPB supports the aerial survey findings.

Peak estimated numbers of red-throated divers in waters around Mull, Coll and Tiree did not exceed the threshold in any of five seasons, nor did the mean of peak estimated numbers for the five most recent seasons.

The inshore waters of Mull, Coll and Tiree do not meet the requirements of stage 1.1 of the selection guidelines for this species.

5.2.6 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).

In the inshore waters of Mull great northern divers did not occur regularly in numbers exceeding this threshold. Despite the increased efforts of local recorders over recent years data are still sparse and comparison of numbers of great northern divers off the west coast of Mull from WeBS core counts and RSPB records is therefore difficult.

Peak estimated numbers of great northern divers in inshore waters of Mull exceed the SPA threshold in only one out of three seasons. Therefore, this area does not meet the requirements of stage 1.1 of the UK Selection Guidelines for this species. However, as a second estimate almost exceeds the qualifying threshold of 50 individuals and the mean peak estimate exceeds the threshold the area could be considered under stage 1.4 of the UK SPA Selection Guidelines.

There was large variation in the peak population estimates of great northern divers in the inshore waters of Coll and Tiree for each season, ranging from 172 to 1,273, with a mean of peaks estimate of 492 individual birds (Table 12). Further details on population estimates can be found in Appendix 4. The estimates for each season all exceed the qualifying threshold of 50 individuals, as does the mean of peak estimated numbers for the five most recent seasons.

It is likely that the large extent of shallow water around the Coll and Tiree make it a suitable area for great northern divers to winter. Shallow waters of depths between20-50m extend far offshore around Coll and Tiree (Figure 2), providing a large area with water of a suitable depth for foraging. Great northern diver numbers from WeBS core counts and systematic recordings from RSPB were slightly lower than JNCC aerial survey estimates. The likely reasons for this is that great northern divers occur further offshore than is possible to see from land, In addition great northern divers have been recorded in flocks up to 175 individuals (WeBS, February 2004) and 131 individuals (WeBS, March 2005) in offshore waters between Mull, Coll and Tiree.

This area does meet the requirements of stage 1.1 of the UK Selection Guidelines for this species. Further analysis may be necessary to determine the most important areas around Coll and Tiree for great northern divers.

The distance sampling estimate of great northern diver numbers in the inshore waters around Coll and Tiree based on the 18 February 2004 survey was 1,273 individuals. This estimate greatly exceeds the 1% threshold and is at least 42% of the current GB wintering population estimate of 2,500-3,000 individuals (Baker *et al.* 2006). The mean peak estimate across all seasons of 492 individuals takes into account variation across survey years, but is still approximately 16% of the current GB wintering

population estimate. Given that ostensibly almost 50% of the estimated GB wintering population of great-northern divers was present within the survey area on one date, it is clear that a reappraisal of the GB wintering population estimate is required.

Despite applying a potentially obsolete qualifying threshold of 50 individuals (Stroud *et al.* 2001, Baker *et al.* 2006), the numbers of great northern divers presented here are very likely to meet the requirements of stage 1.1 of the selection guidelines for this species even if the GB wintering population should be reviewed.

5.2.7 Slavonian grebe

The 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 a 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 400 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.)

Peak estimated numbers of Slavonian grebe in inshore waters of Mull did not exceed the threshold in any of five seasons. Therefore, this area does not meet the requirements of stage 1.1 of the UK Selection Guidelines for this species.

5.2.8 Other waterbird species

No other species of inshore waterbird observed in the waters west of Mull and around Coll and Tiree were recorded in sufficient numbers to reliably estimate total population size (Table 1). It is unlikely that any of these species occur regularly in numbers that would meet stage 1 SPA selection thresholds.

5.2.9 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 estimate of inshore waterbirds in the waters off the west coast of Mull was 220 individuals (Table 4). Therefore, the waterbird assemblage here does not meet the requirements for stage 1.3 of the UK SPA Selection Guidelines.

The mean peak estimates of inshore waterbirds in the waters around Coll and Tiree resulted in a total of 2,102 individual birds (Table 14). Therefore, the waterbird assemblage in waters around Coll and Tiree does not meet the requirements for Stage 1.3 of the UK SPA Selection Guidelines.

6 Conclusions

6.1 Mull

The inshore waters of the Isle of Mull do not meet the UK SPA Selection Guidelines (Stroud *et al.* 2001) for SPA qualifying at stage 1.1., 1.2. or 1.3. However, when the complete suite of marine SPAs, including those for inshore areas, has been determined then the inshore areas of Mull, (or parts thereof) could be considered for inclusion at stage 1.4 for great northern divers. The peak estimated numbers of great northern divers in inshore waters of Mull exceed the SPA threshold in only one out of three seasons. However, a second estimate almost exceeds the qualifying threshold of 50 individuals and the mean peak estimate does exceed the threshold.

If the waters of Mull are selected for SPA classification further analysis will be required to determine a boundary to that SPA.

6.2 Coll and Tiree

On the basis of the UK SPA Selection Guidelines (Stroud *et al.* 2001) the waters around Coll and Tiree qualify as an SPA in the area for the great northern diver at stage 1.1. Therefore, when the complete suite of marine SPAs in inshore areas is being determined the inshore areas of Coll and Tiree (or parts thereof), should be considered for inclusion.

If the inshore areas of Coll and Tiree 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.

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.

7 Acknowledgements

The success of these surveys was due to the hard work and co-operation of those involved. JNCC would like to thank Richard Schofield, Mark Lewis and Ryan Irvine who were observers during aerial surveys.
Thanks are also due to Hebridean Air Services and Ravenair Air Services and their pilots for making the best use of the unpredictable winter weather, communicating with air traffic control and duty managers of danger areas and flying the surveys with the best possible precision and safety.

The collection of these data and the completion of this report was supported by funding from Scottish Natural Heritage (SNH) and from JNCC Grant In Aid. We thank Nigel Buxton of SNH for his comments on an earlier draft of this report.

We thank Neil Calbrade from the British Trust of Ornithology for providing us with WeBS data and to the individuals who carried out the counts. WeBS is a partnership of the British Trust for Ornithology, The Wildfowl & Wetlands Trust, Royal Society for the Protection of Birds and Joint Nature Conservation Committee (the last on behalf of the Countryside Council for Wales, the Environment and Heritage Service, Natural England and Scottish Natural Heritage).

We are also grateful to John Bowler of the RSPB on Tiree for sharing his local knowledge and years of count data on the area.

Finally, we thank Paul Daw of the Argyll Bird Club for supplying additional information on Slavonian grebes.

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Appendix 1: Bird distributions around the west coast of Mull

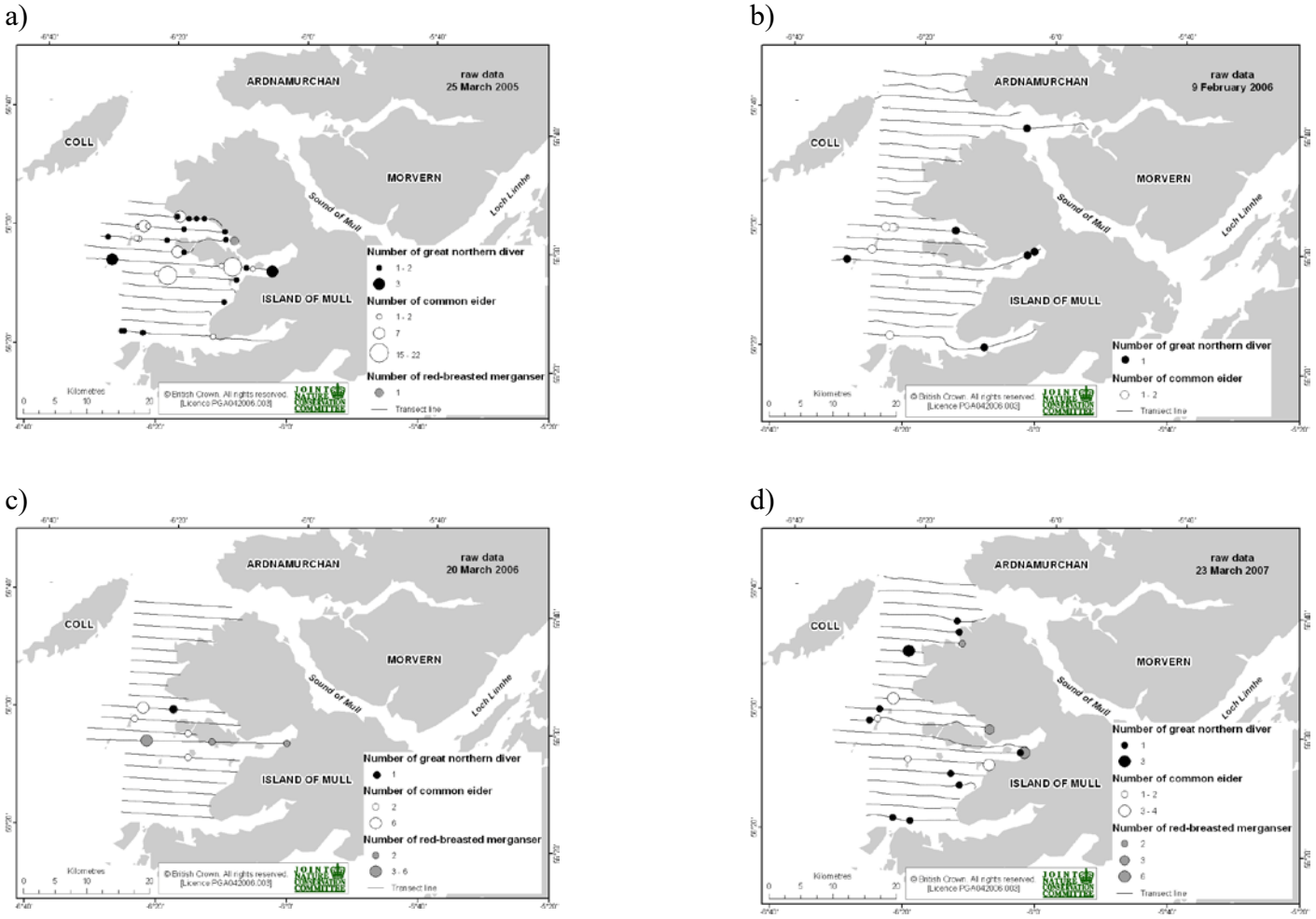
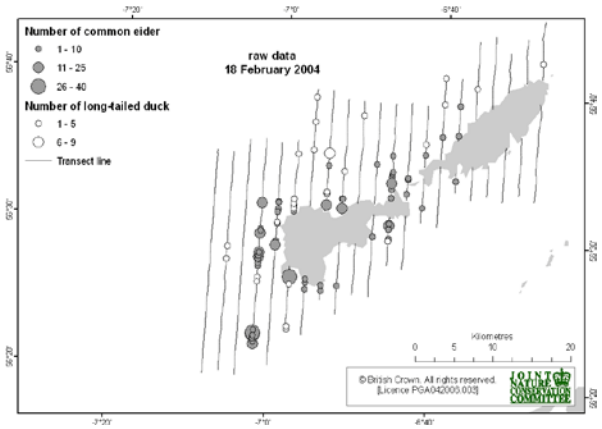


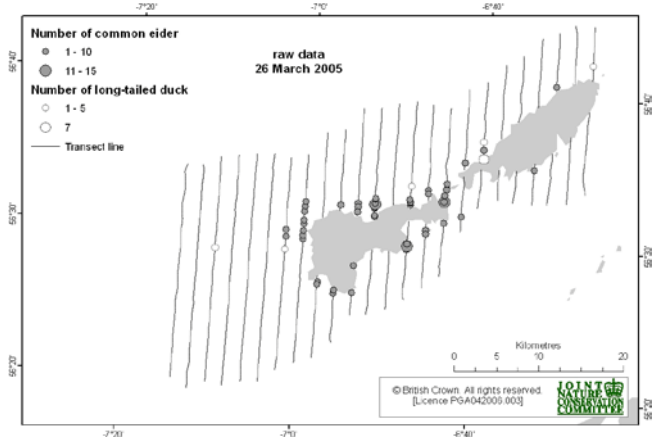
Figure A1: Distribution of great northern diver, common eider and red-breasted merganser observed off western Mull during line transect aerial surveys on a) 25 March 2005, b) 9 February 2006, c) 20 March 2006 and d) 23 March 2007.

Appendix 2: Bird distributions around Coll and Tiree

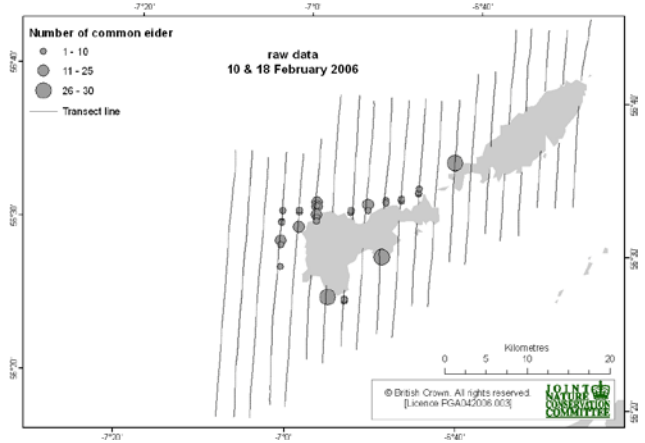
a)



b)



c)



d)

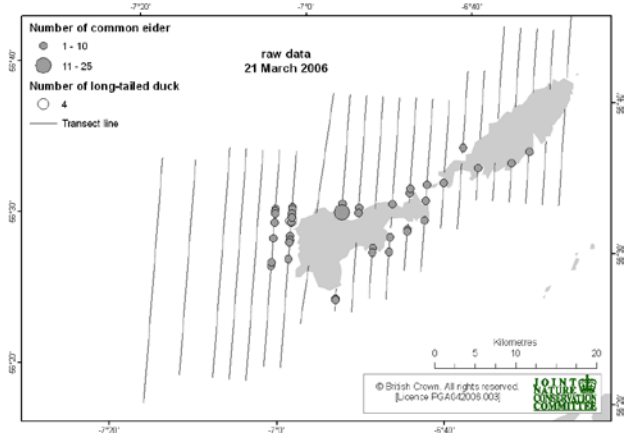


Figure A2: Distribution of common eider and long-tailed duck observed around Coll and Tiree on a) 18 February 2004, b) 26 March 2005, c) 10 & 18 February 2006 and d) 21 March 2006

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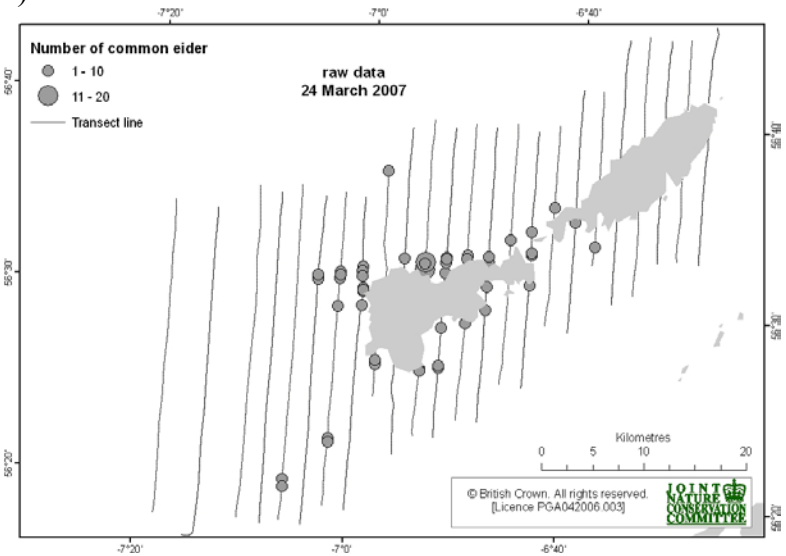
e)



f)

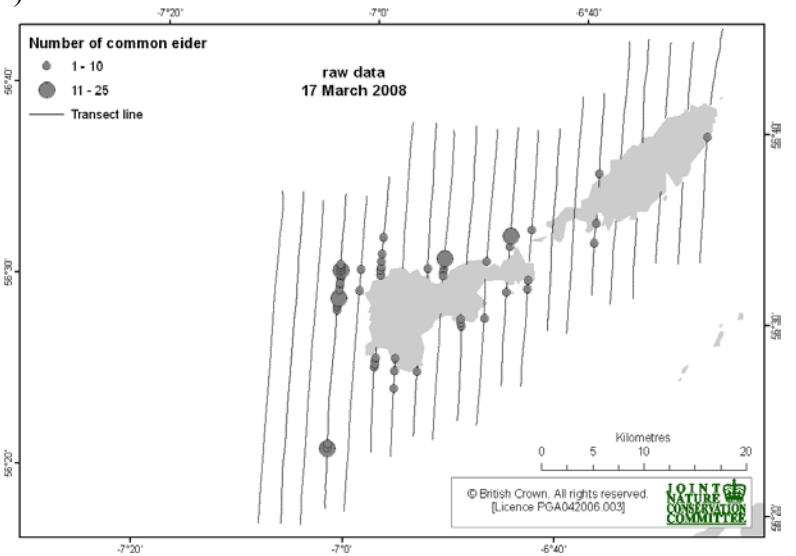
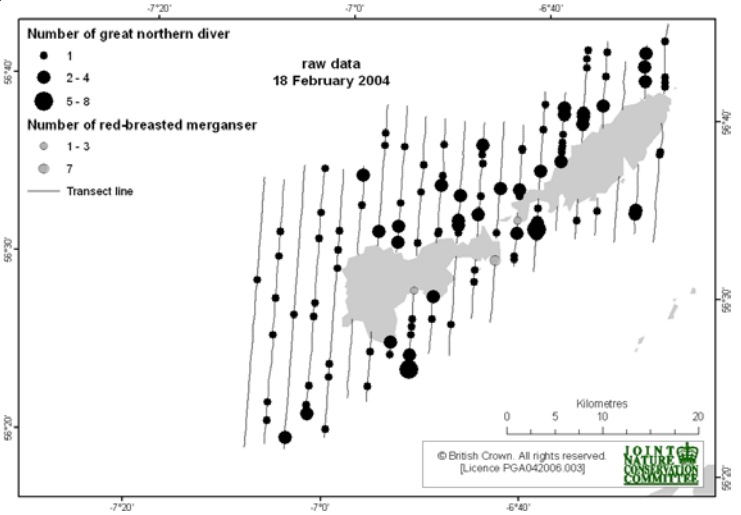


Figure A2 (cont.): Distribution of common eider observed around Coll and Tiree on e) 24 March 2007 and f) 17 March 2008

a)



b)

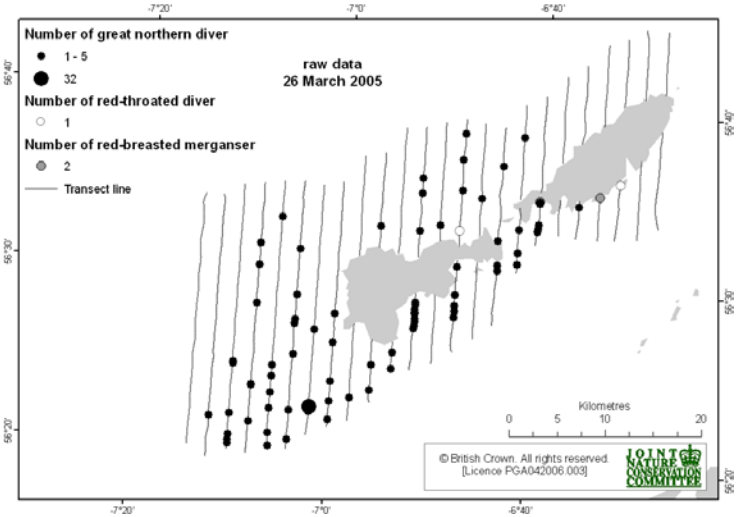


Figure A3: Distribution of red-breasted merganser, great northern diver and red-throated diver observed around Coll and Tiree on a) 18 February 2004 and b) 26 March 2005.

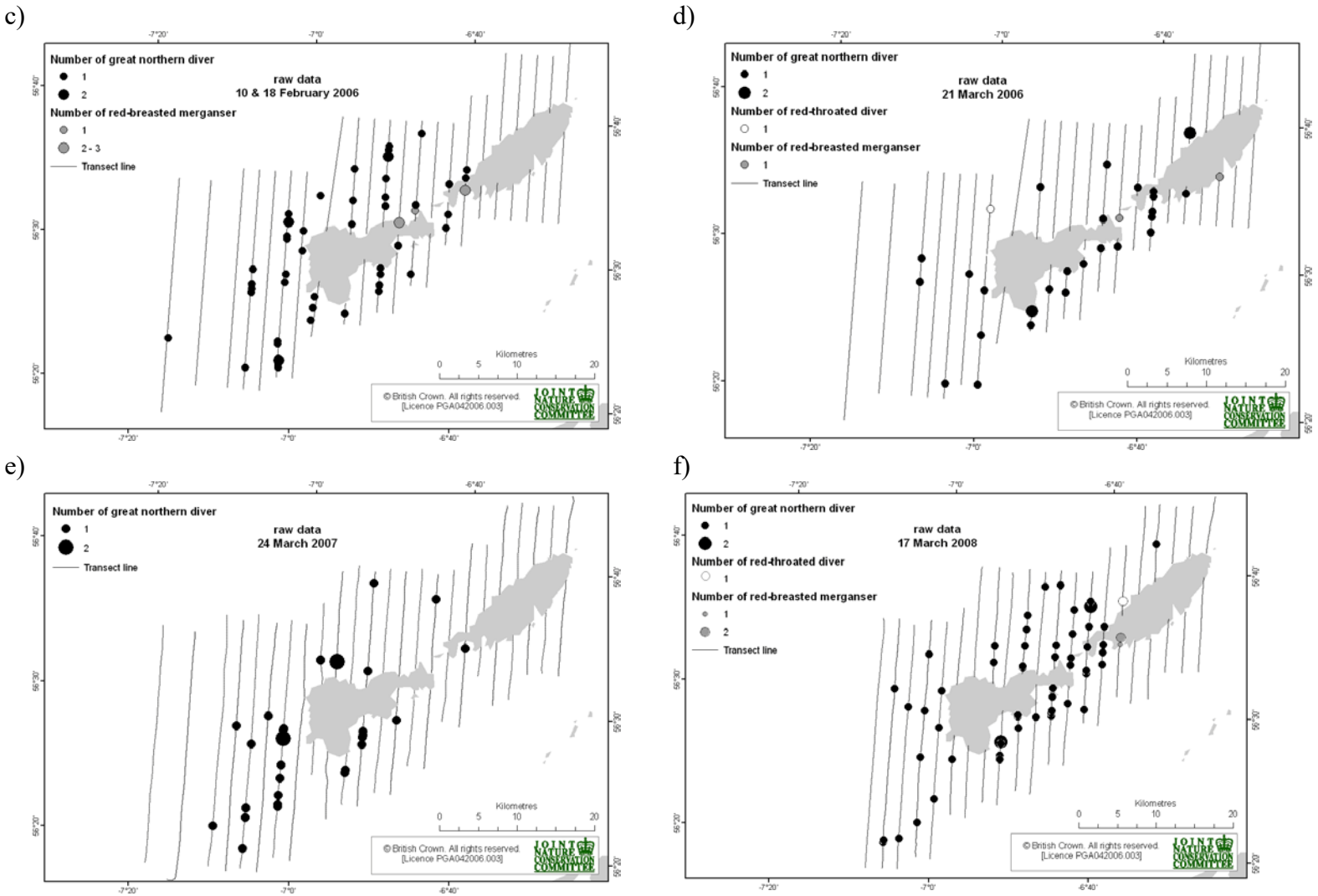


Figure A3 (cont.): Distribution of red-breasted merganser, great northern diver and red-throated diver observed around Coll and Tiree on c) 10 & 18 February 2006 and d) 21 March 2006, e) 24 March 2007 and f) 17 March 2008.

Appendix 3: Detailed population estimates for Mull

Table A1: Density and population estimates for **common eider** from line transect aerial surveys carried out from March 2005 to March 2007 off western Mull. Estimates were derived from raw counts.

Survey date	No. transects	No. observed	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)
2004/05						
25 March 2005	12	67	14	394.0	0.625	246*
2005/06						
9 February 2006	23	6	5	719.7	0.034	24*
20 March 2006	19	12	4	642.3	0.181	116*
2006/07						
23 March 2007	21	10	4	615.0	0.064	39*

Table A2: Density and population estimates for **long-tailed duck** from line transect aerial surveys carried out from March 2005 to March 2007 off western Mull. Estimates were derived from raw counts.

Survey date	No. transects	No. observed	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)
2004/05						
25 March 2005	12	1	1	394.0	0.019	8*
2005/06						
9 February 2006	23	-	-	719.7	no observations	
20 March 2006	19	-	-	642.3	no observations	
2006/07						
23 March 2007	21	-	-	615.0	no observations	

Table A3: Density and population estimates for **red-breasted merganser** from line transect aerial surveys carried out from March 2005 to March 2007 off western Mull. Estimates were derived from raw counts.

Survey date	No. transects	No. observed	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)
2004/05						
25 March 2005	12	1	1	394.0	0.009	4*
2005/06						
9 February 2006	23	-	-	719.7	no observations	
20 March 2006	19	8	3	642.3	0.059	38*
2006/07						
23 March 2007	21	11	3	615.0	0.071	43*

Table A4: Density and population estimates for **red-throated diver** from line transect aerial surveys carried out from March 2005 to March 2007 off western Mull. Estimates were derived from raw counts.

Survey date	No. transects	No. observed	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)
2004/05						
25 March 2005	12	1	1	394.0	0.019	8*
2005/06						
9 February 2006	23	-	-	719.7	no observations	
20 March 2006	19	-	-	642.3	no observations	
2006/07						
23 March 2007	21	-	-	615.0	no observations	

Table A5: Density and population estimates for **great northern diver** from line transect aerial surveys carried out from March 2005 to March 2007 off western Mull. Estimates were derived from raw counts and from distance sampling. The 95% confidence interval (CI) is a bootstrap ([b]) estimate.

Survey date	No. transects	No. observed	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)
2004/05						
25 March 2005	12	27	19	394.0	0.241 (0.127-0.455)	95 (48-138)[b]
2005/06						
9 February 2006	23	6	6	719.7	0.0335	24*
20 March 2006	19	1	1	642.3	0.015	10*
2006/07						
23 March 2007	21	12	10	615.0	0.071	43*

Appendix 4: Detailed population estimates for Coll and Tiree

Table B1: Density and population estimates for **greater scaup** from line transect aerial surveys carried out from February 2004 to March 2008 around the islands of Coll and Tiree. Estimates were derived from distance sampling. The 95% confidence intervals (CI) given are empirical ([e]) or bootstrap ([b]) estimates.

Survey date	No. transects	No. observed	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)
2003/04						
18 February 2004	37	0	0	844.96	no observations	
2004/05						
26 March 2005	42	0	0	1004.85	no observations	
2005/06						
10 & 18 February 2006	40	0	0	1177.19	no observations	
21 March 2006	37	0		1097.23	0.05	60*
2006/07						
24 March 2007	40	0	0	1323.39	no observations	
2007/08						
17 March 2008	38	0	0	844.96	no observations	

Table B2: Density and population estimates for **common eider** from line transect aerial surveys carried out from February 2004 to March 2008 around the islands of Coll and Tiree. Estimates were derived from distance sampling. The 95% confidence intervals (CI) of distance sampling estimates given are empirical ([e]) or bootstrap ([b]) estimates.

Survey date	No. transects	No. observed	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)
2003/04						
18 February 2004	37	496	68	844.96	3.58 (1.94-6.61)	3029 (1642-5587)[e]
2004/05						
26 March 2005	42	218	53	1004.85	0.73 (0.37-1.43)	730 (337-1347)[b]
2005/06						
10 & 18 February 2006	40	259	36	1177.19	1.14 (0.50-2.56)	1336 (559-2347)[b]
21 March 2006	37	138	45	1097.23	0.54 (0.29-1.02)	597 (254-1172)[e]
2006/07						
24 March 2007	40	163	51	1323.39	0.82 (0.51-1.34)	1092 (670-1778)[e]
2007/08						
17 March 2008	38	258	64	844.96	1145 (417-2408)	1.355 (0.652-2.818)[e]

Table B3: Density and population estimates for **long-tailed duck** from line transect aerial surveys carried out from February 2004 to March 2008 around the islands of Coll and Tiree. Estimates were derived from distance sampling, except for those marked with an asterisk (*), which were derived from extrapolation of raw counts. The 95% confidence intervals (CI) of distance sampling estimates given are empirical ([e]) or bootstrap ([b]) estimates.

Survey date	No. transects	No. observed	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)
2003/04						
18 February 2004	37	61	26	844.96	0.51 (0.28-0.93)	428 (233-784)[e]
2004/05						
26 March 2005	42	17	6	1004.85	0.07	71*
2005/06						
10 & 18 February 2006	40	0	0	1177.19	no observations	
21 March 2006	37	4	1	1097.23	0.04	40*
2006/07						
24 March 2007	40	0	0	1323.39	no observations	
2007/08						
17 March 2008	38	0	0	844.96	no observations	

Table B4: Density and population estimates for **red-breasted merganser** from line transect aerial surveys carried out from February 2004 to March 2008 around the islands of Coll and Tiree. Estimates were derived from extrapolation of raw counts.

Survey date	No. transects	No. observed	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)
2003/04						
18 February 2004	37	11	3	844.96	0.12	101*
2004/05						
26 March 2005	42	4	2	1004.85	0.03	34*
2005/06						
10 & 18 February 2006	40	7	3	1177.19	0.05	64*
21 March 2006	37	3	3	1097.23	0.01	15*
2006/07						
24 March 2007	40	0	0	1323.39	no observations	
2007/08						
17 March 2008	38	4	3	844.96	0.008	7*

Table B5: Density and population estimates for **red-throated diver** from line transect aerial surveys carried out from February 2004 to March 2008 around the islands of Coll and Tiree. Estimates were derived from extrapolation of raw counts.

Survey date	No. transects	No. observed	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)
2003/04						
18 February 2004	37	0	0	844.96	no observations	
2004/05						
26 March 2005	42	2	2	1004.85	0.01	16*
2005/06						
10 & 18 February 2006	40	0	0	1177.19	no observations	
21 March 2006	37	1	1	1097.23	0.01	10*
2006/07						
24 March 2007	40	0	0	1323.39	no observations	
2007/08						
17 March 2008	38	1	1	844.96	no observations	

Table B6: Density and population estimates for **great northern diver** from line transect aerial surveys carried out from February 2004 to March 2008 around the islands of Coll and Tiree. Estimates were derived from distance sampling. The 95% confidence intervals (CI) of distance sampling estimates given are empirical ([e]) or bootstrap ([b]) estimates.

Survey date	No. transects	No. observed	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)
2003/04						
18 February 2004	37	175	117	844.96	1.51 (1.11-2.04)	1273 (939-1727)[e]
2004/05						
26 March 2005	42	131	80	1004.85	0.56 (0.35-0.88)	560 (325-854)[e]
2005/06						
10 & 18 February 2006	40	45	42	1177.19	0.17 (0.09-0.31)	202 (94-346)[b]
21 March 2006	37	28	26	1097.23	0.16 (0.08-0.30)	175 (101-274)[b]
2006/07						
24 March 2007	40	33	31	1323.39	0.19 (0.011-0.35)	253 (140-458)[b]
2007/08						
17 March 2008	38	46	43	844.96	0.204 (0. 07-0.55)	172 (95-289)[b]

Table B7: Density and population estimates for '**all diver species'** from line transect aerial surveys carried out from February 2004 to March 2008 around the islands of Coll and Tiree. Estimates were derived from distance sampling. The 95% confidence intervals (CI) of distance sampling estimates given are empirical ([e]) or bootstrap ([b]) estimates.

Survey date	No. transects	No. observed	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)
2003/04						
18 February 2004	37	176	118	844.96	1.51 (1.12-2.04)	1275 (943-1724)[e]
2004/05						
26 March 2005	42	133	82	1004.85	0.55 (0.35-0.86)	547 (321-834)[e]
2005/06						
10 & 18 February 2006	40	51	48	1177.19	0.19 (0.11-0.34)	226 (114-367)[b]
21 March 2006	37	29	27	1097.23	0.17 (0.09-0.31)	184 (103-292)[b]
2006/07						
24 March 2007	40	33	31	1323.39	0.19 (0.011-0.35)	253 (140-458)[b]
2007/08						
17 March 2008	38	61	59	844.96	0.604 (0.33-1.11)	465 (250-866)[b] HN trunc A