A review of the status of Great Northern Diver *Gavia immer* in Galicia, northwest Spain

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Abstract

The status of the Great Northern Diver *Gavia immer* in Galicia, northwest Spain, is reviewed. Numbers peaked in late autumn and early winter, and again in spring. Post-breeding moult was recorded from November to mid December. Individuals in flight feather moult were recorded between February and March, the rest of the pre-breeding moult extending until the last birds departed around mid May. It is suggested that new birds arrive in the area in early spring to moult, replacing part of the wintering population. The species showed a strong preference for exposed sandy coasts in all seasons, but particularly in late winter and spring. The wintering population declined markedly following the *Prestige* oil spill in 2002/03 (c. 57% from 2002 to 2005). After 2005 the population returned to previous levels, possibly through immigration of birds from the nearby region of Asturias, where the wintering population collapsed in the same period. The average wintering population (uncorrected for detectability) was 123 birds (95% CI = 76–166), c. 2.5% of the estimated European wintering population.

Introduction

Great Northern Divers *Gavia immer* are scarce winter visitors to Iberia (Díaz *et al*. 1996), where they prefer the shallow open coasts of the Cantabrian-Atlantic coasts of Spain (Paterson 1997). Until recently there had been no standardised monitoring of the species in these waters, and beyond some notes in regional bird reports, systematic counts were localised with little temporal coverage (Paterson 1997). The Iberian population was estimated to be at least 500 birds in the early 1990s (Álvarez Laó 1993), but with only 60–110 found in northwest Iberia (Paterson 1997). A more recent conservative estimate was of 270–340 individuals for Spain (Sandoval & De Souza 2005), while the species is still considered a rarity in Portugal (Matias *et al*. 2007; Anon. 2010).

Great Northern Divers are highly vulnerable to oil spills (Camphuysen 1989). On 19 November 2002 the tanker *Prestige* broke in two 240 km off the Galician coast, leaking 66,000 tonnes of oil that affected over 800 km of the northwest Spanish coastline (González *et al*. 2006). Although most of the 23,130 birds recorded on beached bird surveys during the incident were auks (Alcidae), 65 Great Northern Divers were found stranded between northern Portugal and southern France, mostly in Galicia (García *et al*. 2003).

Taking all this into account, there is a need for recent and accurate information on numbers, since Great Northern Diver is listed in the Red Book of Birds of Spain (Madroño *et al*. 2004). Here we review its status in Galicia, where most of the Iberian population is concentrated, providing information on phenology, population size and trends, and habitat preferences, with special attention paid to the effect of the *Prestige* oil spill.

Study area and methods

The Galician coast of northwest Iberia is 1,692 km long (Figure 1), mostly rocky, but with sandy shores covering 17% (MOPU 1981). The continental shelf is 30–50 km wide, the shelf break occurring at water depths of 160–180 m. Fine, silty clays dominate most of the seabed, but coarser sediments like sands and gravels are also

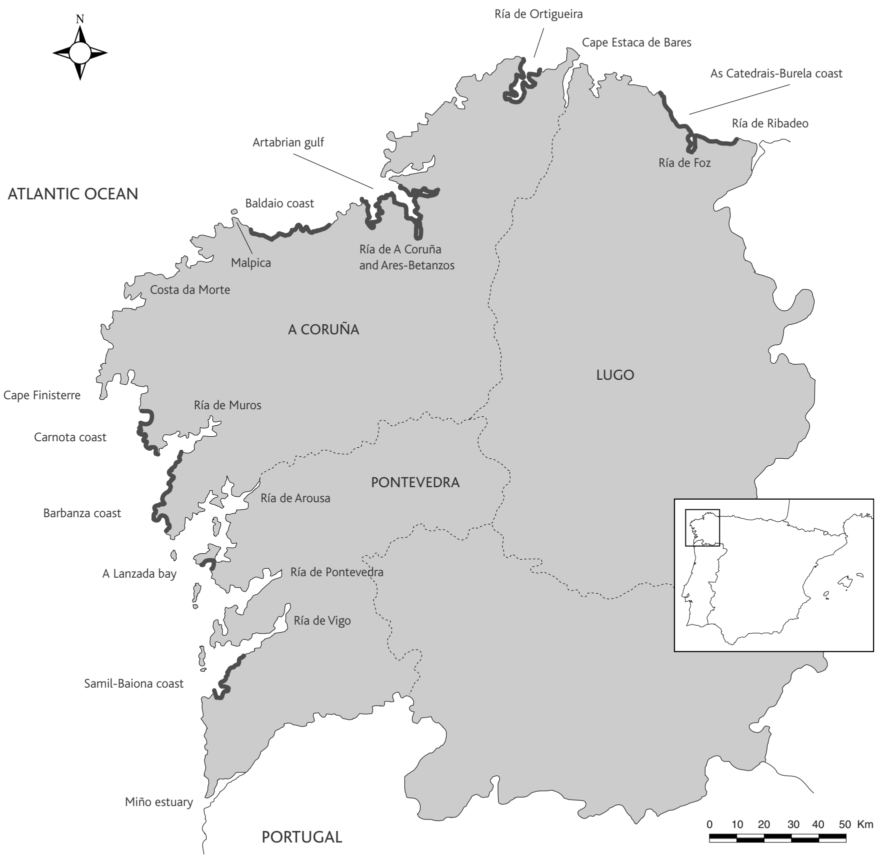

Figure 1. Map of the Galician coast showing the main topographical features and coastline sectors mentioned throughout the text.

deposited near the coastline. The coast is characterised by 'rías', river valleys drowned in the last post-glacial sea level rise (Evans & Prego 2003) the four largest of which (Muros, Arousa, Pontevedra and Vigo), south of Cape Finisterre, form the 'Rías Baixas'. The northern Galician coast has smaller rías, where less oceanic and more estuarine environments are prevalent. Wind and seabed-induced upwellings prompt high levels of biological productivity throughout the coast (Torres & Burton 2007).

Data sources: Great Northern Divers wintering in Europe pose special problems regarding population estimates or assessment of trends, being difficult to count accurately from land (Lack 1986; Slade 1996). Stochastic errors in counts can be much higher in scarce and highly dispersed waterbirds like this (Rappoldt *et al*. 1985). We have therefore tried to use all available information for each site, using the peak number of birds counted by assuming that counts generally underestimate the actual population, a method used previously in species with similar problems (*e.g.* O'Brien *et al*. 2008 and references therein).

Baseline information was obtained from the authors' own observations (1974–2010), from data gathered by experienced collaborators and from the literature, in particular the Galician Annual Bird Reports 1992–2004 and the Asturian Ornithological Reports 1993–96. Results of the unpublished Galician January waterfowl censuses in 1987–2007, censuses conducted in Spain in 1967–2003 (Martí & Del Moral 2003; Wetlands Committee of the Ministry of Environment unpublished), and the summary of censuses in the neighbouring region of Asturias (COA 2010) were also used.

Phenology: A phenological spectrum was constructed using single records for each fortnight and site. Two statistics resistant to outliers and skewness in the distributions of dates, the median (*M*) and interquartile range (*IQR*), were used as central tendency and dispersion parameters of the yearly arrivals and departures, calculated from the Julian dates.

The timing of post-breeding and pre-breeding moults was studied using the same approach as for the phenological database. Additionally, progression of moult in birds observed in spring 2005 off the Baldaio coast was recorded by RB on a fortnightly basis. The frequency of birds in each of five categories of summer plumage coverage (from 0% to 100%) was estimated.

Habitat: The analysis of the seasonal distribution of Great Northern Diver between macrohabitat types was based on land-based observations from the period 1992–2004, discarding records of birds in flight. Following Cramp & Simmons (1977), with some modification, data were assigned to season: autumn (20 August to 31 December), winter (1 January to 10 March) and spring (11 March to 10 June). Sites were assigned to a dominant macrohabitat type, and no location had more than one type assigned to it. The macrohabitat types used were: (1) sandy open coast (> 75% of sandy shore), (2) rocky open coast (> 75% of rocky shore); (3) mixed open coast (25–75% of both sands and rocks), (4) sheltered ('ría') sandy

Table 1. Number of records and number of birds (Great Northern Diver *Gavia immer*) in the macrohabitat types considered and its seasonal variation (period 1992–2004). Macrohabitat types: sandy open coast (CAA), rocky open coast (CAR), mixed open coast (CAM), sheltered sandy shore (CRA), sheltered rocky shore (CRR), sheltered mixed shore (CRM), estuary (EST), other (OTR). The number of sites assigned to each macrohabitat is indicated. Only one record was used in the analysis per site and season.

Macrohabitat		**Autumn**		**Winter**		**Spring**		**TOTAL**	
Sites		**Records**	**Numbers**	**Records**	**Numbers**	**Records**	**Numbers**	**Records**	**Numbers**
CAA	9	38	201	30	251	37	236	105	688
CAR	4	5	5	9	15	7	13	21	33
CAM	3	5	11	5	9	5	7	15	27
CRA	6	9	15	5	6			14	21
CRR	2	2	5	4	13	1	6	7	24
CRM	10	27	35	20	88	8	15	55	138
EST	5	24	78	21	76	8	11	53	165
OTR	2	1	1			2	2	3	3
TOTAL	**41**	**111**	**351**	**94**	**458**	**68**	**290**	**273**	**1099**

shore, (5) sheltered rocky shore, (6) sheltered mixed shore, (7) estuary and (8) other. Measurements were carried out using the GIS SIXPAC v. 6.1.1. (http://emediorural.xunta.es/visorsixpac/), taking 1 km on either side of the observation point or, where it was not exactly specified, on either side of the central point of the stretch of coastline indicated by the observer. Rías and estuaries were classified according to the area of tidal flats and subtidal beds up to a depth of 1 m at low tide, with estuaries having ≥ 50% of the surface of both habitat types over their total area, while the deeper rías had < 50%.

In order to minimise the effect of pseudoreplication, the sum of the presences of the species by macrohabitat and season across years, instead of the number of birds, was used for the analysis. Pearson's chi-square tests based on permutations (10,000 random replicates) were used to test for the independence between season and habitat (Hammer *et al*. 2001).

Population trends: The regional-level trend was modelled using loglinear regression (TRIM 3.51; Pannekoek & van Strien 2001). January counts from eight wintering sites (see Table 2), with an average of 16 counts for the period 1994–2010, were analysed by means of linear switching trend models. Change-points were estimated by a stepwise selection procedure and its statistical significance was tested using the Wald test. The significance of the general trend and the time intervals were tested by a *t* test and its magnitude was assessed according to the 95% confidence limits of the regression coefficient (Pannekoek & van Strien 2001). Site-specific trends were described using linear regression with log-transformed values; slope coefficients (b) were used to calculate the annual percentage rate of change, using the formula $R = 100\ (e^b - 1)$.

Wintering population estimate: The Galician coast was divided into 36 sections and peak counts per winter and section were used. Owing to the severe distortion of the trend between 2001 and 2009 (see Results), the years 1996–2001 were

Table 2. Trends at Great Northern Diver *Gavia immer* wintering sites used for calculating the regional trend. The analysis is divided into the years before (1994–2003) and after (2003–2010) the *Prestige* oil spill (January 2003), and gives the median January count, its range, the annual rate of change for each period (R), and the coefficient of determination of the regression model (r^2) and significance level (* P < 0.05, ** P < 0.01, *** P < 0.001, ns not significant). A dash indicates missing data.

Site	Period	Median	Range	R (%)	r^2
Ría de Ribadeo	1994–2003	6	3–13	-21.2	-0.523 **
	2003–2010	2	1–2	-	-
Ría de Foz	1994–2003	1	0–6	+28.7	0.238 ns
	2003–2010	1	0–2	-	-
Ría de Ortigueira	1994–2003	3	0–23	+41.9	0.353 ns
	2003–2010	4	0–8	+54.3	0.310 ns
Artabrian gulf	1994–2003	2	0–7	-22.4	0.011 ns
	2003–2010	2	0–6	+53.1	0.048 ns
Baldaio coast	1994–2003	16	0–29	+55.0	0.205 ns
	2003–2010	8	7–13	+17.0	0.158 ns
Carnota coast	1994–2003	4	1–30	-27.7	0.449 *
	2003–2010	1	0–3	+32.4	0.542 ns
Barbanza coast	1994–2003	0	0–6	+27.6	0.161 ns
	2003–2010	3	0–12	+43,2	0.773 **
A Lanzada bay	1994–2003	1	0–8	+40.5	0.869 ***
	2003–2010	8	3–20	+26.0	0.187 ns

chosen, in view of their apparent numerical stability, for estimating the average wintering population in recent years.

From January to May and from November to December 2005 one of the authors (AB) conducted a monthly survey in 27 beaches within eight coastal stretches (Figure 1). Multiple scan counts were conducted until the number of divers stabilised or when no birds were found after repeated attempts. The scans were carried out in fair weather and were estimated to be effective for detecting divers up to 2 km offshore under optimal conditions. Overall, sampling lasted for between 10 and 180 min depending on the length of the beach. Each stretch was surveyed in a single day and observer movement from one site to another was as fast as possible in order to account for movements of divers between beaches of the same stretch. The linear densities (birds/km) observed were used later for estimating the population in exposed sandy coast (see below).

Because of the uneven coverage of the coast by observers, the process for estimating the wintering population was done in steps. Firstly, an arithmetic mean was calculated for the peak counts in semi-enclosed habitats and exposed sandy stretches with regular monitoring. For calculating a 95% confidence interval the variances of the counts of each area were summed, so the standard error was calculated by averaging the variances between the median of the number of years for which data were available for all sections (O'Brien *et al*. 2008). Secondly, the expected number in open sandy stretches not monitored regularly was estimated from a linear regression equation relating average population size to length of beach, according to the survey carried out in 2005 by AB. Given the non-normal distribution of residuals, even after applying transformations, bootstrapped 95% confidence limits for the slope (2,000 replicates) were calculated (Hammer *et al*. 2001). The slope coefficient and confidence limits were used in estimating the fraction of the population in five other sections of sandy open coast lacking regular coverage. It should be stressed that, at least in part because of the effects of the *Prestige* spill, the number of Great Northern Divers in 2005 accounted for 67.3% of the average number in the same areas during the period of the estimate of the wintering population size (1996–2001); accordingly, a correction factor of 0.673 was applied to the estimates based on regression. Ten sections lacking data, or where the species seldom appeared during 1994–2010, were discarded from the analysis. Finally, the part of the population present in open rocky coast was estimated applying a correction factor (0.087) to the mean linear density for sandy open coast. This correction factor was derived from the ratio of the number of divers recorded in rocky coast to the total number in open coast. Only those sections with previous known presence of the species (nine out of 15) were used. The estimate of the wintering population in Galicia in recent average years was calculated by taking the sum of the means and confidence limits of divers for the different sections. It should be noted that this estimate is not corrected to compensate for problems of detectability.

Results

Phenology and moult: The phenology of Great Northern Diver occurrence showed a quasi-bimodal distribution (Figure 2). Records were most numerous between November and May (89.4%, n = 282). Peak number of observations were recorded between the beginning of December and late March. Most first occurrences took place in early November (*M* = 3 November, *IQR* = 24 October to 7 November, n = 18), and the bulk of the population departed around mid May (*M* = 14 May, *IQR* = 3 to 21 May, n = 23).

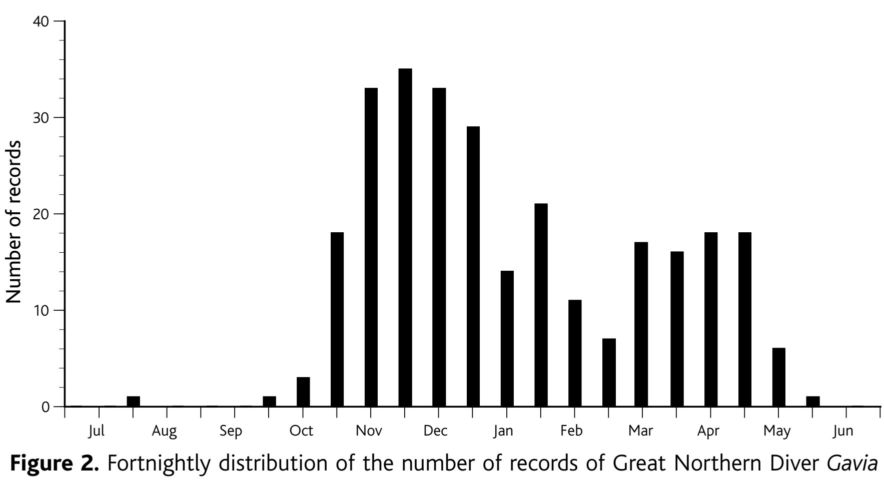

Figure 2. Fortnightly distribution of the number of records of Great Northern Diver *Gavia immer* in Galicia. Data were obtained from Galician Annual Bird Reports (1992–2004). Only one record per site and per fortnight has been used.

Birds still retaining summer plumage or in active moult were recorded from their arrival until the middle of December (*M* = 15 November, *IQR* = 8 November to 21 November, n = 19), representing 7.5% of the birds (n = 307). More common was the observation of individuals moulting into their summer plumage between February and May (*M* = 22 April, *IQR* = 5 April to 1 May, n = 132). Birds moulting flight feathers (Figure 3) were recorded between 9 February and 25 March (n = 5). Observations of birds during pre-breeding moult off the Baldaio coast showed a gradual increase in the percentage of birds moulting from winter plumage into summer plumage from the beginning of March to the second half of April (Figure 4).

Habitat preferences: Most observations occurred in open coastal waters (52.2%, n = 270), and particularly in sandy sectors (Table 1), which yielded 38.9% of the records. Sheltered waters were also important, with a greater concentration of records in sheltered mixed shores (20.4%) and estuaries (19.6%).

The frequency of records in rías and estuaries were very similar throughout the seasons (χ^2 = 0.41, df = 2, n = 129, P = 0.814), so that in the following analysis both macrohabitat types were grouped into a single category. The frequency of records from open coastal waters and sheltered waters were very similar between autumn and winter (χ^2 = 0.21, df = 1, n = 204, P = 0.677), but differed markedly between autumn and spring (χ^2 = 15.62, df = 1, n = 176, P < 0.0001) and between winter and spring (χ^2 = 11.99, df = 1, n = 160, P < 0.0001), so that, while in autumn and winter the percentage of records in open coast stood at 43.6% (n = 110) and 46.8% (n = 94), respectively, in spring this increased to 74.2% (n = 66).

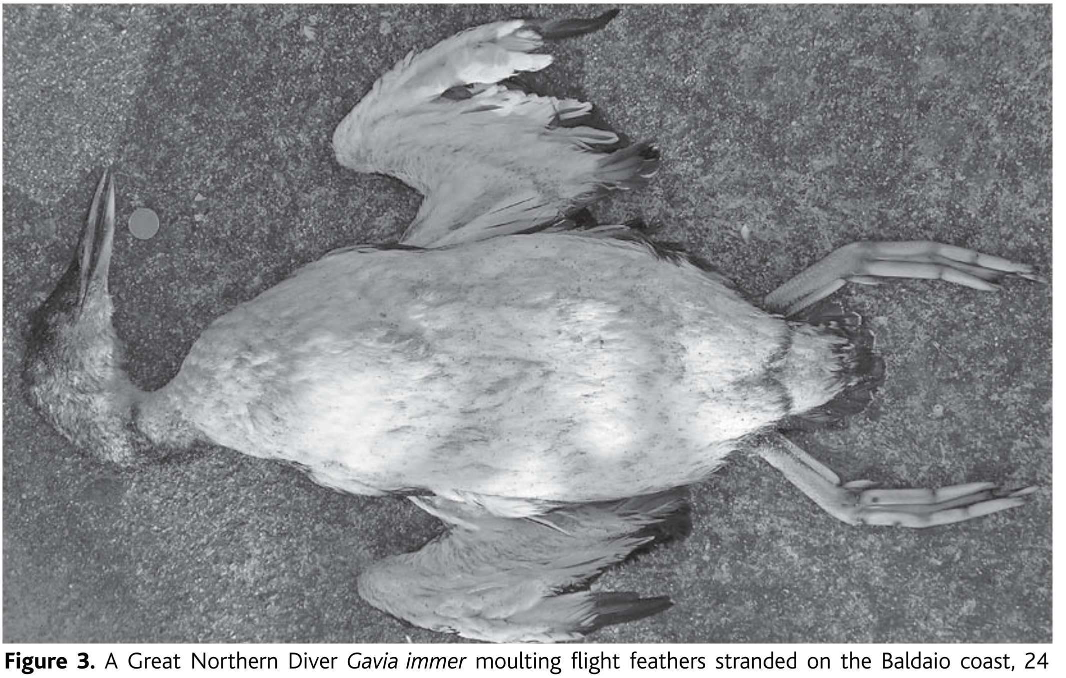

Figure 3. A Great Northern Diver *Gavia immer* moulting flight feathers stranded on the Baldaio coast, 24 February 2009 © *Roberto Bao*

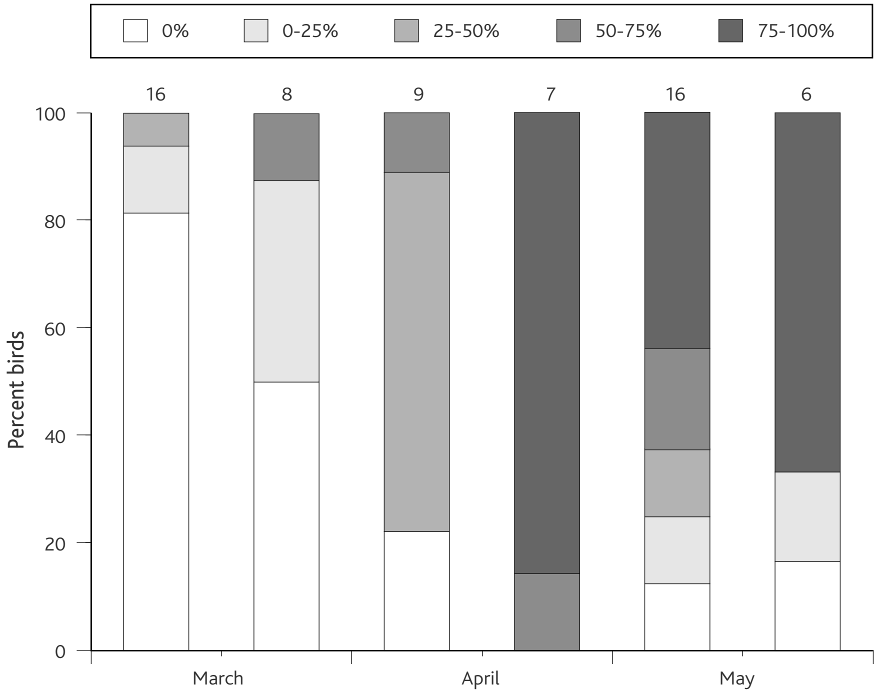

Figure 4. Progression of moult in Great Northern Divers *Gavia immer* observed in the Baldaio coast during spring 2005. Legend shows the percentage of visible summer plumage. Bold figures at the top indicate sample size.

Population trends: The general trend during January 1994–2010 at the most important sites was markedly curvilinear (Figure 5) and can be classified as uncertain (Pannekoek & van Strien 2001). However, three major trends can be seen when analysing separately the slopes for time periods within the general model, leaving aside the outlier of 1995. From 1996 to 2001 (Wald test for a change-point in 1996 = 5.23, P = 0.022) the trend was clearly stable, with $b = 0.999 \pm 0.074$ ($P > 0.05$), whereas from 2001 to 2005, encompassing the winter of the *Prestige* oil spill, it changed markedly downwards, with $b = 0.742 \pm 0.082$ ($P < 0.01$), corresponding to an annual rate of change R = –25.8% (Wald test for a change-point in 2001 = 3.47, P = 0.063). Conversely, from 2005 to 2010 (i.e. from two years after the spill) the trend turned markedly upwards, with $b = 1.308 \pm 0.124$ ($P < 0.05$) and R = 30.8% (Wald test for a change-point in 2005 = 8.91, P = 0.003).

Site trends showed high variability over time, with different responses before and after the spill (Table 2). Nevertheless, the consistency of the models was mostly low ($r^2 < 0.50$ in 10 out of 14 models). Among the negative trends prior to the spill, those of Ría de Ribadeo and the Carnota coast were the most obvious (R = –20% or higher), while A Lanzada bay showed a strong increase (R = 41%) between 1998 and 2003. After the spill, the six areas with available data (Table 2) showed, although with many variations, an upward trend. In fact, the Great Northern Diver population reached 60 individuals in 2010 in these areas, a number of similar magnitude to that observed in 1996–2001 in the same places (50–67 birds).

Wintering population size, density and distribution: The counts in the sheltered rías and estuaries, usually with good coverage by observers over the winter, allowed us to estimate an average population of 32 birds (95% CI = 22–43) during the period 1996–2001. Five stretches of sandy open coast with sufficient coverage (As Catedrais-Burela, Baldaio, Carnota, Barbanza and A Lanzada; Figure 1) harboured a joint average of 59 birds (95% CI = 47–72) during the same period, presenting a linear density of 0.61 birds/km (95% CI = 0.24–0.99). The relationship between the average number of Great Northern Divers (December to March 2005) and the length of beach (n = 27, total length sampled 57.43 km) was described by the linear regression equation $Y = -0.384 + 0.768X$ (95% CI for the slope = 0.145–1.187; $r^2 = 0.48$, $t = 4.83$, $P < 0.0001$). The sum of the previous estimate and the calculations based on the slope coefficient applied to sandy stretches lacking regular coverage yielded an estimated average of 78 birds (95% CI = 49–103) for sandy open coast as a whole. Assuming that, according to the whole dataset, the number of divers in rocky open coast represented 8.7% of the number in open sandy coast, an average density could be placed at 0.053 birds/km (95% CI = 0.021–0.086), which would represent an average estimate of 13 birds (95% CI = 5–20) for rocky open coast.

Taking into account all these calculations, the average wintering population in Galicia was estimated at 123 individuals (95% CI = 76–166) in 1996–2001. Most of the population (63%) occupied sandy open coasts, followed by sheltered waters, covering 26%, denoting a greater number of birds per record in open coasts as compared with the distribution of records by habitat types (see above). Given the overall length of open coast studied (467 km), the overall linear density was estimated as 0.17 birds/km (95% CI = 0.12–0.26).

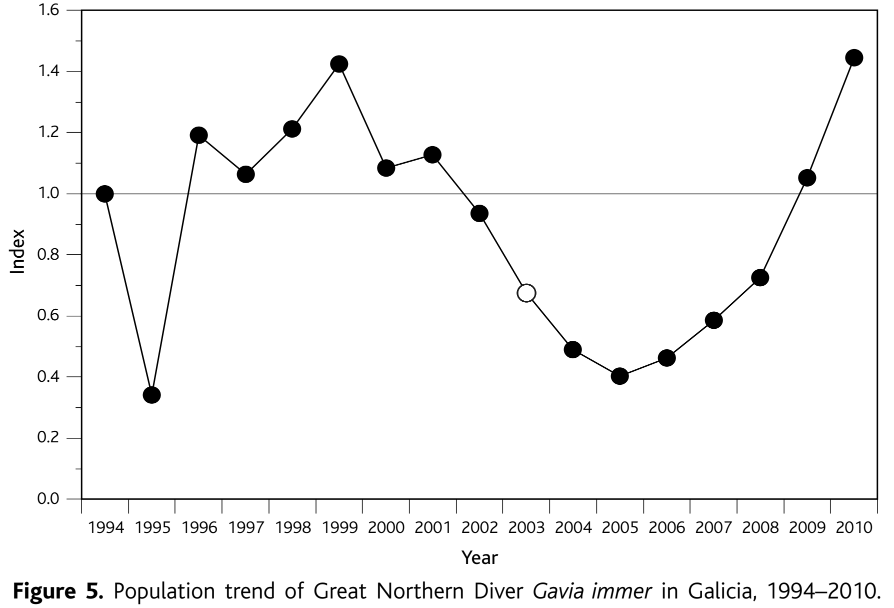

Figure 5. Population trend of Great Northern Diver *Gavia immer* in Galicia, 1994–2010. Imputed time indices correspond to the linear trend model developed with TRIM. The white dot shows the winter in which the *Prestige* oil spill took place.

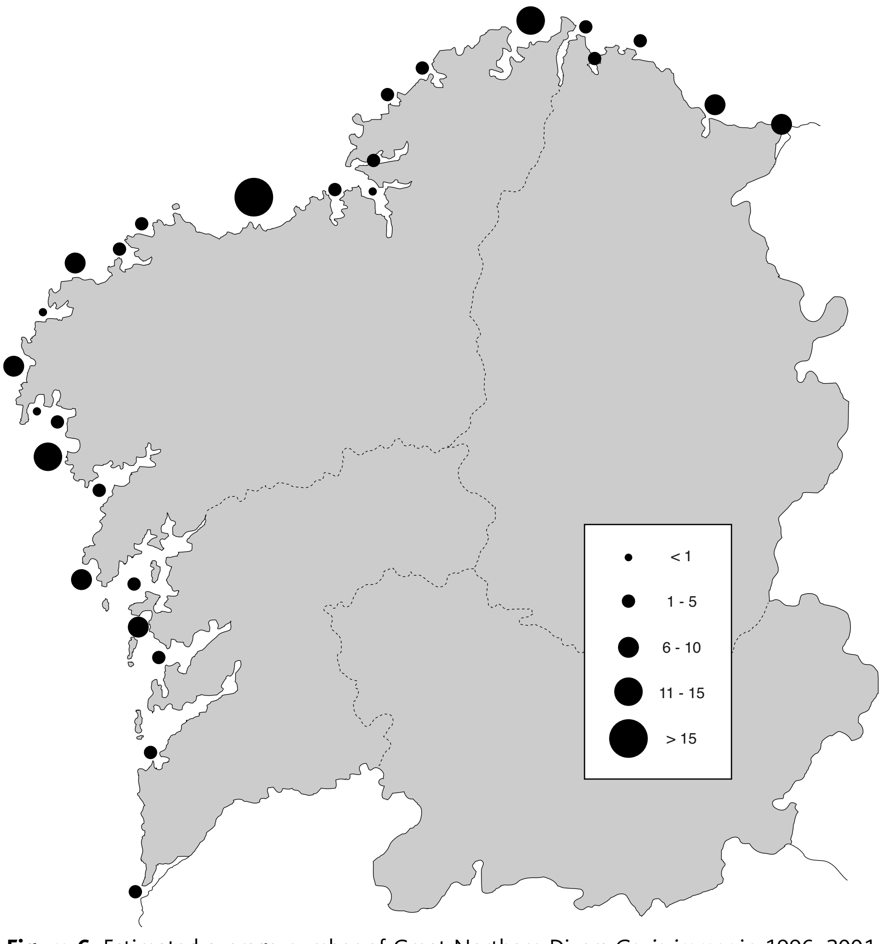

Figure 6. Estimated average number of Great Northern Divers *Gavia immer* in 1996–2001 along the Galician coast.

The number of divers in sheltered waters was generally very low except in Ribadeo estuary and, most of all, the Ría de Ortigueira, where an average of 13 birds were concentrated (range = 1–23). Seven sectors housed the majority of the population in open sandy coast, all with average populations of more than 5 birds (Figure 6). Among them, the Baldaio coast averaged 25 individuals (range = 16–29, or 20% of the Galician wintering population).

Discussion

Phenology and habitat: The phenology of Great Northern Diver in Galicia is similar to that in the British Isles (Cramp & Simmons 1977; Toms 2002). Peak numbers occurred in Galicia from mid November to mid January. An apparent decline in late January and February, followed by a smaller peak between late March and early May, may suggest some immigration of birds that had overwintered elsewhere. Moulting birds were recorded from February until May, this long period presumably reflecting differential timing of moult among age classes (Cramp & Simmons 1977). Although sample sizes were small, observations of birds in winter plumage off Baldaio in May, after most had been in almost full summer plumage in late April (Figure 4), suggest a few new immatures arrived in the area in spring.

Great Northern Divers in Galicia showed a strong preference for exposed sandy coast, as reported in one study from Scotland (Barrett & Barrett 1985), with fewer wintering off rocky coasts. The increase from late winter in the use of extensive shallow waters related to exposed sandy coasts could be explained by the need for open spaces in which to carry out the simultaneous moult of the remiges, a demanding process requiring safety against disturbance and good prey availability (*e.g.* Salomonsen 1968; Hohman *et al*. 1992). These requirements may be limited in the more sheltered Galician rías and estuaries, where human disturbance, related mainly to intense shellfishing and recreational boating, is widespread.

Population trends: Apart from lower numbers in January 1995, probably due to stormy weather and poor counting conditions (JAS pers. obs.), the significant downward trend between 2001 and 2005 might suggest the Great Northern Diver population was in decline two years before the *Prestige* oil spill. However, when a reduced model was run for the period 1994–2002, i.e. until just before the spill, the interval 1996–2002 proved to be fluctuating, with a weak annual rate of change of –2.80% ($b = 0.972 \pm 0.066$, $P > 0.05$). In the light of these contrasting models, it cannot be said whether a downward trend starting in 2001 is genuine, or whether data from 2001 and 2002 merely reflect fluctuation within a general pattern of stability. However, it seems indisputable that the November 2002 *Prestige* oil spill had a devastating effect on the diver population, which was apparently reduced by 36% between 2002 and 2003 and by 57% between 2002 and 2005.

In contrast to a long-term local impact on wintering numbers of Great Northern Divers after an oil spill in Shetland in 1978 (Weir *et al*. 1996; Heubeck 1998), the Galician population seemed to return to pre-oil spill levels in just six years. There is no obvious explanation for this since there has been no apparent change in local winter conditions in recent years. However, some redistribution of birds from other Iberian wintering areas may have occurred, with numbers in neighbouring Asturias having decreased from an average of 51 birds in January 1993–97 (with a conservative regional estimate of 50–100 birds; Paterson 1997) to a minimum of 13 birds in 2006, with a sharp decline after January 2002 (COA 2010) and an overall annual decrease of –32.6% between 2000 and 2008 ($r^2 = 0.58$). This decrease was not offset by any apparent increase to the east of Asturias in Cantabria (González & Herrero 2006) or the Basque Country (Wetlands Committee of the Ministry of Environment unpublished), where diver numbers are relatively low. Any shift of birds from Asturias to Galicia could mask a greater reduction in the Galician population from the oil spill, but this must remain as speculation.

The reported trend does not reflect any changes that took place in previous decades. Until the mid 1990s diver counts were usually only of 1–5 birds per site at the Baldaio coast and A Lanzada bay (Rodríguez Pomares 1991; JAS & AS unpublished data). In contrast, the Carnota coast held 11–53 divers (mean = 31) in January 1990–94 (unpublished Galician January waterfowl censuses), but observations from 1995 to 2000 confirmed a downward trend along this coast (JAS & M. Martínez Lago unpublished data). Coincidentally, numbers began to increase at other sites such as the Ría de Ortigueira, the Baldaio and Barbanza coasts and A Lanzada bay, a process that was partially slowed at the first two sites from the early 2000s, with a clear recovery after the *Prestige* oil spill.

Population estimates, distribution and density: The Galician wintering population could represent 4–8% of the European breeding population, estimated at 700 pairs (BirdLife International 2004) or an expected number of 2,100 individuals (according to suggestions in Wetlands International 2006: p. 10), assuming that the population is more likely of Icelandic origin and there are not North American breeding birds present, as suggested by biometric data (Camphuysen *et al*. 2010). Moreover, the estimate could represent a conservative 2.5% (1.5–3.3% based on the 95% CI) of the European biogeographic population (1% level = 50 birds, Wetlands International 2006), and the Site of Community Importance ES1110005 Costa da Morte, encompassing the Baldaio coast, could qualify as internationally important for this species by supporting a recent average (uncorrected for detectability) of 48 wintering Great Northern Divers.

There are two unresolved issues regarding assessment of the Great Northern Diver population. Among factors influencing the underestimation of diver counts (Barrett & Barrett 1985; Lock & Robins 1994; Slade 1996), the distance of birds from shore is perhaps one of the most important. Off the southeast USA, significant numbers have been found in waters up to 100 m deep or even more, and up to 100 km offshore (Lee 1987; Haney 1990; Kenow *et al*. 2002). For the six most important wintering areas in Galicia, the 50 m isobath occurs 5.4–9.0 km offshore, a distance at which any bird is obviously out of sight of shore-based observers. Observations during at-sea surveys in 2004 and 2005 did not record any Great Northern Divers between the mainland and the 5,000 m isobath, up to 70 km offshore (SEO/BirdLife 2006), although this is perhaps unsurprising given the very low overall density and high dispersion shown by the species.

Secondly, phenological data suggest that some birds may join the wintering population from late winter to the spring departure. During the survey carried out by AB in 2005, numbers recorded increased from an average of 25 birds in January-February to 52 in March (SEO/BirdLife 2006). Since Galicia is at the southern edge of the normal wintering range of the species in Europe, the origin of these birds is intriguing. They may come from Portuguese waters, but this seems unlikely since Great Northern Diver is considered a rarity there (Matias *et al*. 2007; Anon. 2010) and even aerial surveys have failed to find any along the coast (Rufino & Neves 1992).

Sampling 116 km of exposed coast in Galicia in 1997/98, Salvadores (1998) found an overall linear density of 0.17 divers/km, similar to that found in the present study, and reported a lower density south of Cape Finisterre (< 0.1 birds/km) than

Figure 7. The Baldaio coast, one of the main sites for Great Northern Divers *Gavia immer* in Galicia. © *Miguel López Caeiro*.

further north (0.31 birds/km), also consistent with our data. Piñeiro & Álvarez Viéitez (2003) also found a very low density (0.03 birds/km) in the province of Pontevedra, in another sampling of 119 km of exposed coast in 2000/01. These results suggest that the Great Northern Diver population decreases in abundance from north to south of Galicia and, therefore, towards Portugal. It is unclear to what extent this is due to a lack of suitable habitat, to increased human disturbance in the more densely populated 'Rias Baixas' or to the spatial dynamics of a species located, like this, on or near the southern border of its wintering range.

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