

1 **Population size of Oystercatchers *Haematopus ostralegus* wintering in**  
2 **Iceland**

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4 Böðvar Þórisson<sup>1\*</sup>, Verónica Méndez <sup>2,1</sup>, José Alves<sup>1,3</sup>, Jennifer A. Gill<sup>2</sup>, Kristinn H.  
5 Skarphéðinsson<sup>4</sup>, Svenja Auhaug<sup>4</sup>, Sölvi R. Vignisson<sup>5</sup>, Guðmundur Ö. Benediktsson<sup>6</sup>,  
6 Brynjúlfur Brynjólfsson<sup>7</sup>, Cristian Gallo<sup>8</sup>, Hafdís Sturlaugsdóttir<sup>8</sup>, Páll Leifsson<sup>9</sup> & Tómas G.  
7 Gunnarsson<sup>1</sup>

8

9 <sup>1</sup> University of Iceland, South Iceland Research Centre, Lindarbraut 4, IS-840 Laugarvatn,  
10 Iceland

11 <sup>2</sup> School of Biological Sciences, University of East Anglia, Norwich Research Park, Norwich  
12 NR4 7TJ, UK

13 <sup>3</sup> DBIO & CESAM – Center for Environmental and Marine Studies, University of Aveiro,  
14 Campus Universitário de Santiago, 3810-193 Aveiro, Portugal

15 <sup>4</sup> Icelandic Institute of Natural History (IINH), Urriðaholtsstræti 6-8, 212 Garðabær, Iceland

16 <sup>5</sup> Sudurnes Science and Learning Center, Garðvegur 1, 245 Sandgerði, Iceland

17 <sup>6</sup> Duggugerði 1, 670 Kópasker

18 <sup>7</sup> South East Iceland Bird Observatory, Litlubrú 2, 780 Höfn, Iceland

19 <sup>8</sup> Westfjords Natural History Institute, Aðalstræti 21, 450 Bolungarvík

20 <sup>9</sup> Strandgata 7a, 735 Eskifirði, Iceland

21 \*Corresponding author bodvar@hi.is

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1 **Capsule** Iceland-breeding Oystercatchers winter in both Iceland and W Europe, but the  
2 relative numbers of residents and migrants is poorly known. We undertook the first ever  
3 survey of the total number of Oystercatchers wintering in Iceland. Around 11,000 individuals  
4 were counted which almost triples the previous estimate. This is an estimated 30% of the  
5 Icelandic population, including juveniles, suggesting that ~26,000 Icelandic Oystercatchers  
6 migrate to W Europe in the autumn. More Oystercatchers winter in Iceland than at similar  
7 latitudes elsewhere in Europe, which may reflect the remoteness and slightly milder winter  
8 temperatures on this oceanic island.

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## 1 **Introduction**

2 Many species of birds are so-called partial migrants, where a part of the population is  
3 sedentary, remaining on or near the breeding grounds year-round, while another part of the  
4 population migrates (Alerstam 1990). Partially migrant populations are model systems for  
5 studying environmental drivers of variation in individual migration strategies and the  
6 consequences of those strategies for demography and evolution of migration (Hegemann *et*  
7 *al.* 2015). Partial migration at northern latitudes can involve trade-offs between survival of  
8 residents under harsh winter conditions and potential benefits for productivity driven by  
9 factors such as timing of territory acquisition and mate-retention probabilities (Durell 2007,  
10 Duriez *et al.* 2012). These trade-offs may be a key reason why individuals in populations  
11 which breed over large latitudinal ranges are often migratory at higher latitudes but  
12 sedentary at lower latitudes (Newton 2010). Migration can also incur costs related to  
13 migration distance and conditions at destinations (Alves *et al.* 2013, Lok *et al.* 2015). In order  
14 to use the structure of partial migrant systems to understand the demographic causes and  
15 consequences of migration, detailed information is needed about the migratory status of  
16 individuals across populations and the proportion of migrants and residents. For many large  
17 birds this can be achieved through direct observations or, for smaller birds, more often by  
18 indirect evidence of migratory status (such as differences in stable isotope ratios) (Palacín *et*  
19 *al.* 2011, Hegemann *et al.* 2015).

20 The Icelandic breeding Oystercatcher (*Haematopus ostralegus*) population is partially  
21 migrant, with the majority of individuals thought to migrate to coastal Europe during the  
22 winter (Garðarsson 1975). A recent estimate of the size of the breeding population is ~13  
23 thousand pairs (Skarphéðinsson *et al.* 2016). No targeted survey of their total wintering

1 number has taken place so the size of the sedentary Oystercatcher population in Iceland is  
2 currently unknown. However, as Iceland lies at the northernmost latitudes of the winter  
3 range of this species (BirdLife International 2017), the proportion of migrant individuals is  
4 predicted to be high. The maximum wintering number counted in Christmas counts  
5 organised by the Icelandic Institute of Natural History (IINH) since 1952 has been 4466  
6 individuals (IINH 2017). Most Oystercatchers winter in SW and W Iceland but some are also  
7 known to winter in unknown numbers in areas not covered by the Christmas counts. As part  
8 of a larger project comparing demographic parameters of migrant and resident  
9 Oystercatchers, we undertook the first total and targeted census of the Icelandic  
10 Oystercatcher wintering population to estimate the proportions of migrants and residents in  
11 this partial migratory population. We compare our results with the resident proportions of  
12 breeding Oystercatcher populations across coastal NW Europe, between Norway and the  
13 Netherlands, to assess the latitudinal gradient in migration behaviour of the species. Iceland  
14 is a remote oceanic island with a sea crossing that is potentially more risky than migration in  
15 other parts of the range, which may affect the partial migratory continuum (Gunnarsson &  
16 Tómasson 2011).

17

## 1 **Methods**

2 Ground-based surveys of Oystercatchers were carried out between 28 January – 3 February  
3 2017 and an aerial survey over the islands and inaccessible sites in the Breiðafjörður bay  
4 (Figure 1) was conducted on 16 February 2017. At this time, migratory Oystercatchers are  
5 unlikely to be present as colour-ringed migratory individuals do not start arriving in Iceland  
6 until March (unpublished data). Southwest and West Iceland are known to be the key  
7 wintering regions (Wilson & Morrison 1981) as they have most of the suitable wintering  
8 habitats (estuarine bays) for Oystercatchers (Ingólfsson 2006) and a relatively mild winter  
9 climate (Icelandic Met Office; [www.vedur.is](http://www.vedur.is)). All potential and known wintering sites from  
10 Reykjanes peninsula in the SW, in Faxaflói and the north side of the Snæfellsnes peninsula in  
11 the W, along with key areas in the NW were surveyed on foot or by car (Figure 1). Christmas  
12 counts cover several coastal areas in the North and Oystercatchers are rarely found in this  
13 part of the country in the winter (IINH 2017). Only one area, Kópasker, was covered during  
14 our survey and produced no Oystercatchers. All known or potential wintering areas in the E  
15 and SE were covered on the ground. Most of the south coast of Iceland comprises barren,  
16 sandy outwash plains of glacial origin which are unsuitable for wintering waders  
17 (Gunnarsson 2009) and was therefore not covered. Sites were surveyed with binoculars and  
18 telescopes, either on low or high tide, depending on the highly variable local conditions, to  
19 maximise the visibility of birds. An aerial survey over islands and inaccessible sites in the  
20 Breiðafjörður bay, as well as some key sites in Faxaflói Bay, was conducted around high tides  
21 (+/- 2 hrs). We used a fixed-wing aircraft (Cessna-Skyhawk) flying at 120-200 m a.s.l. with a  
22 groundspeed of 120 km/hour. Flocks of roosting Oystercatchers were usually seen from afar  
23 and photographs were used to verify or correct counts without flushing the birds. During

1 both ground and aerial surveys, all other waders which were encountered were also  
2 counted. This information is not used in this study but is included in an appendix.

3 In order to estimate the proportion of migrants and residents it was necessary to determine  
4 the total population size of Icelandic breeding Oystercatchers, which has recently been  
5 estimated at 13 thousand breeding pairs (Skarphéðinsson *et al.* 2016). Our studies during  
6 the past three years have shown that oystercatchers breeding both in inland and coastal  
7 habitats fledge on average ~0.5 chicks/pair (Méndez *et al.* unpublished). We estimate that  
8 50% of these are alive by mid-winter (when the survey took place), that annual survival  
9 probability is 90% (Goss-Custard *et al.* 1982, Durell 2007) and that Oystercatchers start  
10 breeding at the age of 4 years (Ens & Underhill 2014). These values were used to estimate  
11 the number of birds in the four juvenile cohorts, which were then added to the number of  
12 breeding adults to produce a total population estimate of both adults and juveniles in winter  
13 (estimated total winter population = 26,000 adults + the estimated number of juveniles in  
14 each of the four juvenile cohorts (ages 1 to 4)).

15 To put the migratory status of the Icelandic Oystercatcher into context with Oystercatcher  
16 populations breeding in NW Europe, we collated available information about the prevalence  
17 of residency in wintering of Oystercatchers in coastal countries along the East Atlantic  
18 flyway, north of France (see references in table 2). Average January temperature was  
19 extracted, as a surrogate for winter severity, from weather stations (<https://www.yr.no>)  
20 close to main wintering sites for each country. In areas with little or no wintering, weather  
21 stations closest to the centre latitude of the region were used.

22

## 1 **Results**

2 In total, 11,141 Oystercatchers were counted in our survey (Table 1) which approximately  
3 triples previous annual winter counts (Figure 2). As expected from previous studies, the vast  
4 majority of Oystercatchers were found on wintering sites in SW and W Iceland. Large  
5 numbers of Oystercatchers were found on sites not covered by the Christmas counts,  
6 particularly on the north side of the Faxaflói bay and during the aerial survey over the  
7 Breiðafjörður bay.

8 Assuming that our productivity estimate (see methods) applies across the population and  
9 assumptions about survival are reasonable, the four juvenile cohorts would total 11,177  
10 juvenile birds in mid-winter. Adding that to the breeding population estimates gives a total  
11 mid-winter population of ~37,177 individuals. Our winter census results therefore suggest  
12 that ~30% of the total population of Oystercatchers are residents, whereas the remaining  
13 ~70% or ~26,000 Oystercatchers migrate out of Iceland to winter in W Europe.

14 Across the breeding latitudes of Oystercatchers in NW Europe, there is a strong latitudinal  
15 decline in residency which reflects the latitudinal trend in winter temperatures (Table 2).  
16 From Northern Norway (69.6°N) to Southern Sweden (57.7°N), where mean January  
17 temperatures are typically in the range of -1 to -4°C, only occasional individuals are found in  
18 winter, whereas populations in Denmark (55.4°N), where mean January temperatures are  
19 ~0.8°C, and sites that are further south and warmer mostly comprise resident individuals  
20 (Table 2).

21

## 1 **Discussion**

2 In the first targeted and complete survey of the wintering Icelandic Oystercatcher population  
3 we recorded ~11,000 individuals in Iceland, almost tripling previous annual winter counts.

4 We estimate that this represents ~30% of the entire Icelandic population, including  
5 juveniles. There is currently no evidence that Oystercatchers from other breeding  
6 populations occur in Iceland (Skarphéðinsson *et al.* 2016). Wintering Oystercatchers occur  
7 primarily in the Southwest and West of the country, which has abundant estuarine feeding  
8 habitats and a mild winter climate. At present it is not known to what extent the wintering  
9 population comprises local breeders or how many originate from other parts of Iceland.

10 Parts of Iceland which were not covered by the survey, particularly the North and East coasts  
11 have many areas which are surveyed during the Christmas counts and usually have few to no  
12 wintering Oystercatchers (IINH 2017). Areas which were surveyed both during the Christmas  
13 counts and during our census, approximately one month later, had very similar numbers of  
14 Oystercatchers, therefore any major redistribution during this time of winter is unlikely to  
15 have taken place but such events could increase the chances of double counting. We  
16 therefore conclude that our survey results should be considered a minimum estimate of the  
17 number of Oystercatchers wintering in Iceland. The information gathered here forms vital  
18 background for the assessment of the role of partial migration in the dynamics of this  
19 population.

20 There is a strong temperature-related latitudinal pattern in the proportion of wintering  
21 Oystercatchers from breeding populations across NW Europe. Towards the north, from  
22 Norway to South Sweden where mid-winter temperatures are generally below zero, virtually  
23 all Oystercatchers migrate. In the warmer winter regions above the 0°C isotherm, from



1 Denmark to the Netherlands, most Oystercatchers are residents. This follows the general  
2 pattern of birds being more likely to migrate from colder areas with declining food supplies  
3 in winter (Newton & Dale 1996, Newton 2010). However, there are two obvious outliers in  
4 this pattern: Iceland has more wintering Oystercatchers than would be predicted by latitude  
5 and the Faroe Islands have fewer residents (almost none) than would be predicted by the  
6 relatively warm winter temperature. Iceland might hold a higher proportion of residents as it  
7 is far enough away from Britain (about 750 km to mainland Scotland) and Ireland for the sea-  
8 crossing to be a significant barrier, which may require considerable adaptation and  
9 preparation to cross (Gunnarsson & Tómasson 2011, Alves *et al.* 2012). In addition, some  
10 coastal areas, particularly in the west of Iceland, provide relatively mild oceanic climate and  
11 apparently ample food stocks to support high survival during most winters. For another  
12 resident mussel feeder, the Common eider *Somateria mollissima*, analyses of long-term  
13 datasets spanning over one hundred years show that adult mass mortality due to inclement  
14 weather happens only occasionally (Jónsson *et al.* 2009, Jónsson *et al.* 2013). Conversely, the  
15 Faroe Islands have less feeding habitat available (Bengtson & Bloch 1983) but even milder  
16 wintering conditions (Table 2). However, these islands are considerably closer to Britain (320  
17 km to mainland Scotland) and Ireland than Iceland, and the risks associated with this shorter  
18 sea-crossing may thus be lower.

19 Our targeted surveys of the Icelandic wintering population of Oystercatchers showed that  
20 the population is much larger than previously estimated. Contrary to other wintering  
21 locations in coastal W Europe the proportion of residents in Iceland is high, which may relate  
22 to the remoteness of Iceland and the relatively mild weather conditions for this latitude.  
23 These results provide an insight into factors regulating partial migration at higher latitudes  
24 and an invaluable platform into further studies of this population.

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1 Appendix 1. Detailed results of a census of Oystercatchers (Oy) *Haematopus ostralegus*,  
 2 wintering in Iceland and of other waders encountered during the survey: Purple sandpiper  
 3 (PS) *Calidris maritima*, Redshank (RS) *Tringa totanus*, Turnstone (TS) *Arenaria interpres* and  
 4 Curlew (Cu) *Numenius arquata*. Survey: G = ground survey, A = aerial survey. Areas which are  
 5 not covered by Christmas counts are in bold.

Region	Area	Coordinates	Survey	Oy	PS	RS	TS	Cu
E Ice	Norðfjörður	65°08',-13°41'	G	-	13	-	-	-
E Ice	Reyðarfjörður	65°01',-13°55'	G	-	16	7	2	-
E Ice	Fáskrúðsfjörður	64°55',-13°58'	G	-	-	9	-	-
E Ice	Berufjörður	64°45',-14°26'	G	14	15	10	-	-
E Ice	Hamarsfjörður	64°39',-14°25'	G	128	100	4	-	9
SE Ice	Horna-/Skarðsfjörður	64°16',-15°08'	G	437	606	5	4	25
SW Ice	Reykjanes	63°55',-22°20'	G	100	50	15	12	12
SW Ice	Vatnsleysuströnd	64°01',-22°13'	G	1	21	-	40	-
SW Ice	Hafnafjörður-Álftanes	64°05',-21°58'	G	56	2	2	-	-
SW Ice	Reykjavík-Garðabær	64°08',-21°58'	G	340	284	33	5	-
SW Ice	Kjalarnes	64°14',-21°49'	G	102	27	-	1	-
SW Ice	Hvalfjörður	64°22',-21°25'	G	505	-	-	3	-
SW Ice	Grunnafjörður	64°22',-21°56'	G	1229	30	-	-	23
SW Ice	Borgarfjörður	64°32',-21°56'	G	866	-	-	-	-
W Ice	<b>Álftanesvogur</b>	64°28',-22°11'	A	40	-	-	-	-
W Ice	<b>Straumfjörður</b>	64°28',-22°13'	G	90	540	-	1	-
W Ice	<b>Álftarós</b>	64°33',-22°16'	A	340	28	3	-	-
W Ice	<b>Traðir-Helgrindur</b>	64°35',-22°21'	G	42	-	-	-	-
W Ice	<b>Akrarós</b>	64°39',-22°21'	G	1170	660	-	2	-
W Ice	<b>Kaldarós</b>	64°44',-22°21'	G	870	-	-	-	-
W Ice	<b>Stórahraunsnes</b>	64°47',-22°26'	G	32	-	-	-	-
W Ice	<b>Syðra-Skógarnes</b>	64°46',-22°34'	G	1298	280	-	2	-
W Ice	Snæfellsnes North	64°58',-23°04'	G	1576	573	7	23	-
W Ice	<b>Hvammfjörður</b>	65°05',-21°47'	A	420	107	-	-	-
NW Ice	<b>Breiðafjörður North</b>	65°35',-22°30'	A/G	1012	548	-	-	-
NW Ice	<b>Breiðafjörður, Islands</b>	65°23',-22°46'	A	389	1135	-	1	-
NW Ice	Patreksfjörður	65°33',-23°56'	G	-	60	-	-	-
NW Ice	Tálknafjörður	65°37',-23°49'	G	-	46	-	-	-
NW Ice	Dýrafjörður	65°52',-23°26'	G	26	60	-	-	-
NW Ice	Skutulsfjörður	66°03',-23°09'	G	34	-	10	-	-
NW Ice	Steingrímsfjörður	65°41',-21°41'	G	2	517	-	-	-
NW Ice	Kollafjörður	65°33',-21°28'	G	2	98	-	-	-
NW Ice	Bitrufjörður	65°27',-21°24'	G	-	121	-	-	-
NW Ice	<b>Hrútafjörður</b>	65°14',-21°05'	G	20	10	-	-	-
N Ice	Kópasker	66°18',-16°26'	G	-	37	-	-	-
Total				11141	5984	105	96	69



- 1 **Table 1.** Number of Icelandic wintering Oystercatchers recorded in different regions during the 2017  
2 census (28 Jan - 3 Feb). See Figure 1 for regions.

Region	Number	% of total
<b>SW</b>	3,199	28,7
<b>W</b>	5,878	52.8
<b>NW</b>	1,485	13.3
<b>N</b>	0	0
<b>E</b>	142	1.3
<b>SE</b>	437	3.9
<b>S</b>	0	0
<b>total</b>	<b>11,141</b>	<b>100</b>

3

1 **Table 2.** Estimated percent of resident Oystercatchers in relation to breeding latitude ordered from  
 2 north to south and mean January temperatures (<http://www.yr.no>) across the range.

Country	Place	N°	Mean temp in January (C°)	Estimated residents	Source
North Norway	Tromsø	69.6	-4.4	None	(Bakken <i>et al.</i> 2003)
Iceland	Reykjavík	64.4	-0.6	~ 30%	(Skarphéðinsson <i>et al.</i> 2016)
Mid Norway	Verdal	63.8	-4.5	~ none	(Bakken <i>et al.</i> 2003)
Faroe islands	Tórshavn	62.0	3.4	~ none	(Hammer <i>et al.</i> 2014)
South Norway	Kristiansand	58.2	-1.7	~ none	(Bakken <i>et al.</i> 2003)
Sweden	Göteborg	57.7	-0.9	~ none	(Duriez <i>et al.</i> 2012)
Denmark	Esbjerg	55.4	0.8	Mostly residents	(Duriez <i>et al.</i> 2012)
Germany	Schleswig-Holstein	54.5	0.9	Mostly residents	(Duriez <i>et al.</i> 2012)
Netherlands	Texel	53.0	3.2	Mostly residents	(Duriez <i>et al.</i> 2012)
Britain	The Wash	52.9	3.6	Mostly residents	(Wernham 2002)

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1 **Figure 1.** Map of Iceland showing regions and names with numbers of wintering Oystercatchers  
2 shown as ranges recorded at each location during this survey.

3

4 **Figure 2.** Total number of wintering Oystercatchers counted in Iceland during the Christmas  
5 counts since 2002 (black bars) and in the present survey in 2017 (striped bar).