Waterbird populations on non-estuarine coasts in Ireland: results of the 2006/07 Non-Estuarine Coastal Waterbird Survey (NEWS)

Olivia Crowe[1], Graham Austin[2] and Helen Boland[1]

[1] BirdWatch Ireland, Unit 20, Block D, Bullford Business Campus, Kilcoole, Co. Wicklow
[2] British Trust for Ornithology, The Nunnery, Thetford, Norfolk, IP24 2PU

A second national survey of waterbirds on non-estuarine coasts was carried out in December 2006 and January 2007 as part of a joint survey between Britain and Ireland. It represents the second full national survey of Ireland, undertaken nine years after the first in 1997/98 (NEWS-1). A total of 1,694 km of non-estuarine coastline was covered across Northern Ireland and the Republic of Ireland, which represents 51% of available coastline. Observers recorded all waterbirds seen in three broad-scale habitats, on the sea, within the intertidal zone and on land. Linear densities (totals per km) were used to compare distributions between counties and coastal regions. A bootstrap method was used to generate population estimates for 30 species within each county and in Ireland overall. The total number of birds counted was 102,664 of 64 species, with waders comprising more than half of all the waterbirds recorded. Oystercatcher *Haematopus ostralegus* was the most numerous and widely distributed species. Other numerous waders included Golden Plover *Pluvialis apricaria,* Lapwing *Vanellus vanellus* and Curlew *Numenius arquata.* Common Scoter *Melanitta nigra* and Light-bellied Brent Goose *Branta bernicla hrota* were the most numerous of the wildfowl species recorded. There were considerable differences in the estimates generated for species on non-estuarine coasts between NEWS-1 and NEWS-2. These differences were consistent with national trends overall for only a small selection of species. Substantial proportions of the overall national populations of Red-throated Diver *Gavia stellata,* Sanderling *Calidris alba,* Ringed Plover *Charadrius hiaticula* and Turnstone *Arenaria interpres* were found to occur along non-estuarine coasts. It is recommended that an increased representation of non-estuarine coasts is included during regular annual wetland bird surveys (WeBS & I-WeBS) in Ireland to ensure that any future significant trends are detected.

Introduction

The importance of Ireland's wetlands for waterbirds is well documented (Crowe 2005, Boland & Crowe 2012), and the most recent population estimates indicate that more than one million wildfowl and waders winter in Ireland (Crowe *et al*. 2008). The Wetland Bird Survey (WeBS) in Northern Ireland and Britain, together with the equivalent scheme in the Republic of Ireland, the Irish Wetland Bird Survey (I-WeBS), are Ireland's ongoing monitoring systems for wintering waterbirds. They have been in operation each winter since the early 1990s, and between 300 and 400 sites are monitored annually (Holt *et al.* 2011, Boland & Crowe 2012). These

Plate 175. Oystercatchers (Liam Ryan).

surveys focus on key wetlands that support high densities of birds, predominantly coastal estuaries and inland lake and river complexes. However, these alone are not adequate for monitoring some wintering species, chiefly those that occur on non-wetland sites such as swans and geese, and also species that are prevalent along open coastline. Periodic special surveys of these populations are thus undertaken to improve our baseline information on population sizes and distribution (e.g. Walsh & Crowe 2008, Boland *et al.* 2010).

In December 1997 and January 1998 the first thorough national survey of waterbirds occurring on non-estuarine coasts was undertaken in Ireland (NEWS-1). A random selection of coastal stretches was surveyed from which estimates of total numbers occurring in these habitats were generated (Colhoun & Newton 2000, Rehfisch *et al.* 2003). The results of this work showed that substantial proportions of several species occur along non-estuarine coasts, and are not regularly monitored during WeBS and I-WeBS. Some 46,000 waders were recorded overall during that survey, including significant concentrations (more than 50% of the all-Ireland totals) of Purple Sandpiper (scientific names of species are presented in Table 3), Sanderling, Turnstone and Ringed Plover (Crowe *et al.* 2008).

This paper reports on the results of the second national survey of waterbirds on non-estuarine coasts carried out in December 2006 and January 2007 (NEWS-2). It provides an update on the total numbers of waterbirds occurring on open coasts, a broad-scale assessment of habitat use, and an indication of changing proportions using non-estuarine coasts. These estimates will feed into the next revision of the non-breeding waterbird population estimates.

Methods

Field methods

Non-estuarine habitat is defined here as open rocky and sandy coastline not regularly covered by WeBS and I-WeBS counts, but excluding areas of tall cliffs with little or no exposed shoreline. It was recommended that counts be carried out between 1 December 2006 and 31 January 2007. The methodology used closely follows that of NEWS-1 (Colhoun & Newton 2000), and was broadly similar to the Winter Shorebird Count (WSC) in Britain in the mid-1980s (Moser & Summers 1987, Moser & Prŷs-Jones 1988), entailing coverage of pre-defined short sections of non-estuarine coasts within a period of 3.5 hours either side of low tide, preferably in good weather conditions. The non-estuarine sections defined during NEWS-1 were digitized using ArcView 3.2. Their boundaries were based on obvious changes in substrate type. Most sections were between 2 and 4 km long. Assuming *a priori* that, like NEWS-1, NEWS-2 would not achieve complete coverage of the open coast, and with the aim of avoiding the introduction of bias by counters if allowed select their count stretches, a random sampling element was introduced for NEWS-2. The count sections defined for NEWS-1 once again were ordered randomly and were allocated in this random sequence within each county. In the Republic of Ireland, the top 50% of sections selected were prioritized for survey. Thereafter, county coverage depended on the availability of counters. In Northern Ireland, Regional Organisers were asked to aim to arrange coverage of at least the first ten randomly chosen count stretches in each county, or all stretches where there were fewer than ten. Both approaches (Republic of Ireland and Northern Ireland) ensured a random survey design at the local level, while also avoiding large gaps in geographic coverage. Selected count stretches were omitted only on the grounds of practical complications such as difficulty of access or remoteness from available counters, but explicitly not on prior expectations of waterbird numbers. Counters were asked to cover adjacent sectors synchronously on a given count day. A small number of professional counters were also deployed to enhance coverage in poorly covered areas, particularly those in the west and northwest.

The NEWS-2 count methodology was substantially based on that used during the WSC and NEWS-1 (Moser & Summers 1987, Rehfisch *et al.* 2003). Observers were asked to record on standard recording sheets all waterbirds (waders, wildfowl, divers, grebes, Cormorant, herons and gulls) in each of the three main habitats (sea, intertidal, land). Land habitats were those adjoining, but above the high tide mark, e.g. marsh and fields visible from the high tide mark. Observers were asked to explicitly state whether or not they surveyed each of the three habitats. Although the scale of the issue was not quantifiable, it had been apparent from comments and data received from counters in Britain during the previous non-estuarine waterbird survey that not all habitats always received equal attention. This additional information gathered during NEWS-2 allowed a more rigorous approach when estimating waterbird numbers across all three habitats (but has also highlighted the dangers of using direct comparisons of waterbird numbers from different surveys as a means of quantifying change over time). Observers were also asked to record details on tidal state, weather, disturbance and coverage which may account for the quality of counts. Observers in Northern Ireland did not record gulls, because coastal gulls there are counted as part of the winter gull roost survey undertaken regularly throughout the United Kingdom.

Analysis

Species totals were generated and compared between habitat types. To examine the geographical distribution of birds, linear densities, defined as total number of birds per km, were calculated for each species of wildfowl (including allies) and waders, and compared across coastal regions. Regions were

defined as 'Northwest' (Donegal, Leitrim, Sligo), 'West' (Mayo, Galway, Clare), 'Southwest' (Kerry, Cork), 'Southeast' (Waterford, Wexford), 'East' (Wicklow, Dublin, Meath, Louth), and 'Northeast' (Down, Antrim, Derry).

The analytical approach used to estimate the total numbers of waterbirds on the non-estuarine coasts during the winter of 2006/07 is similar to that previously used for estimating numbers from data collected by NEWS-1 (Colhoun & Newton 2000, Rehfisch *et al.* 2003). This uses a bootstrap approach to derive estimates at the county level and summed across the relevant bootstrapped samples to derive all-Ireland estimates. Thus for each species, for each county, for each habitat (sea, intertidal, land) and for 119 repetitions, the total number of each species recorded within that county was added to a total for that species obtained from a sample with replacement of stretches drawn from the county in question until the summed lengths across the sample equated to the length of uncounted open coast within that county. Equivalent repetitions upon which to derive overall estimates for the Republic of Ireland, Northern Ireland and all-Ireland were derived by summing across unsorted repetitions for the relevant constituent counties. The latter approach was used so that, for example, estimates of numbers on uncounted stretches in southwest Ireland would not be influenced by counts in northeast Ireland, and vice versa when estimating the numbers across these larger regions, as would be the case had the sample been drawn from the whole of Ireland. For each geographical extent, the median, lower and upper 95% confidence limit estimates for the number of birds were obtained by taking the 60th, 3rd and 116th ascendant ordered bootstrap values, respectively. Because NEWS-2 recorded details of which of the three principal habitat types had been surveyed for each count stretch, each of the 119 all-habitat county estimates were first obtained by summing the unordered estimates from each of the three constituent habitats. This approach allows for differential proportional coverage at the county level for each habitat. This process was generated separately for the Republic of Ireland, Northern Ireland and all-Ireland. Consequently, the totals for each may not necessarily sum to the all-Ireland total. All-Ireland estimates were generated for species that were sufficiently widespread and abundant, defined here as those that occurred in ten or more sectors and whose overall totals exceeded 50 individuals.

Plate 176. Golden Plover (John Fox).

Comparison between NEWS-1 and NEWS-2

Population estimates generated for NEWS-2 were compared with those generated for NEWS-1 for the Republic of Ireland only. Also, the differences between surveys in regional densities were evaluated by comparing the linear densities of selected wildfowl and wader species at regional scales for both NEWS-1 and NEWS-2. Because most coverage was focused on non-estuarine coasts during both surveys, coverage effort for this habitat was consistent between surveys, and accordingly, densities were generated from counts of birds within intertidal habitats only for waders. However, wildfowl (and their allies) are generally more widely distributed in all three habitats, so densities for this group were based on counts from all habitats combined.

Results

Coverage

In total, 1,694 km and 541 sectors of coastline were covered (Table 1), which represents 51% of the total non-estuarine coastline available (Figure 1). Coverage ranged from 34% in Sligo to 100% in Dublin, Leitrim, Louth and Meath (Table 1). The survey was completed between 29 November 2007 and 4 February 2008, with greatest coverage in January (77%) and December (21%), and the remaining 2% in November and February (one and seven sections respectively). Differences in coverage for wildfowl (including allies) and waders within each of the three habitats (sea, intertidal, land) for Northern Ireland are shown in Table 2.

Table 1. Total coverage by county*, and overall coverage of non-estuarine coasts during NEWS-2, 2006/07. Lengths of coast are expressed in km.

County covered	Total length	Length covered	Proportion surveyed (%)	No. of sectors
Clare	222.9	91.4	41.0	25
Cork	605.4	230.7	38.1	57
Donegal	560.5	260.4	46.5	54
Dublin	63.0	63.0	100.0	12
Galway	575.8	293.1	50.9	60
Kerry	207.1	114.6	55.4	23
Leitrim	5.3	5.3	100.0	2
Louth	41.9	41.9	100.0	10
Mayo	266.4	119.7	45.0	29
Meath	7.4	7.4	100.0	3
Silgo	131.5	44.7	34.0	22
Waterford	50.8	39.5	77.7	18
Wexford	153.0	63.9	41.8	19
Wicklow	59.2	54.5	92.0	14
Derry	41.4	25.2	61.0	13
Antrim	152.0	107.7	70.8	67
Down	166.8	130.8	78.4	113
Republic of Ireland	**2,950.1**	**1,430.0**	**48.5**	**348**
Northern Ireland	**360.2**	**263.7**	**73.2**	**193**
All Ireland	**3,310.3**	**1,693.7**	**51.2**	**541**

* In Northern Ireland counters were asked to explicitly state whether or not they surveyed each of the three habitats (sea, intertidal, land) for wildfowl and waders. Therefore, coverage for each combination varied. Refer to Table 2 for further details.

Figure 1. Coverage achieved during NEWS-2, 2006/07, illustrating stretches of coast that were covered (black) and not covered (red).

Overall numbers and distribution

Overall, 102,664 birds of 64 species were recorded. This included 33 wildfowl (and allies), 19 waders, ten gulls, one tern (Sandwich Tern) and Kingfisher. Waders were the most numerous group forming more than half of the total (54%), and most (84%) were recorded in the intertidal zone (Table 3). Wildfowl (and allies) formed 17% of the total, with 50% recorded on the sea and almost equal proportions occurring in the intertidal and land zones (Table 3). Gulls were also especially numerous, comprising 28% of the total (Table 3).

The Oystercatcher was the most numerous and most widespread species, with a total count of 12,950 birds, and it was present in almost 80% of sectors (Table 3). Golden Plover, Lapwing and Curlew were also especially numerous among the waders, with relatively large numbers using the intertidal zone as well as nearby terrestrial areas (land). Common Scoter, Light-bellied Brent Goose and Cormorant were the most numerous wildfowl (and allies) recorded. Records of the latter two were divided between all three habitats, while Common Scoter was almost entirely recorded on the sea. Herring Gull, Black-headed Gull and Common Gull were the most numerous of the gulls (Table 3). Curlew, Redshank and Herring Gull were all recorded in at least 50% of sectors,

Table 2. Coverage of non-estuarine coasts in Northern Ireland during NEWS-2, 2006/07 showing differences in coverage for wildfowl (including allies) and waders, and for each of the three habitats (intertidal, land, sea). Totals given represent length of coast in km, with percentage of coast/ number of sections in parentheses.

	Habitat	Derry	Antrim	Down	Northern Ireland
Wildfowl					
	Intertidal	24.2 (58.5/ 12)	107.7 (70.8/ 67)	127 (76.1/ 110)	258.9 (71.9/ 189)
	Land	12.4 (30/ 5)	103.9 (68.3/ 64)	77.2 (46.3/ 71)	193.5 (53.7/ 140)
	Sea	23.1 (55.8/ 11)	107.6 (70.8/ 65)	129 (77.3/ 113)	259.7 (72.1/ 189)
Waders					
	Intertidal	25.2 (61/ 13)	104 (68.4/ 64)	130.8 (78.4/ 113)	260.1 (72.2/ 190)
	Land	19.2 (46.3/ 11)	98.7 (65/ 62)	92.2 (55.3/ 79)	210.1 (58.3/ 152)
	Sea	7.7 (18.6/ 3)	20.1 (13.2/ 13)	29.2 (17.5/ 23)	57 (15.8/ 39)
Total coast	41.4	152.0	166.8	360.2	

Cormorant was the most widely recorded of the wildfowl (and allies), while Grey Heron, Shag and Great Northern Diver were also relatively widespread among this group, and Turnstone, Common Gull and Great Black-backed Gull all were present in about 40% of sectors (Table 3).

Population estimates were generated for 30 species (Table 4). By comparing these estimates with all-Ireland estimates based on the 1999/00-2003/04 period (Crowe *et al.* 2008), it is shown that substantial proportions of Red-throated Diver, Sanderling, Ringed Plover and Turnstone occur along non-estuarine coasts. Proportions of Common Scoter, Eider, Grey Heron, Oystercatcher, Curlew and Purple Sandpiper on non-estuarine coasts are also relatively high. There was considerable change between NEWS-1 and NEWS-2 in the population estimates of most species (Table 4). The estimates for just four species changed very little (within 10%) between surveys. Eight species showed declines in excess of 50% (Wigeon, Teal, Red-breasted Merganser, Grey Plover, Purple Sandpiper, Dunlin, Snipe, Greenshank), and three (Eider, Cormorant, Bar-tailed Godwit) showed increases of more than 50% (Table 4).

Table 3. Waterbird totals recorded within each of the main habitat types and overall, together with distribution (number and proportion of sectors in which recorded) on non-estuarine coasts in the Republic of Ireland and Northern Ireland during NEWS-2, 2006/07.

Species		Intertidal	Land	Sea	Total	Number sectors present (with %)
Mute Swan	*Cygnus olor*	106	21	30	157	18 (3.3)
Whooper Swan	*Cygnus cygnus*	3	52	-	55	4 (<1)
Greylag Goose	*Anser anser*	-	316	-	316	1 (<1)
Canada Goose	*Branta canadensis*	7	-	-	7	2 (<1)
Barnacle Goose	*Branta leucopsis*	55	629	20	704	5 (<1)
Brent Goose	*Branta bernicla hrota*	1,585	918	104	2,607	81 (15)
Feral/hybrid Goose		1	-	-	1	1 (<1)
Shelduck	*Tadorna tadorna*	82	7	5	94	22 (4.1)
Wigeon	*Anas penelope*	372	758	110	1,240	21 (3.9)
Gadwall	*Anas strepera*	-	2	-	2	1 (<1)
Teal	*Anas crecca*	276	532	11	819	20 (3.7)
Mallard	*Anas platyrhynchos*	483	236	103	822	63 (11.6)
Shoveler	*Anas clypeata*	-	5	-	5	2 (<1)
Tufted Duck	*Aythya fuligula*	-	-	2	2	1 (<1)
Scaup	*Aythya marila*	-	-	3	3	1 (<1)

Table 3. (continued)

Long-tailed Duck	*Clangula hyemalis*	-	-	40	40	8 (1.5)
Eider	*Somateria mollissima*	25	-	377	402	33 (6.1)
Common Scoter	*Melanitta nigra*	140	-	3,939	4,079	25 (4.6)
Velvet Scoter	*Melanitta fusca*	-	-	3	3	1 (<1)
Goldeneye	*Bucephala clangula*	1	-	5	6	2 (<1)
Red-breasted Merganser	*Mergus serrator*	38	4	288	330	60 (11.1)
Red-throated Diver	*Gavia stellata*	3	-	461	464	79 (14.6)
Black-throated Diver	*Gavia arctica*	-	-	5	5	3 (<1)
Great Northern Diver	*Gavia immer*	11	-	526	537	172 (31.8)
Little Grebe	*Tachybaptus ruficollis*	1	21	25	47	10 (1.8)
Great Crested Grebe	*Podiceps cristatus*	2	-	114	116	22 (4.1)
Slavonian Grebe	*Podiceps auritus*	-	-	2	2	3 (<1)
Cormorant	*Phalacrocorax carbo*	806	120	1,618	2,544	269 (49.7)
Shag	*Phalacrocorax aristotelis*	567	86	876	1,529	175 (32.3)
Little Egret	*Egretta garzetta*	25	13	1	39	26 (4.8)
Grey Heron	*Ardea cinerea*	458	40	9	507	208 (38.4)
Moorhen	*Gallinula chloropus*	-	12	-	12	5 (<1)
Coot	*Fulica atra*	-	70	-	70	2 (<1)
Oystercatcher	*Haematopus ostralegus*	11,838	1,112	-	12,950	429 (79.3)
Ringed Plover	*Charadrius hiaticula*	4,052	4	-	4,056	135 (25)
Golden Plover	*Pluvialis apricaria*	6,916	1,182	-	8,098	30 (5.5)
Grey Plover	*Pluvialis squatarola*	155	-	-	155	33 (6.1)
Lapwing	*Vanellus vanellus*	4,127	3,159	-	7,286	69 (12.8)
Knot	*Calidris canutus*	1,445	1	-	1,446	14 (2.6)
Sanderling	*Calidris alba*	1,960	-	-	1,960	51 (9.4)
Purple Sandpiper	*Calidris maritima*	352	-	-	352	50 (9.2)
Dunlin	*Calidris alpina*	4,530	20	-	4,550	91 (16.8)
Jack Snipe	*Lymnocryptes minimus*	1	-	-	1	1 (<1)
Common Snipe	*Gallinago gallinago*	86	76	-	162	37 (6.8)
Black-tailed Godwit	*Limosa limosa*	1	2	-	3	2 (<1)
Bar-tailed Godwit	*Limosa lapponica*	781	1	-	782	40 (7.4)
Whimbrel	*Numenius phaeopus*	4	-	-	4	4 (<1)
Curlew	*Numenius arquata*	4,185	3,003	-	7,188	355 (65.6)
Greenshank	*Tringa nebularia*	107	1	-	108	59 (10.9)
Redshank	*Tringa totanus*	3,204	73	-	3,277	289 (53.4)
Turnstone	*Arenaria interpres*	3,628	55	-	3,683	238 (44)
Grey Phalarope	*Phalaropus fulicarius*	-	-	1	1	1 (<1)
Black-headed Gull	*Chroicocephalus ridibundus*	4,698	1,418	3,005	9,121	140 (25.9)
Little Gull	*Hydrocoleus minutus*	5	-	1	6	2 (<1)
Mediterranean Gull	*Larus melanocephalus*	29	-	3	32	6 (1.1)
Common Gull	*Larus canus*	4,234	1,143	2,094	7,471	214 (39.6)
Lesser Black-backed Gull	*Larus fuscus*	182	46	411	639	54 (10)
Herring Gull	*Larus argentatus*	5,997	630	2,650	9,277	279 (51.6)
Yellow-legged Gull	*Larus michahellis*	1	-	-	1	1 (<1)
Iceland Gull	*Larus glaucoides*	6	5	2	13	10 (1.8)
Glaucous Gull	*Larus hyperboreus*	6	1	-	7	7 (1.3)
Great Black-backed Gull	*Larus marinus*	1,485	84	897	2,466	231 (42.7)
Sandwich Tern	*Sterna sandvicensis*	-	-	2	2	1 (<1)
Kingfisher	*Alcedo atthis*	-	1	-	1	1 (<1)
Total wildfowl and allies		**5,047**	**3,842**	**8,677**	**17,566**	
Total waders		**47,372**	**8,689**	**1**	**56,062**	
Total gulls*		**16,643**	**3,327**	**9,063**	**29,033**	

* Gull counts are included for the Republic of Ireland only.

Table 4. Population estimates for 30 waterbird species on non-estuarine coasts in the Republic of Ireland, Northern Ireland and all-Ireland (ranges in parentheses). For each species the all-Ireland population estimate is given where known, together with the proportion (%) on non-estuarine coasts based on the coastal estimate generated during NEWS-2, 2006/07.

Species	Republic of Ireland	Northern Ireland	All Ireland	Percentage change NEWS-1 - NEWS-2 (Republic of Ireland)*	All-Ireland population estimate**	Proportion using non-estuarine coasts
Brent Goose***	2,874 (2,501-3,469)	685 (501-1,050)	3,598 (3,114-4,179)	-7.9	30,000	12
Shelduck	183 (129-254)	<20 -	198 (140-268)	-	14,610	1.4
Wigeon	1,782 (1,418-2,519)	0 -	1,782 (1,418-2,519)	-65.2	82,370	2.2
Teal	1,023 (818-1,386)	96 (88-224)	1,133 (932-1,474)	-80.0	45,010	2.5
Mallard	1,431 (1,274-1,613)	64 (46-92)	1,498 (1,342-1,670)	-48.3	38,250	3.9
Common Scoter	6,227 (4,444-8,518)	0 -	6,227 (4,444-8,518)	-13.2	23,190	26.9
Eider	757 (476-1,167)	79 (62-111)	832 (555-1,246)	60.4	2,890	28.8
Red-breasted Merganser	601 (528-687)	<20 -	610 (536-699)	-51.5	3,390	18.0
Red-throated Diver	864 (661-1,109)	35 (27-52)	899 (697-1,141)	34.8	1,025	87.7
Great Northern Diver	1,144 (976-1,294)	10 (7-14)	1,154 (986-1,305)	13.4	-	-
Little Grebe	83 (62-105)	0 -	83 (62-105)	-	2,345	3.5
Great Crested Grebe	88 (81-95)	62 (34-124)	150 (118-216)	-	5,385	2.8
Cormorant	4,278 (4,013-4,482)	208 (176-240)	4,485 (4,216-4,684)	77.7	131,710	3.4
Shag	2,217 (1,913-2,482)	501 (427-598)	2,729 (2,402-3,035)	-	-	-
Grey Heron	863 (804-925)	104 (94-127)	970 (895-1,037)	4.9	2,960	32.8
Oystercatcher	16,124 (15,341-16,876)	5,267 (4,875-5,824)	21,437 (20,331-22,464)	-0.2	67,620	31.7
Ringed Plover	7,127 (6,201-8,232)	639 (536-815)	7,794 (6,861-8,859)	-7.8	14,580	53.5
Golden Plover	5,464 (4,578-6,390)	4,331 (4,229-11,229)	10,142 (8,809-16,381)	-45.3	166,700	6.1
Grey Plover	215 (184-255)	13 (11-21)	228 (198-269)	-85.6	6,315	3.6
Lapwing	8,377 (6,474-10,529)	2,743 (2,325-3,363)	11,142 (9,265-13,443)	-49.5	207,700	5.4
Knot	728 (601-920)	9 (7-17)	741 (613-937)	-	18,970	3.9
Sanderling	3,702 (2,979-4,351)	124 (88-186)	3,808 (3,083-4,490)	-11.6	6,680	57.0
Purple Sandpiper	616 (414-861)	114 (88-163)	735 (522-957)	-77.2	3,330	22.1

Dunlin	4,567 (3,663-5,960)	2,767 (2,339-3,872)	7,454 (6,313-9,571)	-52.8	88,480	8.4
Snipe	242 (175-323)	74 (56-114)	317 (251-412)	-63.3	-	-
Bar-tailed Godwit	1,117 (680-1728)	57 (47-83)	1,170 (746-1781)	94.9	16,280	7.2
Curlew	10,384 (9,517-11,262)	2,207 (1,925-2,529)	12,643 (11,686-13,718)	-12.5	54,650	23.1
Greenshank	199 (170-230)	6 (5-10)	206 (177-240)	-63.7	1,265	16.3
Redshank	2,550 (2,334-2,831)	2,397 (2,169-2,702)	4,990 (4,642-5,406)	-22.0	31,090	16.1
Turnstone	4,402 (3,730-5,057)	1,844 (1,705-2,202)	6,264 (5,612-7,004)	-26.1	11,810	53.0

* From Colhoun and Newton (2000).

** From Crowe *et al.* (2008).

*** From Colhoun (2007).

Geographical patterns of distribution

Greatest densities of wildfowl and waders were recorded in the eastern region, while lowest densities of wildfowl and waders were recorded in the west and southwest regions respectively (Table 5). Densities ranged between 4.7 and 43.5 birds per km for wildfowl, and between 13.4 and 82.1 birds per km for waders (Table 5). The regional distribution of densities of a selection of wildfowl and waders is presented in Figure 2. This selection includes species that are especially prevalent on non-estuarine coasts. The figure illustrates the importance of the eastern region for most of the species presented, and the importance of the west and northwest regions for Great Northern Diver, Ringed Plover, Sanderling and Purple Sandpiper.

The densities of 17 species increased when compared with NEWS-1, while a further 17 declined (Table 6). Most density declines were in the northwest region, for both wildfowl and waders, but there were many declines in the northeast region also. Density increases were most prevalent in the eastern region, and in both the wildfowl and wader groups (Table 6).

Discussion

More than one-third of the coastline of Ireland consists of open, non-estuarine coasts that form a suitable habitat for wintering waterbirds. Relatively few stretches of open coastline are regularly covered during WeBS and I-WeBS core counts. This represents the second national survey of non-estuarine coastal waterbirds, undertaken nine years after the first in 1997/98. The survey has shown that non-estuarine coastal habitats continue to support a broad diversity of waterbirds, and are especially important for divers, seaducks, Cormorant, Shag and several waders.

Most open coast habitats in Ireland (78%) are located in western counties between Donegal and Cork (Table 1). Here, the important estuarine sites used by wintering waterbirds are few and widely spaced relative to the eastern coastline, which is comparatively straight, yet broken up by highly productive and important estuarine complexes, many of which lie in close proximity to each other. Indeed, this is a likely reason for the higher densities of most species recorded in eastern counties. Inflated counts of some species were undoubtedly due to birds 'spilling out' at open coastal sections immediately

Table 5. Densities of wildfowl (and allies) and waders within six coastal regions in Ireland during NEWS-2, 2006/07.

Region	Non-estuarine coast length (km)	Total wildfowl	Wildfowl density (birds/km)	Total waders	Wader density (birds/km)
Northwest	310.4	3,602	11.6	4,996	16.1
West	504.2	2,369	4.7	11,309	22.4
Southwest	345.3	1,748	5.1	4,629	13.4
Southeast	103.4	857	8.3	3,338	32.3
East	166.7	7,246	43.5	13,684	82.1
Northeast	259.7/260.1*	1,744	6.7	18,105	69.6

* Stretches of coast counted for wildfowl and waders differed in Northern Ireland.

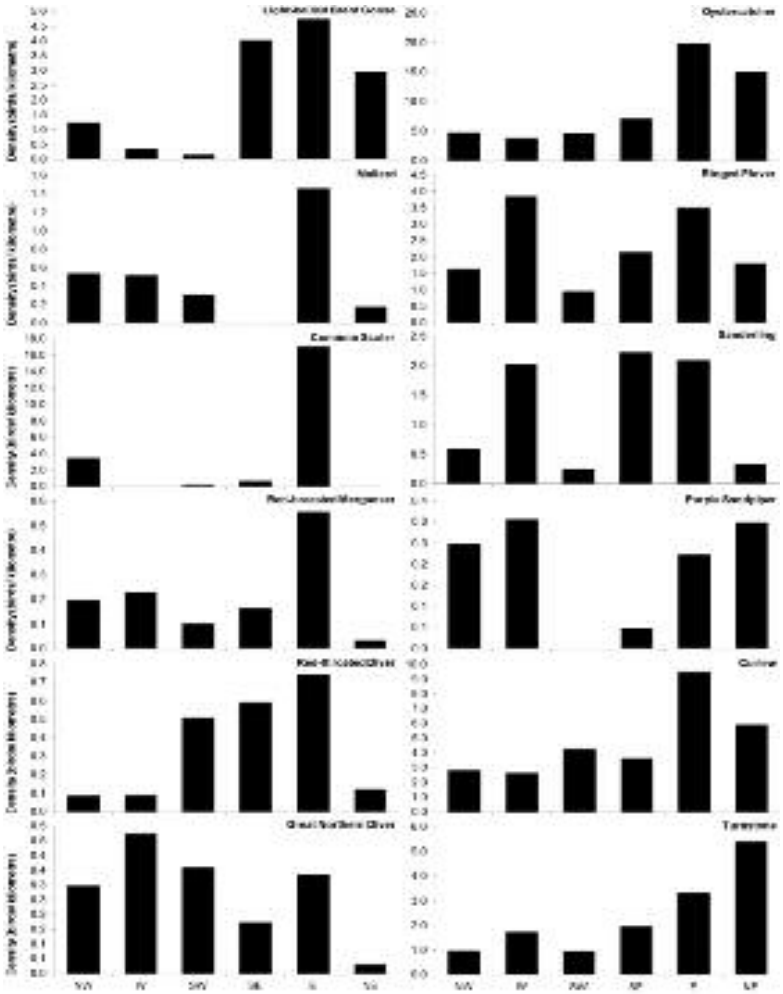

Figure 2. Linear densities of a selection of wildfowl (left) and waders (right) between regions as recorded during NEWS-2, 2006/07.

adjacent to important waterbird estuaries. One notable record includes a flock of 894 Knot between Baltray and Termonfekin, located immediately to the north of the Boyne Estuary on the border between Counties Meath and Louth. However, artificially high counts along other stretches of coast demonstrate that incidences of spill-over were not unique to east coast estuaries. Another high count involved 280 Bar-tailed Godwit recorded at Ardtermon Strand near Drumcliffe Bay in County Sligo. These specific records were excluded from the bootstrapping process used to generate population estimates.

Three wader species occurred in relatively high densities along the west coast, namely Ringed Plover, Sanderling and Purple Sandpiper (Figure 2). The sandy and rocky shoreline at Quilty on the County Clare coast has long been recognized as important for Purple Sandpipers (Crowe 2005), and it is counted during I-WeBS. Counts of up to 330 birds have been recorded there, although more recent annual peak counts range between 80 and 150 (I-WeBS data). Counts of this species at other locations seldom exceed 50 birds. Sanderling and Ringed Plover are typical species of open sandy coastline (Summers *et al.* 1988, 2002), thus, the distribution of wintering flocks is defined by the location of suitable sandy substrate which is prevalent on the Irish coastline.

The findings relating to the distribution of waders are supported by an analysis of habitat preferences shown by wintering waders on the shoreline of the Orkney Islands (Summers *et al.* 2002). This showed the preference of Ringed

Table 6. Linear densities (birds per km) of waterbirds on non-estuarine coasts during NEWS-2, together with the percentage change (in parenthesis) since NEWS-1 within six coastal regions in Ireland. No change estimate was possible where a species was absent during NEWS-1, while an asterisk indicates when it was present during NEWS-1 and absent during NEWS-2, 2006/07.

Species	NW	W	SW	SE	E	NE	Overall
Mute Swan	0.18	0.02	0.08	-	1.32	*	0.18
	(-22)	(-92.4)	(-38.2)		(153.8)		(-11.6)
Barnacle Goose	3.8	0.45	-	-	-	-	0.83
	(-70.4)	(43.7)					(-60.8)
Brent Goose	2.51	0.72	0.31	8.07	9.49	2.87	2.61
	(11)	(406.2)	(-69.8)	(182.2)	(29.2)	(470.5)	(58.8)
Shelduck	0.29	0.02	0.16	0.04	0.06	0.04	0.1
		(-86.7)	(638.1)	(251.9)			(150)
Wigeon	1.14	0.79	0.81	-	8.67	*	1.46
	(-51.4)	(72.1)	(-51.6)		(323.4)		(33.9)
Teal	0.28	0.51	0.23	*	6.23	0.33	0.91
	(-87.3)	(-36.9)	(-78)		(690.2)		(-4.2)
Mallard	1.08	1.03	0.62	-	2.92	0.17	0.94
	(-41.1)	(4.4)	(-55.4)		(146.7)	(-10.8)	(-9.1)
Long-tailed Duck	0.08	0.1	-	0.02	-	-	0.05
	(-88.5)	(36.9)					(-63.6)
Eider	2.2	*	-	-	0.01	0.22	0.44
	(-43.5)				(-23.9)	(-77.6)	(-38.8)
Common Scoter	7	0.09	0.32	1.41	34.11	*	4.8
	(3,037)	(-98.4)		(-93.7)	(220.2)		(-8.1)
Red-breasted Merganser	0.39	0.46	0.2	0.33	1.12	0.03	0.38
	(-22)	(-57.7)	(0.7)	(232.4)	(254)	(-88.1)	(-25.1)
Red-throated Diver	0.17	0.18	1.01	1.18	1.49	0.12	0.53
	(-71.5)	(187.7)	(1,025.6)	(973.4)	(114.5)	(-65.5)	(117.7)
Great Northern Diver	0.59	0.95	0.72	0.35	0.67	0.03	0.63
	(-52.8)	(0.4)	(222.8)	(-4)	(2,031.6)	(-80.6)	(6.1)
Little Grebe	0.03	0.1	0.02	-	0.17	*	0.06
	(-44.3)	(-20.5)	(337.4)				(8.9)
Great Crested Grebe	0.01	0.02	-	0.02	0.89	0.13	0.12
		(258)		(-41.3)	(156.1)	(-59)	(72)
Cormorant	1.52	1.89	3.27	4.12	10.74	0.59	2.9
	(47.3)	(-5.3)	(84.4)	(374.4)	(472.6)	(-70)	(76.6)
Shag	1.39	1.19	1.67	0.64	3.08	1.62	1.54
	(-38.8)	(5.3)	(208.7)	(56.9)	(226.1)		(62.8)
Little Egret	-	0.01	0.14	0.1	0.07	-	0.05
		(168.5)	(583.4)				(605.1)
Grey Heron	0.43	0.83	0.52	0.31	0.56	0.29	0.55
	(17)	(27.9)	(13.2)	(134.6)	(257.8)	(24.2)	(33.1)
Oystercatcher	9.03	6.64	8.15	12.31	37.55	13.31	11.82
	(-34.3)	(-23.5)	(27.1)	(-6.6)	(-20.8)	(53.9)	(-6.5)
Ringed Plover	3.25	7.7	1.91	4.3	6.99	1.75	4.49
	(-47.3)	(53)	(6.1)	(37.1)	(387.7)	(-27.8)	(23.7)
Golden Plover	-	3.28	0.1	-	22.09	15.68	5.65
		(139)	(1,868.1)		(-79.2)	(-4.3)	(-55.6)
Grey Plover	0.03	0.1	0.12	0.41	0.88	0.04	0.18
	(-96.7)	(-74.3)	(-41.1)	(-75.5)	(-61.1)	(27.9)	(-73.9)
Lapwing	0.41	3.76	0.58	-	12.11	7.44	3.68
	(-97)	(-0.3)	(-65)		(-0.1)	(-59.4)	(-44.3)
Knot	0.68	0.05	*	0.06	15.8	0.03	1.7
	(121.3)	(287.8)		(427.9)	(194.9)	(-99.1)	(113.8)
Sanderling	1.2	4.05	0.5	4.45	4.18	0.33	2.25
	(99.8)	(224.9)	(-10.3)	(-6.5)	(100.7)	(-53.9)	(60.3)
Purple Sandpiper	0.5	0.61	-	0.1	0.44	0.29	0.37
	(-64)	(-45.2)		(-45)	(156.1)	(-37.9)	(-41.5)

Dunlin	2.58	5.03	0.54	1.08	5.51	8.35	4.01
	(-34.6)	(-45.4)	(-54.4)	(8.3)	(-30.4)	(59.3)	(-18.7)
Snipe	-	0	0.27	0.15	-	0.11	0.08
		(-77.6)	(105.6)	(1,307.7)		(190.8)	(-49.9)
Bar-tailed Godwit	3.09	0.71	0.01	0.77	0.38	0.17	0.89
	(-2.5)	(198.3)	(-56.3)	(-3.6)	(-55.7)	(-19.6)	(16.5)
Curlew	3.16	3.1	3.8	4.2	7.17	4.28	3.91
	(-76.9)	(-38.3)	(-2)	(149.6)	(57.5)	(-6.5)	(-30.5)
Greenshank	0.1	0.13	0.14	0.15	0.26	0.02	0.12
	(-31.2)	(2.3)	(-53.7)	(8.3)	(235)	(-63.7)	(-25)
Redshank	1.38	1.71	1.61	0.95	4.7	6.82	2.69
	(-72.1)	(-24)	(-2.9)	(-20.2)	(69.6)	(132.5)	(6.7)
Turnstone	2	3.39	1.91	3.87	6.56	5.15	3.45
	(-60.1)	(-22.4)	(33.2)	(22.6)	(146.4)	(138.8)	(6.7)

Plover, Sanderling and Bar-tailed Godwit for sandy shores, Lapwing, Snipe, Redshank, Curlew and Dunlin for muddy shores, Oystercatcher, Golden Plover and Purple Sandpiper for rocks, and Turnstone for gravel and rocky shores. Summers *et al*. (2002) also showed that Ringed Plover, Purple Sandpiper and Bar-tailed Godwit preferred exposed coast, and Sanderling, Purple Sandpiper, Dunlin, Bar-tailed Godwit and Turnstone preferred wide shores.

Among the wildfowl (and allies), open sea species such as divers, Cormorant, Shag, Common Scoter, Eider and Red-breasted Merganser are not limited to estuarine areas of higher productivity. Common Scoter and Eider move between areas of relatively shallow waters, usually less than 10 m (Degraer *et al.* 1999, Larsen & Guillemette 2000), where they can gain access to their preferred prey, such as shellfish and other marine invertebrates. The distribution of Red-breasted Merganser, Cormorant, Shag and the divers is influenced by the distribution of their prey, largely shoals of small fish (Dennis 1993). Thus, the distribution of these flocks is relatively mobile.

Surveys of intertidal areas are manageable in most conditions, although there are much fewer days when conditions at sea are optimal for counts of divers and seaducks. There was an additional component to the recording form in 2006/07 asking observers to indicate which of the three main habitat types (sea, intertidal, land) they surveyed. This addition greatly improves the analyses as it identifies those sections of coast where conditions for counting birds on the sea were unfavourable. This option was available but was generally not used during surveys in the Republic of Ireland, and it was assumed that efforts were focused on all habitats in all sections surveyed. It is likely that counts of birds occurring on the sea in some sections were hampered by adverse conditions, but that no indication was given that counts were poor quality on the basis that those of birds in other habitats were not affected. Therefore, the totals given in this paper for birds occurring on the sea are likely to have been underestimated. It is important that this facility is acknowledged in future surveys of non-estuarine coasts.

Notable proportions of the estimated Irish population of several species occurred on non-estuarine coasts, especially of Red-throated Diver, Ringed Plover, Sanderling and Turnstone (Table 4). The Light-bellied Brent Goose total represented 12% of the Irish population, and linear densities increased in most regions, and overall, compared to NEWS-1 (Table 6). The increase in Light-bellied Brent Goose is consistent with an increase in the overall flyway population from almost 22,000 birds during the early 2000s (Crowe *et al.* 2008) to just over 30,000 birds recorded in October 2006 (Colhoun 2007).

The differences observed in estimates generated for species in the Republic of Ireland between non-estuarine surveys was quite variable, but are consistent with national trends (Boland & Crowe 2012) for only a small selection of species, namely Wigeon, Red-breasted Merganser, Grey Plover, Lapwing and Dunlin (declines) and Grey Heron (stable). The increases shown overall in Light-bellied Brent Goose, Oystercatcher, Ringed Plover and Sanderling, and the decline in Curlew at national level were less apparent on non-estuarine coasts where numbers were relatively stable between surveys. Increases in Purple Sandpiper, Greenshank, Redshank and Turnstone at national level contrasted with declines shown at non-estuarine coasts. Furthermore, a number of species showing stable trends at national level increased (Cormorant and Bar-tailed Godwit), or declined (Teal, Mallard and Golden Plover) between NEWS-1 and NEWS-2. This lack of consistency may reflect differences in coverage between NEWS-1 and NEWS-2, but possibly also is related to a change in the behaviour of these species.

Wintering migratory waterbirds are affected by a wide variety of factors, and their numbers have been shown to fluctuate widely (Wetlands International 2006, Boland & Crowe 2012, Holt *et al.* 2011), and for some, significant changes have been shown to take place over relatively short periods of less than five years (e.g. McLean *et al.* 2006). Thus, ongoing annual monitoring of key wetland sites through regular core counts is essential to track these changes. However, for species with considerable proportions occurring

on open coasts such as Purple Sandpiper and Turnstone, core counts at predominantly estuarine sites may not adequately reflect the national trends of these species. Therefore, the frequency of surveys at non-estuarine coasts is not sufficient to detect changes that may take place during the intervening years. While one solution may be to increase the frequency of non-estuarine surveys, it may also be possible to integrate coverage of non-estuarine coasts as part of regular WeBS and I-WeBS core counts.

Estimates of the size of waterbird populations on non-estuarine coast should be regularly updated as they provide a basis for population and site conservation. Many waders have been shown to be highly site-faithful to wintering areas (Burton 2000, Burton *et al.* 2005, Leyrer *et al.* 2006, Hallgrimsson *et al.* 2012). This factor, combined with likely impacts of future sea-level rises at non-estuarine coastal habitats, may mean that additional and more regular counts of non-estuarine coasts are needed to improve our understanding of the dynamics of this group of birds within this habitat type.

Acknowledgements

NEWS-2 was organised under the auspices of WeBS and I-WeBS, the national waterbird monitoring schemes in Northern Ireland and the Republic of Ireland respectively. In Northern Ireland, the Wetland Bird Survey allowed the WeBS counter network to be used for this survey, and this was supplemented by the British Trust for Ornithology's (BTO) Regional Network. NEWS-2 in Northern Ireland was supported financially by the Northern Ireland Environment Agency. I-WeBS is a joint project of BirdWatch Ireland and the National Parks and Wildlife Service (NPWS) in the Republic of Ireland. The fieldwork for this project was carried out by a large body of amateur volunteers and professional conservation staff of the above agencies to whom thanks are due and without which this survey would not have been carried out. We would wish to list the name of every person who took part in both Northern Ireland and the Republic of Ireland, but very regretfully that is not possible. However, special thanks are due to the following for their active roles in coordinating coverage within their counties or region: Shane Wolsey and Neil McCulloch (Northern Ireland); Paul Walsh (Waterford); Marianne ten Cate (Galway); Jill Crosher (west Kerry); Trevor Hunter (Sligo). Thanks to Oscar Merne for assisting with gap-filling and to Cerian Thomas and Kathryn Finney for carrying out fieldwork in various counties in the west of Ireland. Thanks to John Lusby and Pat Smiddy for their comments on an earlier version of this manuscript.

References

Boland, H. & Crowe, O. 2012. *Irish Wetland Bird Survey: waterbird status and distribution 2001/02-2008/09.* BirdWatch Ireland, Kilcoole.

Boland, H., McElwaine, J.G., Henderson, G., Hall, C., Walsh, A. & Crowe, O. 2010. Whooper *Cygnus cygnus* and Bewick's *C. columbianus bewickii* Swans in Ireland: results of the international census, January 2010. *Irish Birds* 9: 1-10.

Burton, N.H.K. 2000. Winter site-fidelity and survival of Redshank *Tringa totanus* at Cardiff, south Wales. *Bird Study* 47: 102-112.

Burton, N.H.K., Fuller, R.A. & Eaton, M.A. 2005. Between-year changes in the wintering sites of Ruddy Turnstones *Arenaria interpres:* a response to diminished food resources? *Wader Study Group Bulletin* 107: 36-39.

Colhoun, K. 2007. Increases in East Canadian High Arctic Light-bellied Brent Geese may be slowing. *Goose News* 6: 17.

Colhoun, K. & Newton, S. 2000. Winter waterbird populations on non-estuarine coasts in the Republic of Ireland: results of the 1997-98 Non-Estuarine Coastal Waterfowl Survey (NEWS). *Irish Birds* 6: 527-542.

Crowe, O. 2005. *Ireland's Wetlands and their Waterbirds: status and distribution.* BirdWatch Ireland, Newcastle.

Crowe, O., Austin, G.E., Colhoun, K., Cranswick, P., Kershaw, M. & Musgrove, A.J. 2008. Estimates and trends of waterbird numbers wintering in Ireland, 1994/95-2003/04. *Bird Study* 55: 66-77.

Degraer, S., Vincx, M., Meire, P. & Offringa, H. 1999. The macrozoobenthos of an important wintering area of the Common Scoter *(Melanitta nigra). Journal of the Marine Biological Association of the UK* 79: 243-251.

Dennis, R. 1993. *Loons.* Voyager Press, Stillwater, Minnesota.

Hallgrimsson, G.T., Summers, R.W., Etheridge, B. & Swann, R.L. 2012. The winter range of Nearctic Purple Sandpipers *Calidris maritima* on the East Atlantic flyway. *Ardea* 100: 13-18.

Holt, C.A., Austin, G.E., Calbrade, N.A., Mellan, H.J., Mitchell, C., Stroud, D.A., Wotton, S.R. & Musgrove, A.J. 2011. *Waterbirds in the UK 2009/10: the Wetland Bird Survey.* BTO/RSPB/JNCC, Thetford.

Larsen, J.K. & Guillemette, M. 2000. Influence of annual variation in food supply on abundance of wintering Common Eiders *Somateria mollissima. Marine Ecology Progress Series* 201: 301-309.

Leyrer, J., Spaans, B., Camara, M. & Piersma, T. 2006. Small home ranges and high site fidelity in Red Knots *(Calidris c. canutus)* wintering on the Banc d'Arguin, Mauritania. *Journal of Ornithology* 147: 376-384.

McLean, I.M.D., Burton, N.H.K. & Austin, G.A. 2006. Declines in over-wintering diving ducks at Lough Neagh and Lough Beg: comparisons of within site, regional, national and European trends. *BTO Research Report* No. 432, Thetford.

Moser, M.E. & Prŷs-Jones, R.P. 1988. Population estimates, distribution patterns and site evaluations for waders wintering on the coast of Northern Ireland. *Irish Birds* 3: 551-568.

Moser, M.E. & Summers, R.W. 1987. Wader populations on the non-estuarine coasts of Britain and Northern Ireland: results of the 1984/85 Winter Shorebird Count. *Bird Study* 34: 71-84.

Rehfisch, M.M., Holloway, S.J. & Austin, G.E. 2003. Population estimates of waders on the non-estuarine coasts of the UK and the Isle of Man during the winter of 1997-98. *Bird Study* 50: 22-32.

Summers, R.W., Ellis, P.M. & Johnston, J.P. 1988. Waders on the coast of Shetland in winter: numbers and habitat preferences. *Scottish Birds* 15: 71-79.

Summers, R.W., Underhill, L.G. & Simpson, A. 2002. Habitat preferences of waders (Charadrii) on the coast of the Orkney Islands. *Bird Study* 49: 60-66.

Walsh, A.J. & Crowe, O. 2008. Barnacle Geese *Branta leucopsis* in Ireland, spring 2008. *Irish Birds* 8: 430-432.

Wetlands International. 2006. *Waterfowl Population Estimates.* Fourth edition. Wetlands International, Wageningen.