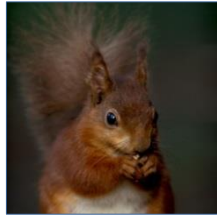


NATIONAL PARKS AND WILDLIFE SERVICE

AERIAL THERMAL-IMAGING
SURVEY OF SEALS IN IRELAND,
2017 TO 2018

Chris Morris & Callan Duck



An Roinn Cultúir,
Oidhreachta agus Gaeltachta
Department of Culture,
Heritage and the Gaeltacht

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Front cover, small photographs from top row:

Coastal heath, Howth Head, Co. Dublin, Maurice Eakin; **Red Squirrel** *Sciurus vulgaris*, Eddie Dunne, NPWS Image Library; **Marsh Fritillary** *Euphydryas aurinia*, Brian Nelson; **Puffin** *Fratercula arctica*, Mike Brown, NPWS Image Library; **Long Range and Upper Lake**, Killarney National Park, NPWS Image Library; **Limestone pavement**, Bricklieve Mountains, Co. Sligo, Andy Bleasdale; **Meadow Saffron** *Colchicum autumnale*, Lorcan Scott; **Barn Owl** *Tyto alba*, Mike Brown, NPWS Image Library; **A deep water fly trap anemone** *Phelliactis* sp., Yvonne Leahy; **Violet Crystalwort** *Riccia huebeneriana*, Robert Thompson

Main photograph:

Seals hauled out on sandy beach, Co. Wexford, C. Morris, SMRU.



Aerial thermal-imaging survey of seals in Ireland, 2017 to 2018

Chris Morris & Callan Duck

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Executive Summary

In August of 2017 and 2018, the Sea Mammal Research Unit (SMRU) of the University of St Andrews carried out an aerial thermal-imaging survey of Harbour Seal (*Phoca vitulina vitulina*) and Grey Seal (*Halichoerus grypus*) numbers and distribution around Ireland. The survey was commissioned by the National Parks and Wildlife Service (NPWS), Department of Culture, Heritage and the Gaeltacht (DCHG) and it was the third such nationwide survey of seals in Ireland in summer. Previous thermal-imaging surveys were carried out in 2003 and in 2011/2012.

In the 2017/2018 survey, 4,007 Harbour Seals were counted, compared with 3,489 counted in 2011/2012 (Duck & Morris, 2012; 2013) and 2,955 counted in 2003 (Cronin *et al.*, 2004; 2007). The Irish coast was divided into five regions, East, South-east, South-west, West and North. The greatest proportion of Harbour Seals was found in the West region in all three surveys (41% in 2017/2018, 43% in 2011/2012 and 32% in 2003). The North and South-west regions had similar, but lower, proportions to previous surveys (27% and 28% respectively in 2017/2018; 25% and 28% in 2011/2012; 31% and 32% in 2003). The smallest proportions were in the East and South-east (3% and 1% in 2017/2018; 3% and 2% in 2011/2012; 4% and 1% in 2003).

In 2017/2018, 3,698 Grey Seals were counted in Ireland compared with 2,964 counted in 2011/2012 and 1,309 counted in 2003. The Grey Seal count in 2017/2018 was 25% higher than the 2011/2012 count and almost three times higher than the 2003 count. The numbers of Grey Seals in the five Irish regions used to describe distribution in this report were not as consistent across the three surveys as were Harbour Seal numbers. In all three surveys, the greatest proportions of Grey Seals were counted in the west of Ireland (32% in 2017/2018; 40% in 2011/2012; 28% in 2003). In the east, south-east and south-west the Grey Seal count was substantially higher in 2017/2018 than in 2011/2012. In the west and north of Ireland the 2017/2018 Grey Seal count was slightly lower than in 2011/2012.

The survey results suggest that the populations of both species are either stable or increasing in all regions of Ireland. The 2017/2018 survey produced the highest total count of the three nationwide summer surveys for both species. The 2017/2018 survey found that there is currently only very little spatial overlap between major haul-out aggregations of Harbour Seals and Grey Seals.

Acknowledgements

These surveys were commissioned by the National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht in 2017. We would like to thank PDG Aviation Services, including pilots Douglas Gray (2017) and Tom Kidd (2018) and refueller Phil Shewan (both years), for helping us to complete the aerial surveys in 2017 and 2018. Huge thanks to Dr Oliver Ó Cadhla of DCHG for his good humour and his logistical support, especially in finding appropriate accommodation at short notice. We are also grateful to Dr Ferdia Marnell for his support in management and administration of the survey contract

1 Introduction

Harbour Seals and Grey Seals are included in Annex II of the European Union Council Directive 92/43/EEC (1992), commonly known as the Habitats Directive. The Directive's aim is to encourage the maintenance or restoration of biodiversity through the conservation of natural habitats and of wild fauna and flora in the territories of European Union member states. Member states are required to report on the conservation status of such protected species every six years. The surveys described in this report provide part of the information on numbers and distribution of Harbour Seals and Grey Seals in Ireland that are required for this reporting, complementing existing monitoring programs for Harbour Seal (e.g. NPWS, 2010; 2012; Rakka & Minto, 2015) and Grey Seal (e.g. Ó Cadhla & Strong, 2007; Ó Cadhla *et al.*, 2007; Ó Cadhla *et al.*, 2013).

In Ireland and the UK, Harbour Seal population surveys are carried out during their annual moulting period which occurs between July and September (Thompson & Rothery, 1987). Grey Seals hauled ashore are also counted during these surveys, providing additional information on their summer distribution although Grey Seal numbers can be highly variable from day to day during the summer months (SMRU unpublished data; personal observations).

In August 2017 and August 2018, SMRU carried out a comprehensive aerial survey of Harbour Seals and Grey Seals which together comprised the entire coastline and offshore islands of Ireland. In August 2017, the coast from Lough Foyle, Co. Donegal, to Castlemaine Harbour, Co. Kerry, and the east coast from Mizen Head, Co. Wicklow, to Carlingford Lough, Co. Louth, was surveyed. In August 2018, the remaining south and south-east coasts, from Mizen Head to Castlemaine Harbour, were completed. This is the third complete nationwide survey carried out for DCHG by SMRU, following on from previous thermal-imaging surveys carried out in 2003 (Cronin *et al.*, 2004; 2007) and in 2011/2012 (Duck & Morris, 2012; 2013). In August 2018, SMRU's survey coverage was extended into Northern Ireland as part of a separate contract to the Department of Agriculture, Environment and Rural Affairs of Northern Ireland.

2 Methods

The Sea Mammal Research Unit carried out surveys of Harbour seals by helicopter using a multi-camera gyro-stabilised gimbal fitted externally beneath the cockpit. The gimbal contains a laser range-finder (Vectronix LRF 5020), a colour High Definition digital video camera (Sony FCB-EV7500), a mid-wavelength (3-5 μ m) thermal-imaging video camera (FLIR μ Core-280) and a digital single-lens reflex camera (Nikon D810) equipped with a 300mm telephoto lens (AF-S Nikkor 300mm f4 PF ED VR).

Thermal-imaging surveys follow the standard SMRU Harbour Seal survey protocol:

- Surveys were restricted to the peak Harbour Seal moult season, in August and early September.
- Surveys were restricted to within two hours either side of low tides occurring between 12:00 and 19:30 local time.
- There was no surveying on days with moderate, heavy or prolonged rainfall.
- All intertidal areas were searched using the thermal-image video display.
- High-resolution digital photographs were taken of all groups of seals where possible.
- The colour and thermal-image videos were recorded along with the digital still images onto two Microsoft Surface Pro 4 computers.
- The mapping system (TrakkaMap) recorded detailed flight tracks as well as the target centre coordinates for each photo and video frame.
- Complete flight tracks were recorded on two Garmin Foretrex 401 GPS units.

A screenshot of the mapping software display, showing colour video, thermal-image video and the live mapping system is shown in Figure 1. A close-up from the high resolution photograph of the same group of seals is shown in Figure 2.

Video and still images were reviewed at SMRU's base in St Andrews. Viewed in conjunction with a detailed digital map and satellite imagery of Ireland (<https://maps.biodiversityireland.ie/Map>), the recorded data enabled accurate positioning of all seal sightings. All groups of seals were accurately identified, counted and located in a geographic information system (Manifold System 8.0 Ultimate Edition GIS). Maps were produced using the same software. The coastlines were drawn based on Ordnance Survey Ireland shapefiles provided by DCHG.

For the purposes of data collection and reporting, the coastline of Ireland was divided into five nominated regions: East, South-east, South-west, West and North (Figure 3, Table 1). These five regions were further subdivided into 29 smaller coastal areas. These regions and areas simplify the examination of seal distribution and abundance over time. Please note that the regions and areas used in this report are not the same as the regions and subregions used in the reports of the 2011/2012 survey (Duck & Morris, 2012; 2013).

On the final survey day in August 2017, a section of the east coast could not be surveyed as aircraft were not permitted to enter the Gormanston Danger Area due to military activity (Figure 4). This section of coast was surveyed six days later, on 6 September 2017, by DCHG (O. Ó Cadhla) using hand-held oblique photography from a fixed-wing aircraft. The results from this short aerial survey are incorporated into this report.

When processing the data from the 2017 survey we noticed that we inadvertently omitted to survey the islands of Inishbiggle and Annagh Island, to the east of Achill Island, Co. Mayo, on 25 August 2017 (Figure 5). On these two islands, 35 Harbour Seals were counted in 2003, with 39 Harbour Seals and three Grey Seals counted there in 2011.



Figure 1 Screenshot of the live mapping software display with colour and thermal image video, showing a group of seals hauled out ashore in the Croagh River estuary in Co. Cork on 28 August 2018.



Figure 2 Close-up from a high-resolution digital still image of the group of five Harbour Seals ashore in the Croagh River estuary on 28 August 2018.

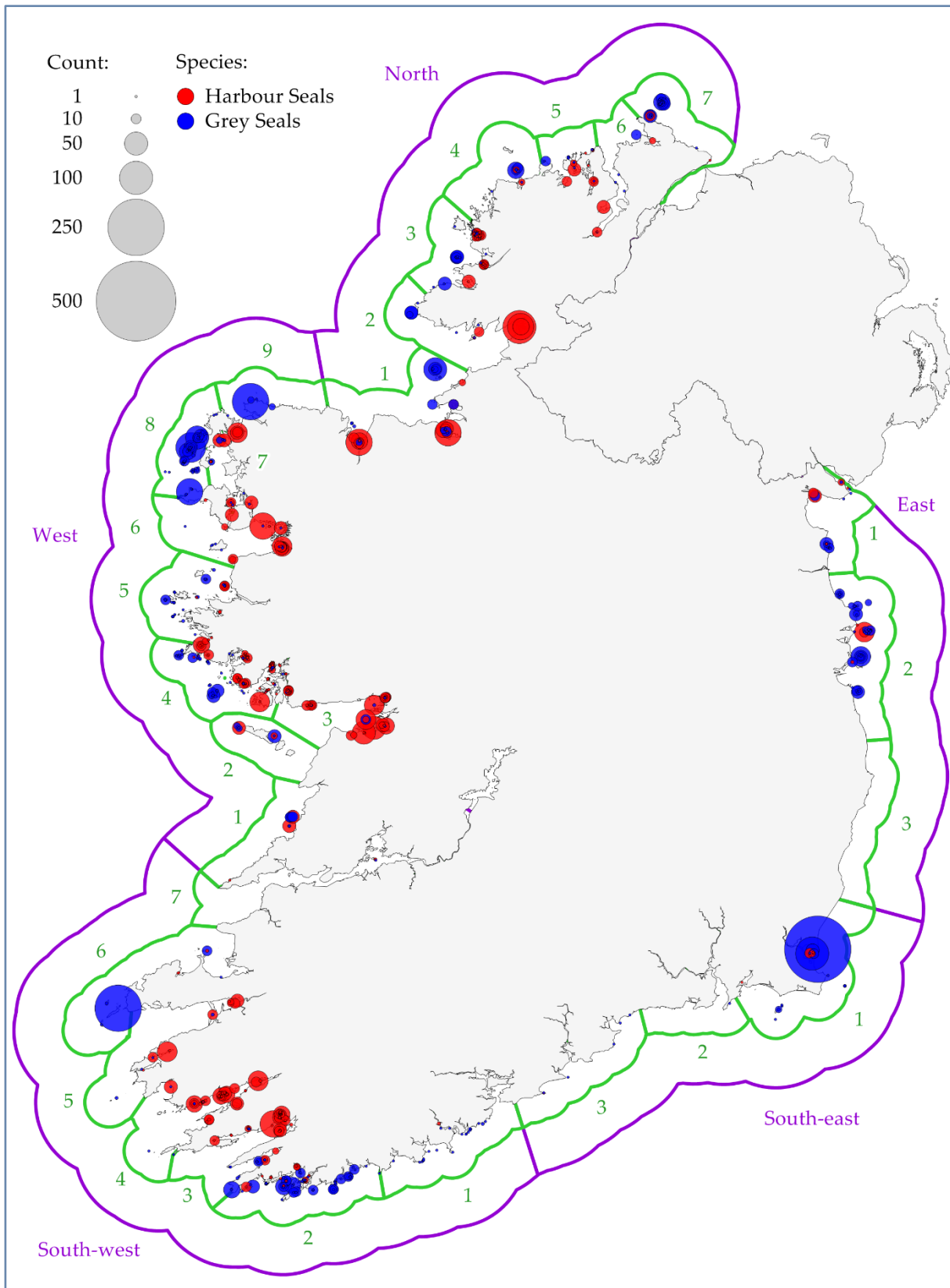


Figure 3 Numbers and distribution of Harbour Seals (red circles) and Grey Seals (blue circles) in Ireland in August 2017 and August 2018. The displayed symbol size represents the recorded group size with count guides given in the Legend (top left). Numbers of seals counted in each region and area are given in Table 2.

Table 1 Counts of Harbour Seals and Grey Seals in Ireland from surveys in 2003, in 2011/2012 and in 2017/2018. Regions and areas are outlined in Figure 6 together with the actual distribution of seal haul-out groups counted in 2017/2018.

Region	Area	Harbour Seals			Grey Seals		
		2003	2011/12	2017/18	2003	2011/12	2017/18
East	1	89	61	61	39	48	83
	2	34	29	70	211	172	335
	3	0	0	0	12	3	0
South-east	1	17	49	33	189	239	550
	2	0	0	0	0	0	1
	3	1	4	1	0	4	5
South-west	1	10	0	5	13	28	46
	2	52	88	115	58	198	411
	3	422	363	393	10	55	88
	4	399	345	441	8	11	12
	5	36	90	131	2	11	12
	6	0	1	11	45	150	222
	7	8	1	4	2	0	1
West	1	17	27	48	11	64	55
	2	39	53	41	11	73	53
	3	396	501	570	7	11	32
	4	152	358	349	58	238	192
	5	36	106	134	61	100	107
	6	124	282	311	4	17	21
	7	144	134	90 *	21	49	38
	8	0	0	0	176	304	531
	9	47	34	87	22	343	154
North	1	377	309	366	134	211	184
	2	150	204	218	27	87	59
	3	327	338	374	90	219	169
	4	12	19	18	27	45	77
	5	57	73	76	7	7	32
	6	5	20	49	0	3	23
	7	4	0	11	64	274	205
East		123	90	131	262	223	418
South-east		18	53	34	189	243	556
South-west		927	888	1,100	138	453	792
West		955	1,495	1,630	371	1,199	1,183
North		932	963	1,112	349	846	749
Ireland		2,955	3,489	4,007	1,309	2,964	3,698

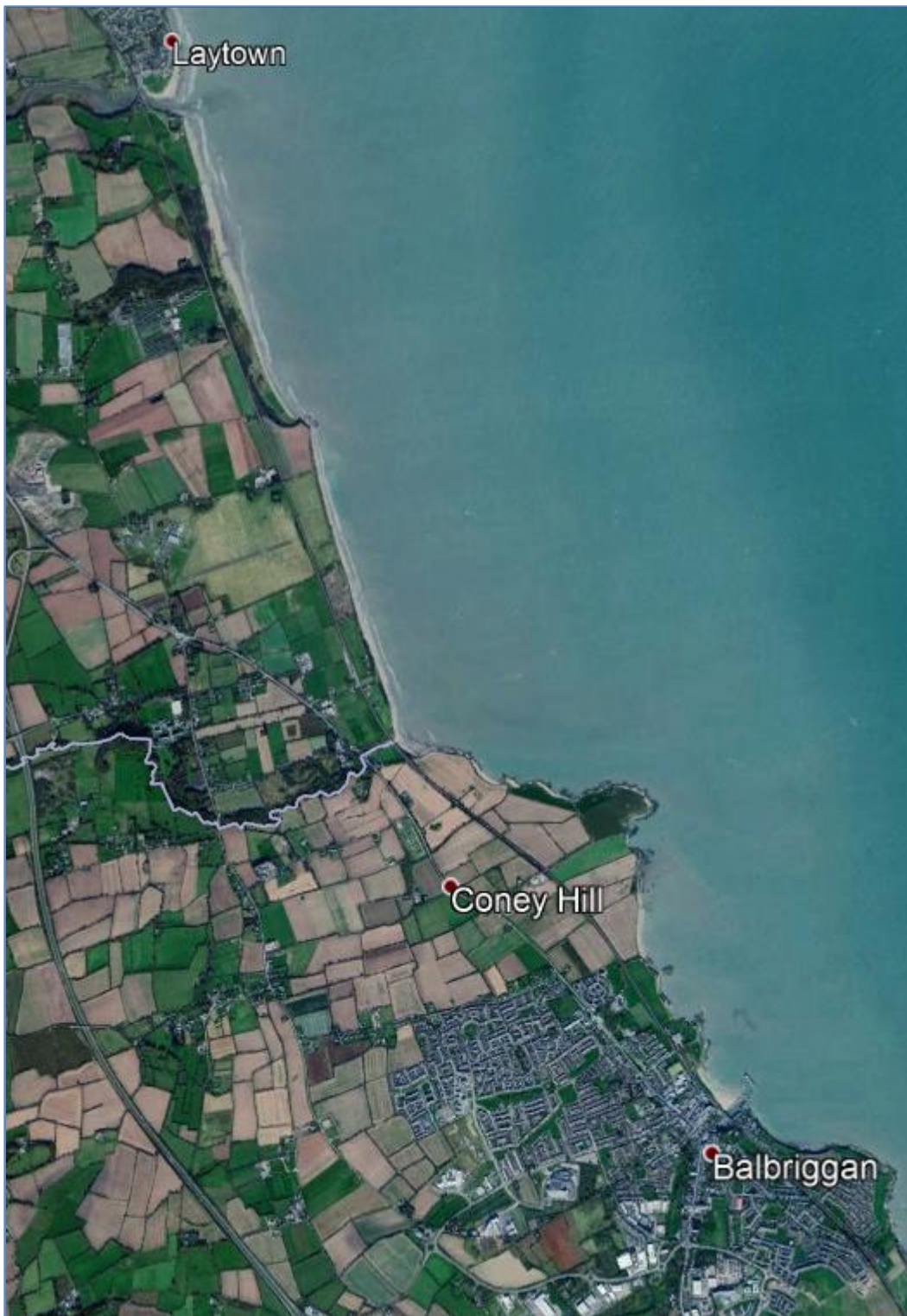


Figure 4 The coast between Balbriggan, Co. Dublin, and Laytown, Co. Meath, was not surveyed by helicopter with a thermal-imaging camera system, since aircraft entry into the Gormanston Danger Area was prohibited on 30 Aug 2017. This section of coast was surveyed on 6 Sept 2017 by DCHG using a fixed-wing aircraft and oblique stills photography.

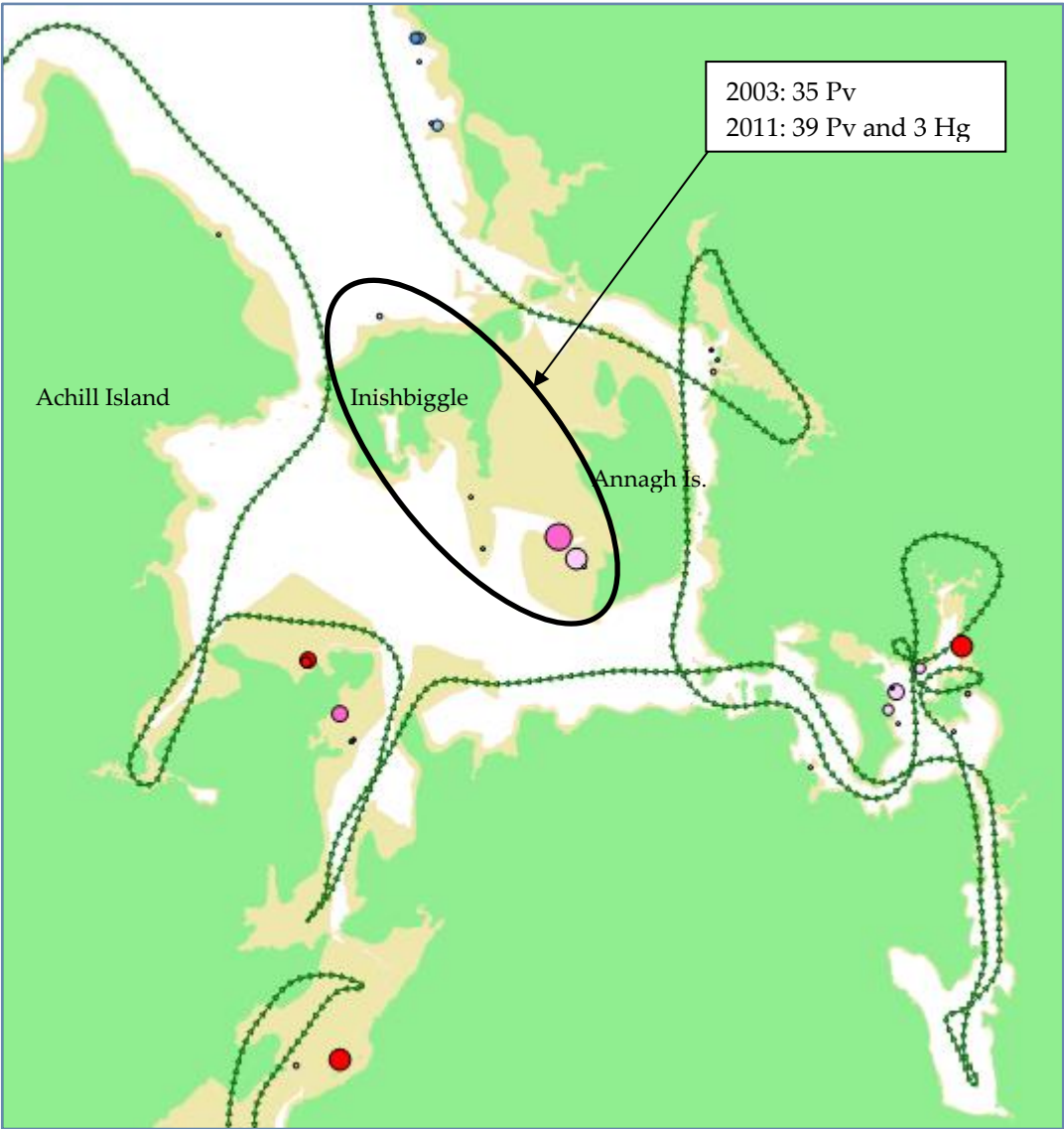


Figure 5 Survey track (green line) from 25 August 2017 around Inishbiggle and Annagh Island off the east side of Achill Island, Co. Mayo. The track shows that these two islands were, in error, not surveyed. Pink circles represent Harbour Seal (Pv) sightings from previous surveys in 2003 (pale pink) and 2011 (dark pink). Light blue circles represent previous Grey Seal (Hg) records. Sightings from the 2017/2018 survey are shown in red (Pv) and dark blue (Hg).

3 Results & Discussion

The extent of coastline surveyed each day in August 2017 and August 2018 is shown in Figure 6. A summary daily diary is presented in Table 1, including days when surveying was not possible and the reasons why.

The distribution of the actual haul-out sites of Harbour Seals and Grey Seals counted during the 2017/2018 survey is shown in Figure 3. There was little overlap between major Harbour Seal and Grey Seal haul-out areas. Whereas most Harbour Seal aggregations were found in more sheltered coastal areas, large groups of Grey Seals were generally located on more exposed shorelines, rocky skerries and offshore islands.

A total of 4,007 Harbour Seals were counted in 2017/2018, compared with 3,489 counted in 2011/2012 and 2,955 counted in 2003 (Table 1). A total of 3,698 Grey Seals were counted in 2017/2018 compared with 2,964 counted in 2011/2012 and 1,309 counted in 2003 (Table 1). The 2017/2018 national total is the highest on record for both species in the summer.

It is important to note that changes in seal haul-out behaviour between survey years (e.g. weather-related influences on the numbers recorded ashore) are not accounted for in the methodology however, and there is an assumption of relative consistency in this regard, i.e. no significant role played by haul-out behaviour in the numbers observed.

Whereas Harbour Seal counts suggest that this species' status is relatively stable in Ireland, based on these summer data, Grey Seal numbers are increasing at a significantly higher rate. Even though the number of Harbour Seals counted at haul-out sites was higher than the number of Grey Seals counted for all three national surveys, a difference in species' haul-out behaviour during the Harbour Seal moult season means that there are significantly more Grey Seals in Ireland overall. Based on tagging data collected in Scotland, Lonergan *et al.* (2013) estimated that 72% (95% Confidence Intervals: 54-88%) of Harbour Seals are hauled out during the moult survey window. Using similar methods, Russell *et al.* (2016) calculated that 23.9% (95% CIs: 19.2-28.6%) of Grey Seals are hauled out during the same period. These estimates of the proportions of populations available ashore for counting suggest that there are currently in the order of 2.5 to 3.5 times more Grey Seals than Harbour Seals in Ireland. This would accord with Grey Seal breeding population figures collected in Ireland since 2005 (Ó Cadhla *et al.*, 2007; 2013).

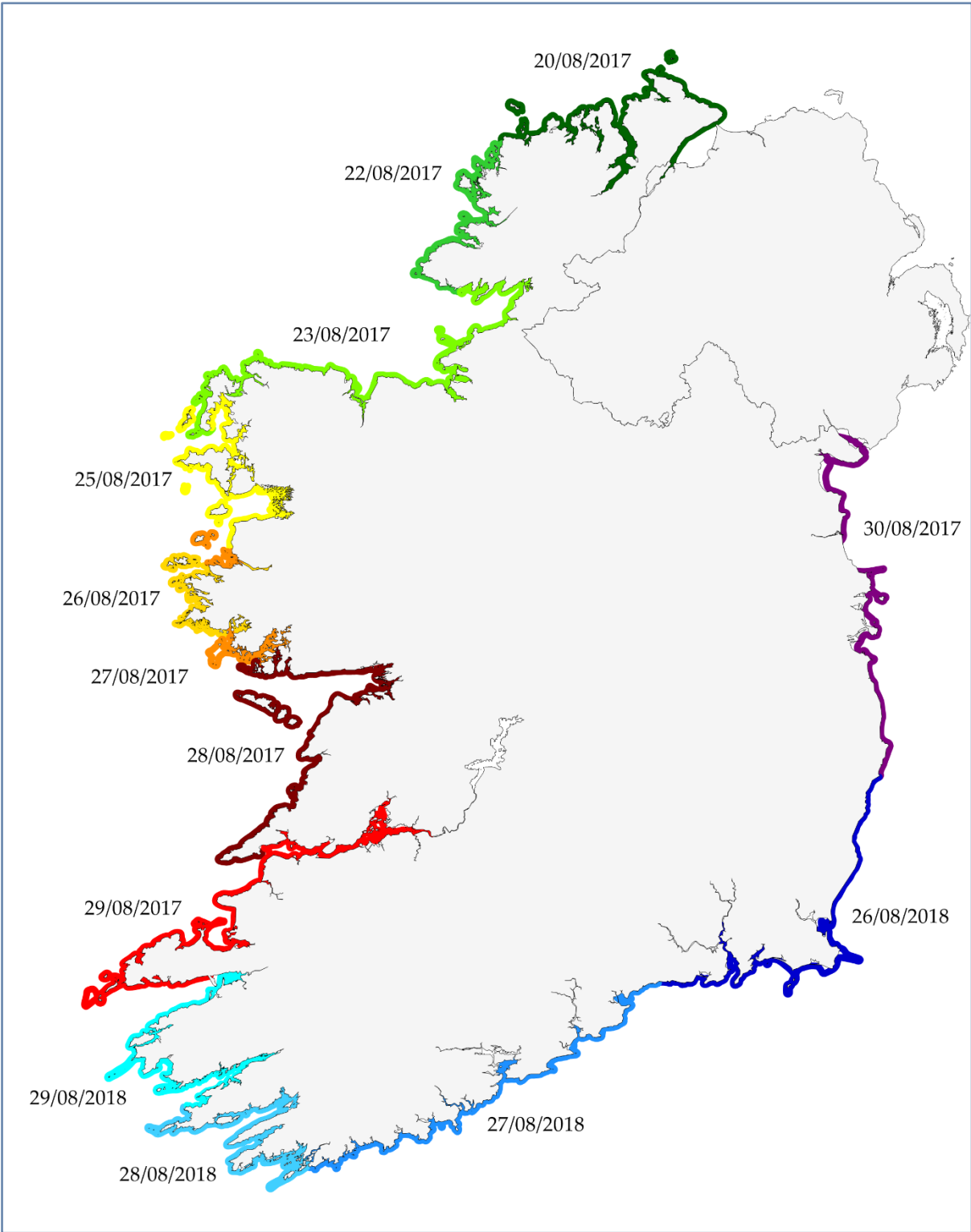


Figure 6 The coastline of Ireland covered by SMRU during 13 survey days in August 2017 and August 2018, shown by the helicopter flight path and survey dates. The asterisk indicates the section of coast within the Danger Area D1 at Gormanston (see Figure 4). This danger area was active on 30 August 2017 and entry was denied. This missing segment of coast was surveyed by DCHG staff on 6 September 2017 using oblique stills photography from a Cessna 172 fixed-wing aircraft.

Table 2 Daily schedule for 2017 and 2018 thermal-image surveys of seals in Ireland.

Date	Coast surveyed	Conditions
August 2017		
Sat 19	Load survey equipment into helicopter in Cumbernauld. Set off to survey east coast from Wexford to Carlingford Lough. Camera connection issues on route necessitated returning to Cumbernauld. Positioned to Donegal town later in day	Scattered low cloud, occasional showers
Sun 20	Inishsirrier Island northwards to Mulroy Bay; refuelled at Cranford; Mulroy Bay to Derry/head of Lough Foyle.	Good, overcast, dry little wind
Mon 21	No survey due to weather.	Low cloud, mist, rain
Tues 22	Inishsirrier to Muckcross Head. Heavy rain curtailed second half of survey.	Good until Donegal Bay, then persistent rain
Wed 23	Muckcross Head to Aughris Head for refuel; Aughris Head to Blacksod.	Good, some sun, no wind
Thurs 24	No survey due to weather.	Low cloud, drizzle all day
Fri 25	Inishkeas to Mallaranny; refuelled; Mallaranny to mouth of Killary Harbour.	Overcast; low cloud and mist cleared before survey start
Sat 26	Roundstone Bay to Clifden; refuelled Abbeyglenn Hotel; Clifden to Rinivyle Point including Inishbofin.	Very sunny; hot rocks reduced thermal contrast
Sun 27	Rinivyle Point to Killary Harbour including Inishturk, Roundstone Bay to Cionlai (Kilkieran Bay); refuelled Lettermullan; Corcaigh (Kilkieran Bay) to Daiginis (Kilkieran Bay).	Good, overcast; light rain later in survey
Mon 28	Daiginis (Kilkieran Bay) to Kinvarra; refuelled Crushoa Pier; Kinvarra to Carrigaholt, including the Aran Islands.	Overcast; rain and mist cleared before survey start
Tues 29	Insh Beach (Dingle Bay) to Beal Point, including the Blasket Islands, Carrigaholt to Rusheen Point (Knock, lower Shannon Estuary); refuelled Rusheen Point; Rusheen Point to Beal Point (upper Shannon Estuary).	Good, mostly overcast
Wed 30	Mizen Head, by Arklow, to Carlingford Lough (east coast), excluding the coast inside the Gormanston Danger Area; refuel Ravensdale; return to Cumbernauld.	Good, mostly sunny
Wed 6 Sep	<i>The east coast within the Gormanston Danger Area was surveyed by O. Ó Cadhla, DCHG, from a fixed-wing aircraft using oblique, hand-held photography (see Figure 1).</i>	
August 2018		
Sat 25	Position from Carlingford Lough to Rochestown, Wellingtonbridge after survey of Northern Ireland.	
Sun 26	Bunmahon Bay to Mizzen Head, by Arklow; refuel Rochestown.	Good, overcast
Mon 27	Bunmahon Bay to Skibbereen; refuel Ballycotton.	Good, mixed overcast, sunny
Tues 28	Skibbereen to Cod's Head, Kenmare River; refuel Dooneen.	Sunny, rocks quite hot, good
Wed 29	Cod's Head to Castlemaine Harbour Dingle Bay, return to Cumbernauld; refuel Rossbehy Dunes & Enniskillen.	Good, occasional sun

3.1 Harbour Seals

The 2017/2018 total Harbour Seal count of 4,007 was 14.8% higher than the 2011/2012 total count of 3,489 (Figure 7), equivalent to an average annual increase of 2.3% over six years. For comparison, the 2011/2012 total Harbour Seal count was 18.1% higher than the 2003 count of 2,955 (Figure 7), equivalent to an average annual increase of 1.9% over nine years.

Among the five coastal regions of Ireland (Figure 3) Harbour Seals were quite sparse in the East and South-east and more numerous in the South-west, West and North regions of Ireland (Figure 7, Figure 8). These three regions contributed approximately 95% to the total Harbour Seal count in all three nationwide surveys (Figure 8). In four of the five regions the number of Harbour Seals counted was higher in 2017/2018 compared to either previous survey (Table 1). The 2018 Harbour Seal count for the South-east region of Ireland (Wexford to east Cork) of 34 was slightly lower than the 2012 count of 53 (Table 1).

Whereas the overall difference in the national Harbour Seal count between 2003 and 2011/2012 was mainly due to changes in the West region from Galway Bay to Clew Bay (Areas 3-6 combined: +539, equivalent to a 6.5% average annual increase), the overall change shown in the most recent count is due to slightly higher numbers found in all three main Harbour Seal regions (South-west, West and North combined: +496, equivalent to a 2.3% average annual increase).

Figure 9 shows the distribution of Harbour Seals in 2017/2018 aggregated by 10km grid squares. The relative density of Harbour Seals across Ireland is more obvious at this scale than in Figure 3, as numbers at closely adjacent sites are aggregated rather than superimposed on top of each other. The difference can be clearly seen at Dunglow, in western Co. Donegal, where a large number of overlapping small haul-out sites (Figure 3) combine to deliver a large overall total for the area (Figure 9). For comparison, Figure 10 shows the 10km grid distribution of Harbour Seals in 2011/2012 while Figure 11 shows their 10km grid distribution in 2003.

Figure 12 shows the locations of 13 Special Areas of Conservation (SAC) for Harbour Seals in Ireland, including the site code for each SAC. Table 3 shows the number of Harbour Seals counted during SMRU's aerial thermal-imaging surveys in each of these SACs. Interestingly, the proportion of the total count found within the 13 SACs has remained remarkably constant over the three surveys: 65.7% in 2003, 64.3% in 2011/2012 and 63.2% in 2017/2018 (Table 3).

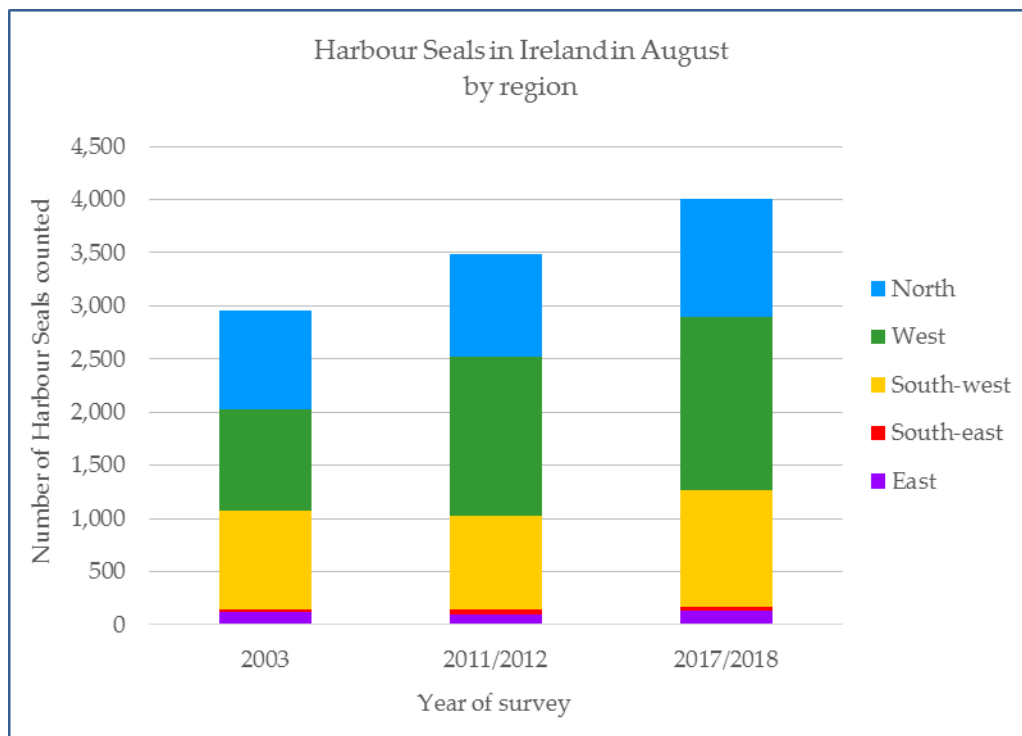


Figure 7 A comparison of the counts of Harbour Seals from three surveys in five coastal regions of Ireland. The region boundaries are shown in Figure 3.

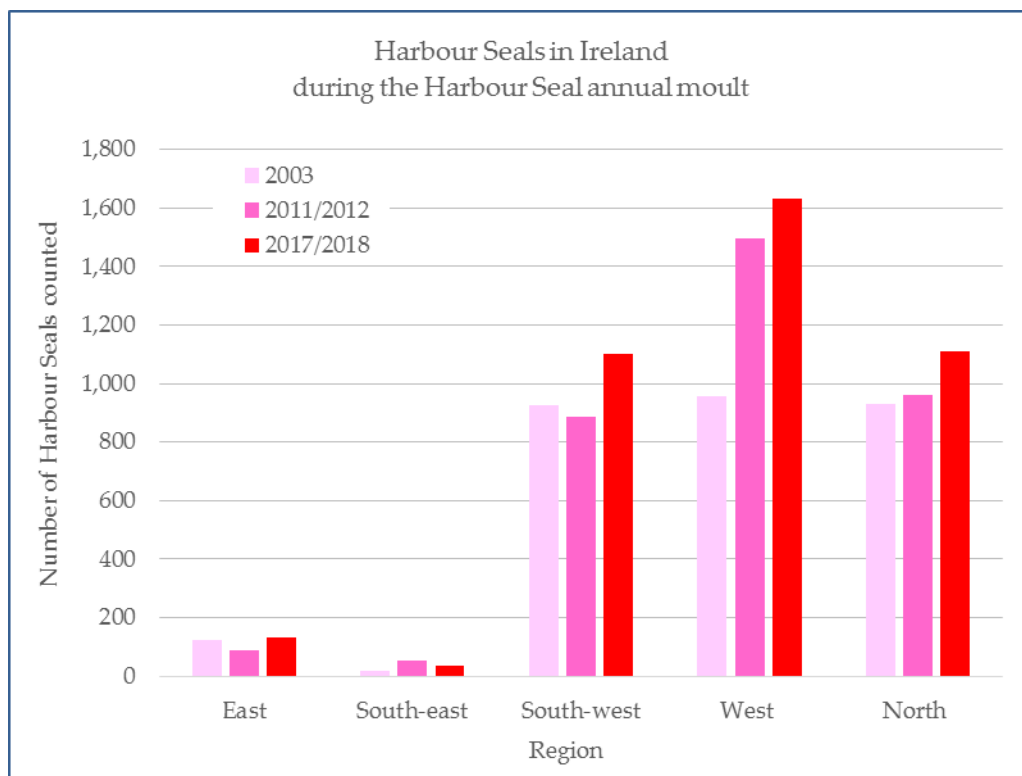


Figure 8 A comparison of the number of Harbour Seals counted in coastal regions of Ireland in 2003, 2011/2012 and 2017/ 2018. The region boundaries are shown in Figure 3.

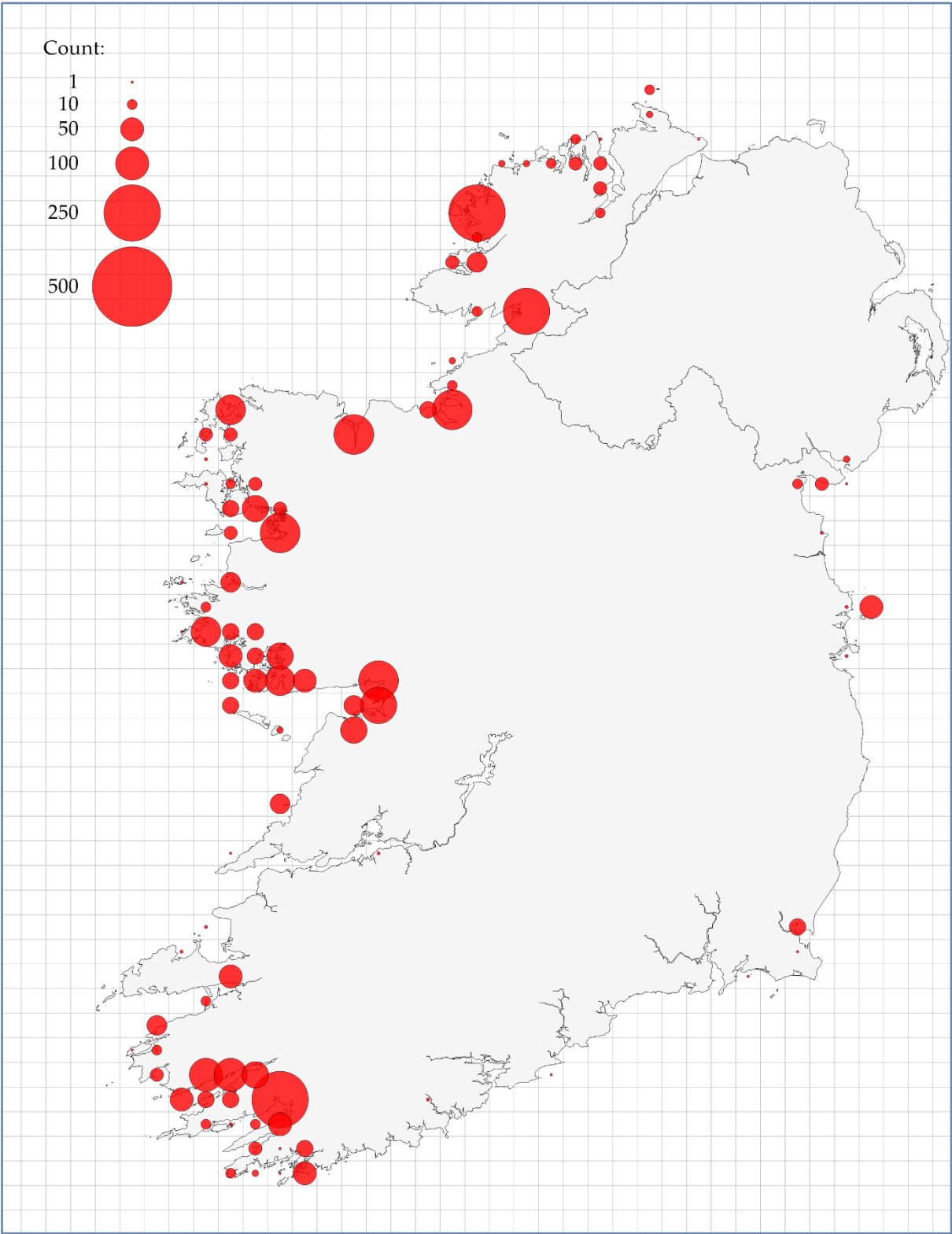


Figure 9 Distribution of Harbour Seals in Ireland from aerial surveys carried out in 2017/2018. These are the same data as in Figure 3 but counts are aggregated by 10km grid squares. Symbol size is in proportion to numbers counted with size guides given in the Legend (top left). The dotted black circle lying east of Achill Island in the west of Ireland indicates the number of Harbour Seals for this grid cell if adding an estimated 30-40 individuals to the 2017/2018 count to accommodate the segment of coastline missed in 2017 (see Figure 5).

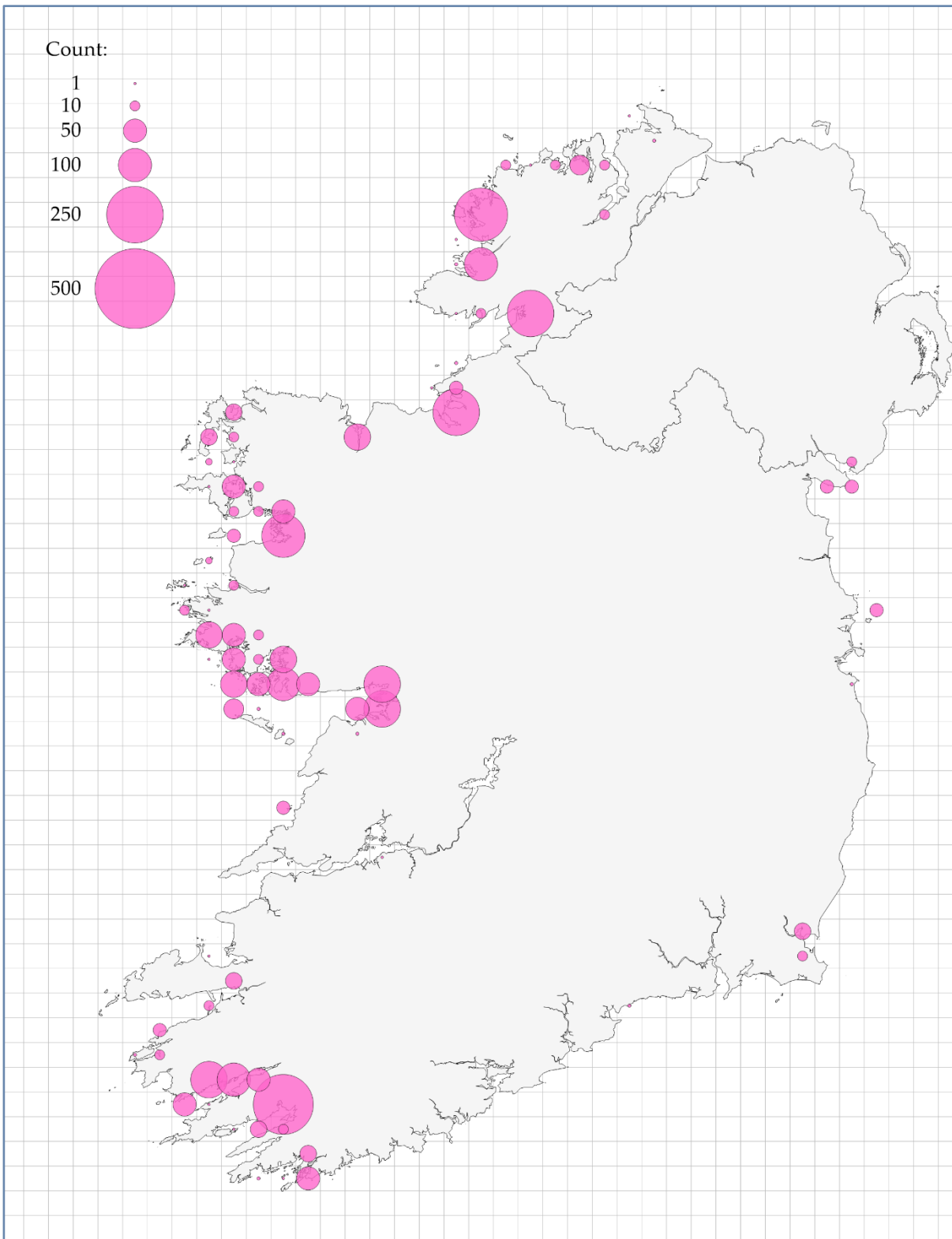


Figure 10 Distribution of Harbour Seals in Ireland from aerial surveys carried out in 2011/2012. Counts are aggregated by 10km grid squares. Symbol size is in proportion to numbers counted with size guides given in the Legend (top left).

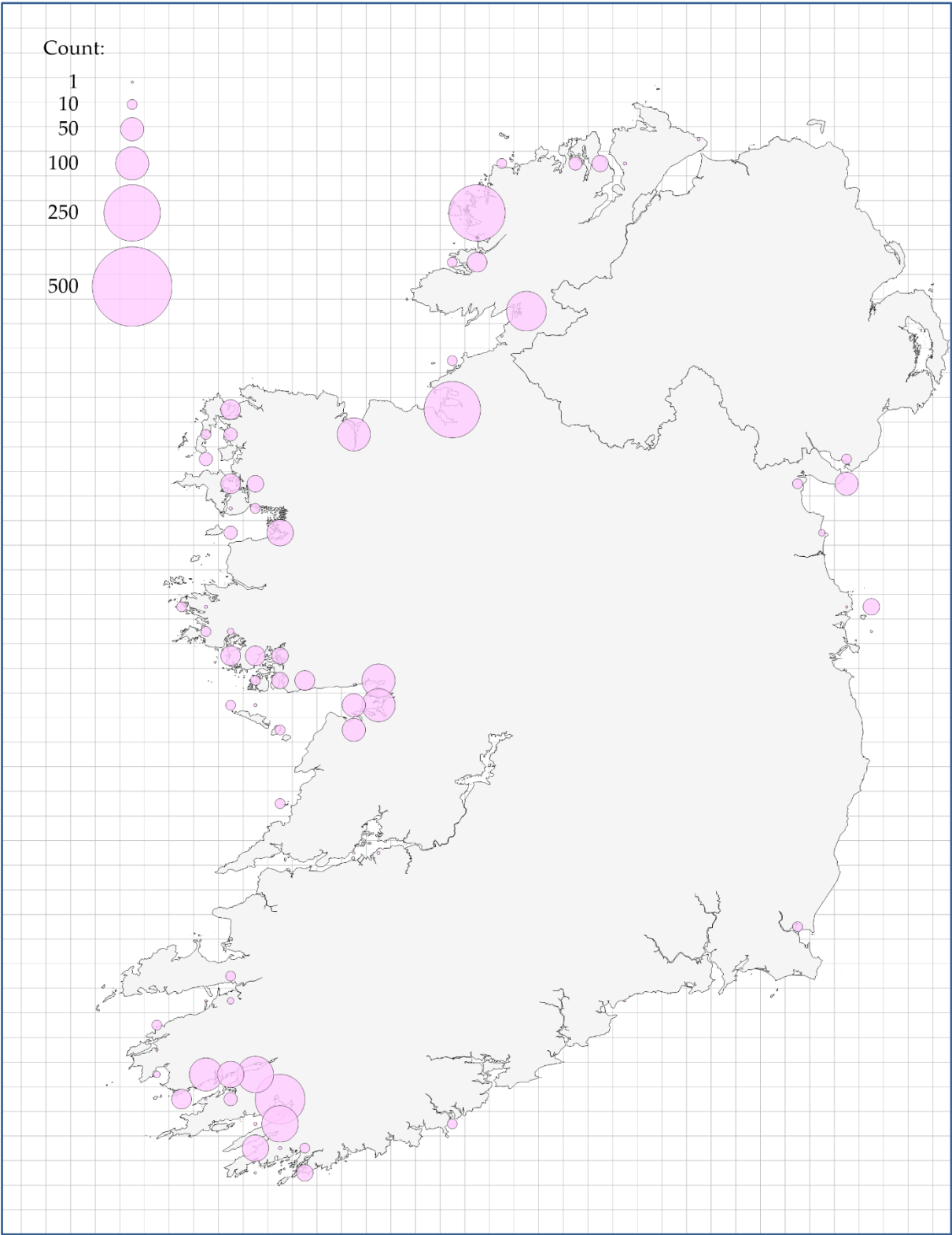


Figure 11 Distribution of Harbour Seals in Ireland from aerial surveys carried out in August 2003. Counts are aggregated by 10km grid squares. Symbol size is in proportion to numbers counted with size guides given in the Legend (top left).

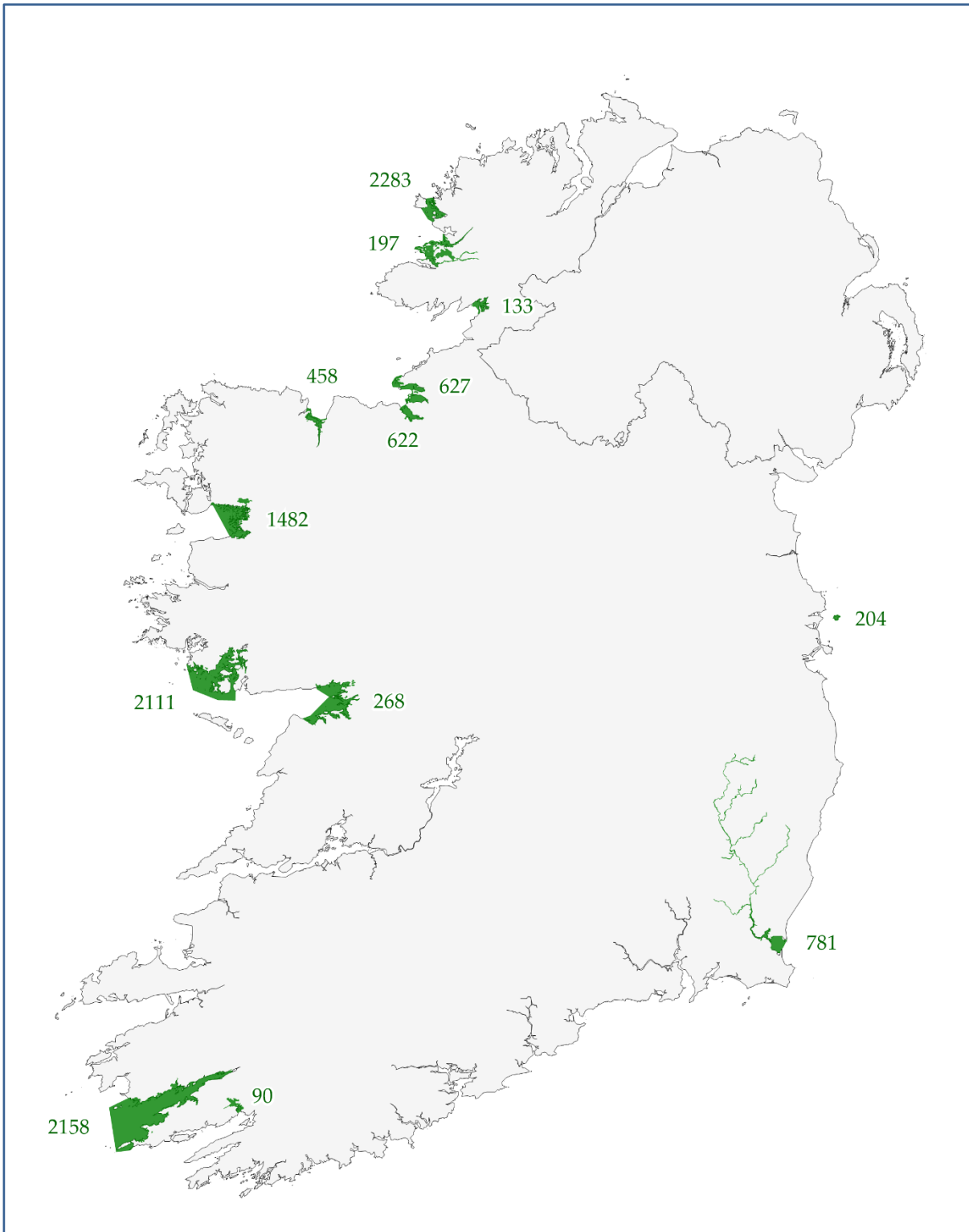


Figure 12 Special Areas of Conservation (SAC) for Harbour Seals in Ireland, with corresponding site codes. See Table 3 for SAC names and Harbour Seal counts.

Table 3 Numbers of Harbour Seals counted in Special Areas of Conservation (SACs) during thermal-imaging surveys carried out in Ireland by the Sea Mammal Research Unit during the moult season.

Site code	SAC Name	2003	2011/12	2017/18
90	Glengarriff Harbour And Woodland SAC	134	155	158
133	Donegal Bay (Murvagh) SAC	148	190	202
197	West Of Ardara/Maas Road SAC	59	107	90
204	Lambay Island SAC	31	23	60
268	Galway Bay Complex SAC	317	333	421
458	Killala Bay/Moy Estuary SAC	108	81	158
622	Ballysadare Bay SAC	257	200	185
627	Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC	0	24	15
781	Slaney River Valley SAC	17	49	32
1482	Clew Bay Complex SAC	95	241	248
2111	Kilkieran Bay And Islands SAC	116	264	261
2158	Kenmare River SAC	391	345	419
2283	Rutland Island And Sound SAC	268	230	284
	All Harbour Seal SACs	1,941	2,242	2,533
	Percentage of total count	65.7%	64.3%	63.2%
	Ireland Total	2,955	3,489	4,007

3.2 Grey Seals

The total number of Grey Seals counted in 2017/2018 (3,698) was the highest recorded in summer so far and was 25% higher than in 2011/2012 (2,964), equivalent to an average annual increase of 3.8% over six years (Figure 13). In comparison, the 2011/2012 total Grey Seal count was 126.4% higher (i.e. more than double) than the 2003 count (1,309), equivalent to an average annual increase of 9.5% over nine years (Figure 13). The numbers of Grey Seals counted in the five coastal regions of Ireland are given in Table 2. Figure 13 and Figure 14 compare the numbers of Grey Seals counted in the five regions in the three nationwide surveys.

The overall change in Grey Seal numbers between the first two national surveys (2003, 2011/2012) was mainly due to significant differences in three regions along the Atlantic coast of Ireland (South-west, West and North regions combined: +1,640, equivalent to a 12.6% average annual increase). In contrast, the West and North regions showed no significant changes between the summers of 2011/2012 and 2017/2018. Instead, the overall change found in the most recent survey is due to higher counts in the East, South-east and South-west regions (combined: +847, equivalent to an 11.5% average annual increase).

Figure 15 shows the distribution of Grey Seals in 2017/2018 aggregated by 10km grid squares. The density of seals across Ireland is more obvious at this scale than in Figure 3, as numbers at closely adjacent sites are aggregated rather than superimposed on top of each other. The difference can be clearly seen at Clear Island and Sherkin Island off Roaringwater Bay, west Co. Cork, and at the Inishkea island group, off western Co. Mayo, where a large number of overlapping small haul-out sites (Figure 6) combine to deliver a large overall total for the area (Figure 15). For comparison, Figure 16 shows the 10km grid distribution of Grey Seals in 2011/2012 while Figure 17 shows their 10km grid distribution in 2003.

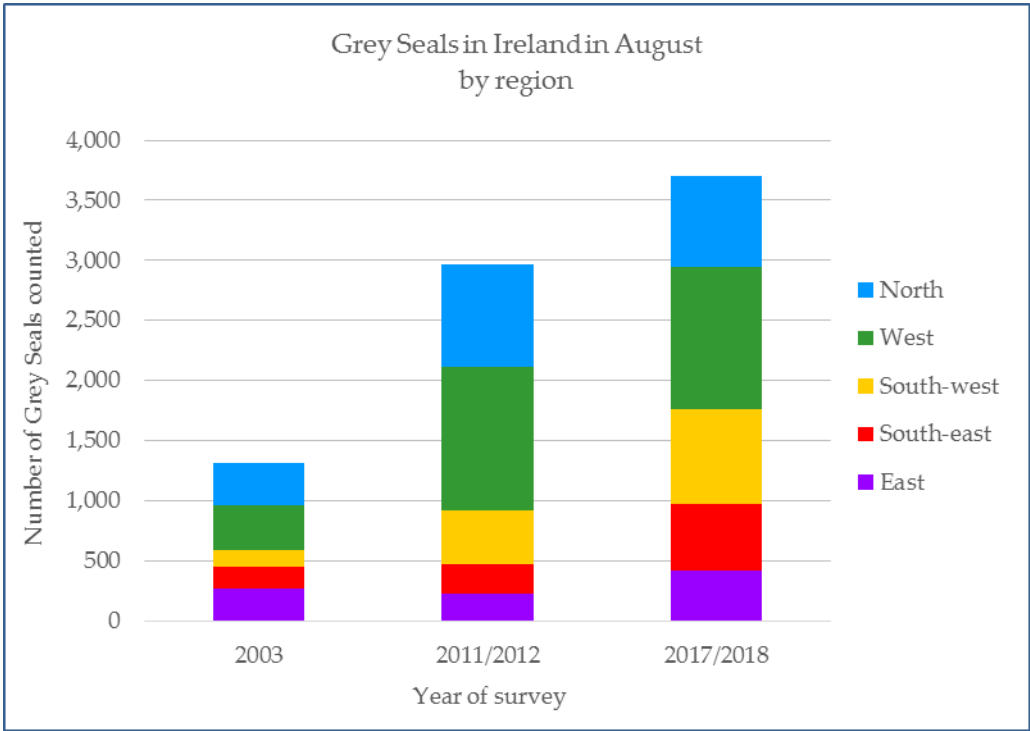


Figure 13 A comparison of the counts of Grey Seals in five coastal regions of Ireland. The region boundaries are shown in Figure 3.

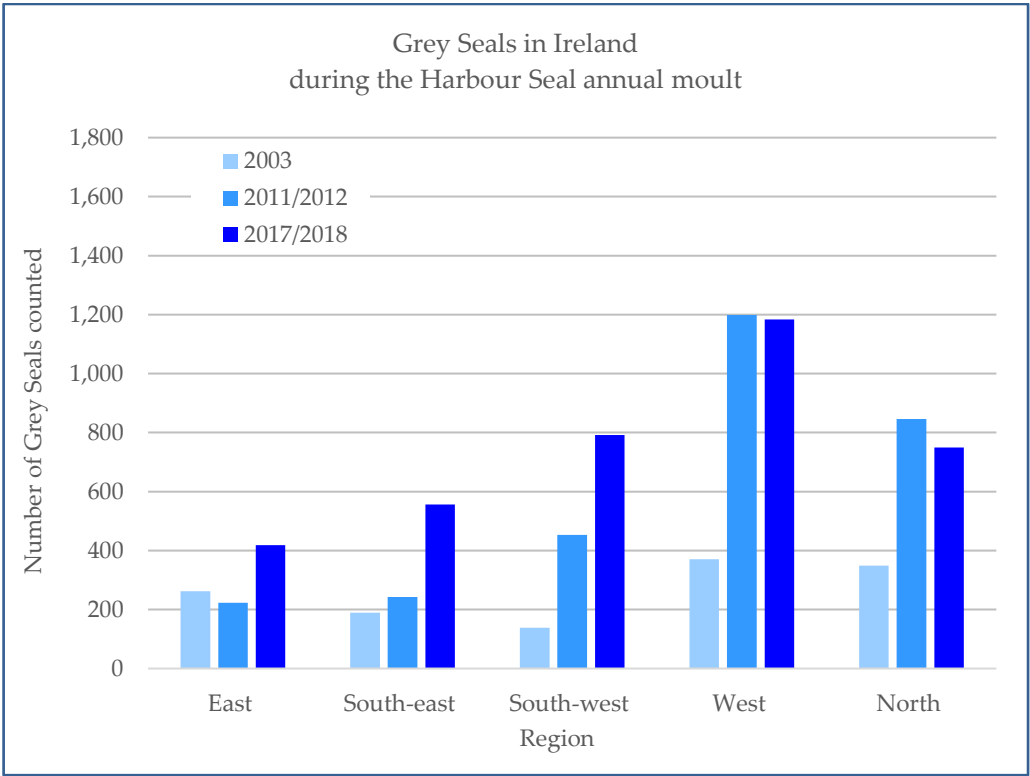


Figure 14 A comparison of the number of Grey Seals counted in coastal regions of Ireland in 2003, 2011/2012 and 2017/ 2018. The region boundaries are shown in Figure 3.

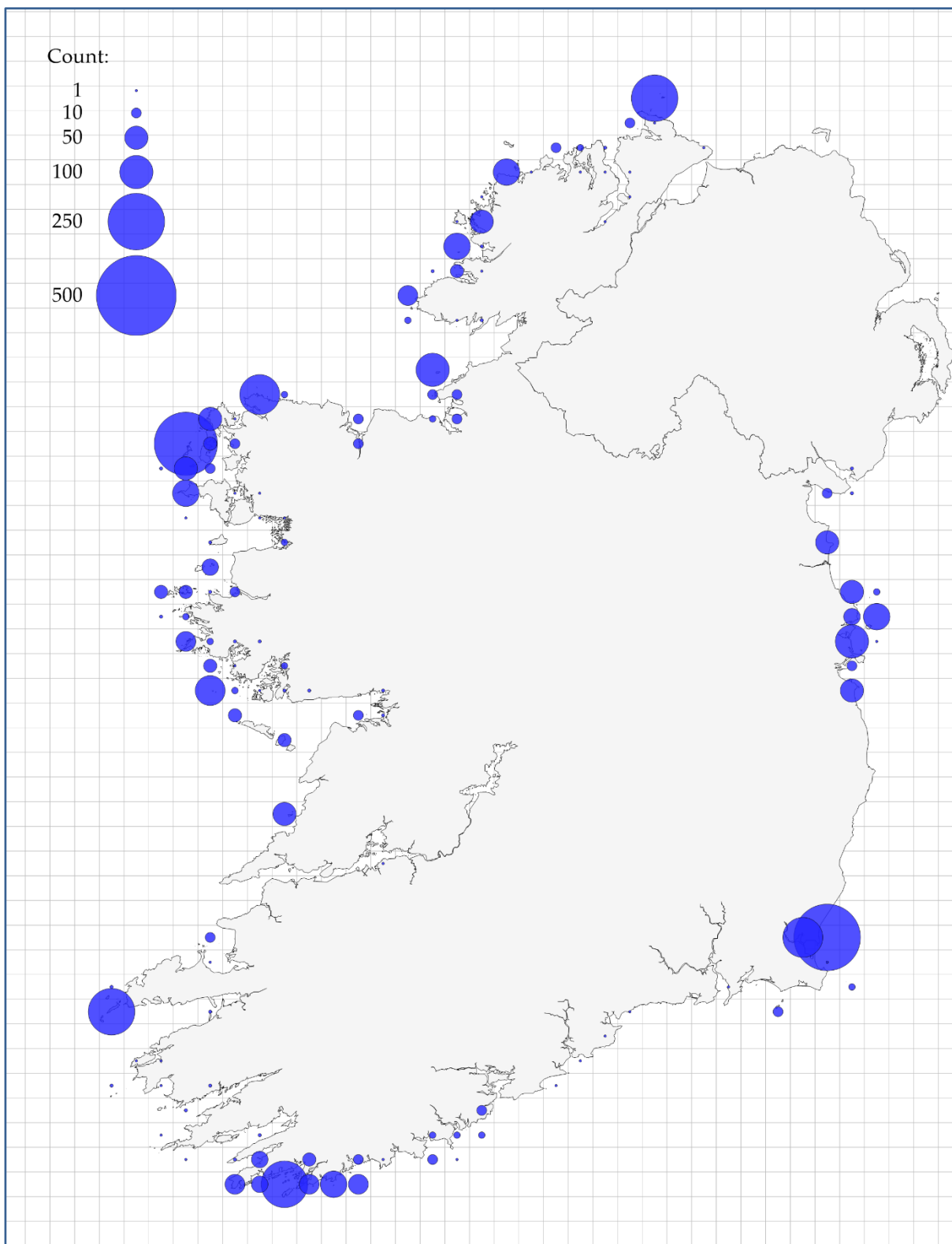


Figure 15 Distribution of Grey Seals in Ireland from aerial surveys carried out in 2017/2018. These are the same data as in Figure 3 but counts are aggregated into 10km grid squares. Symbol size is in proportion to numbers counted with size guides given in the Legend (top left).

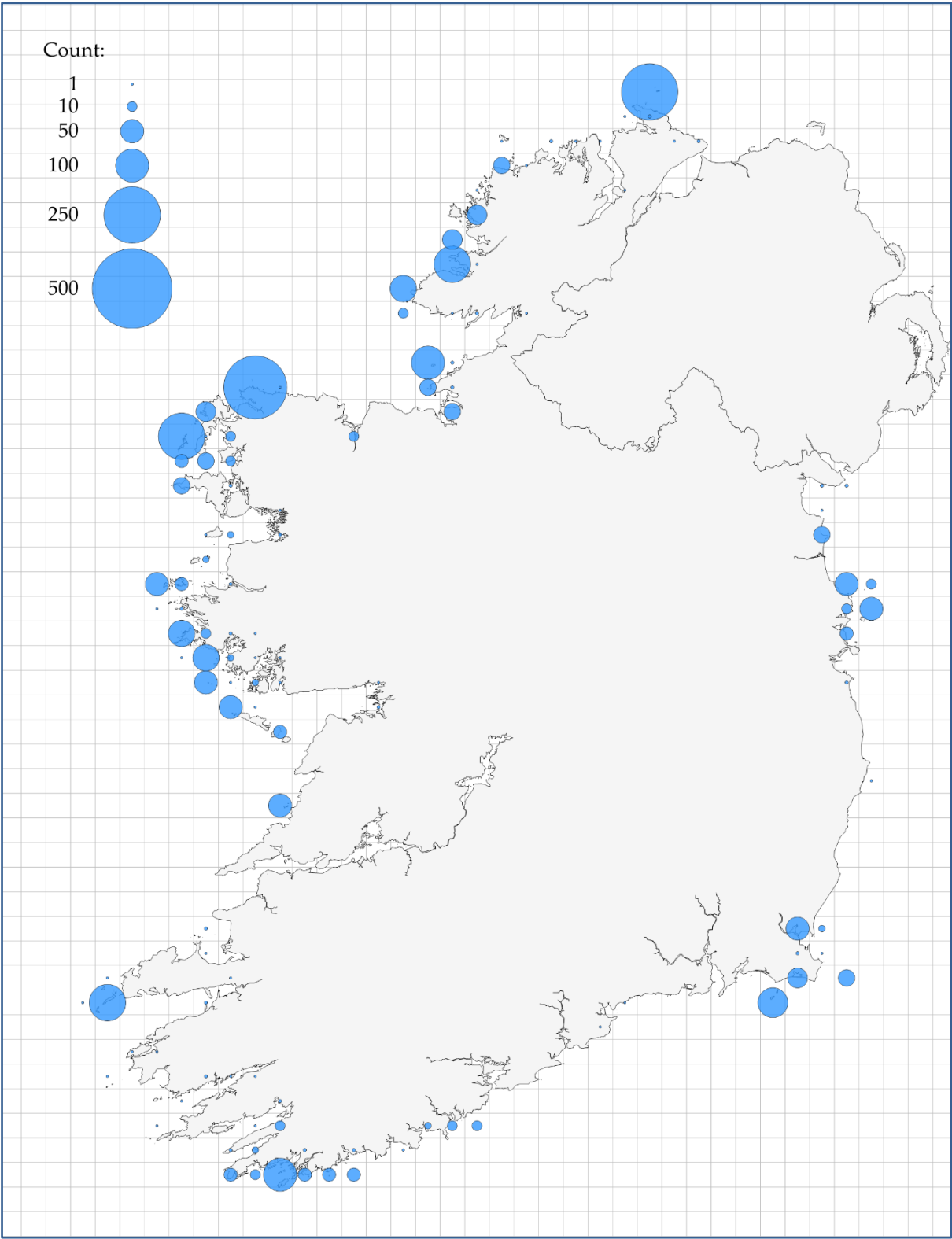


Figure 16 Distribution of Grey Seals in Ireland from aerial surveys carried out in 2011/2012. Counts are aggregated by 10km grid squares. Symbol size is in proportion to numbers counted with size guides given in the Legend (top left).

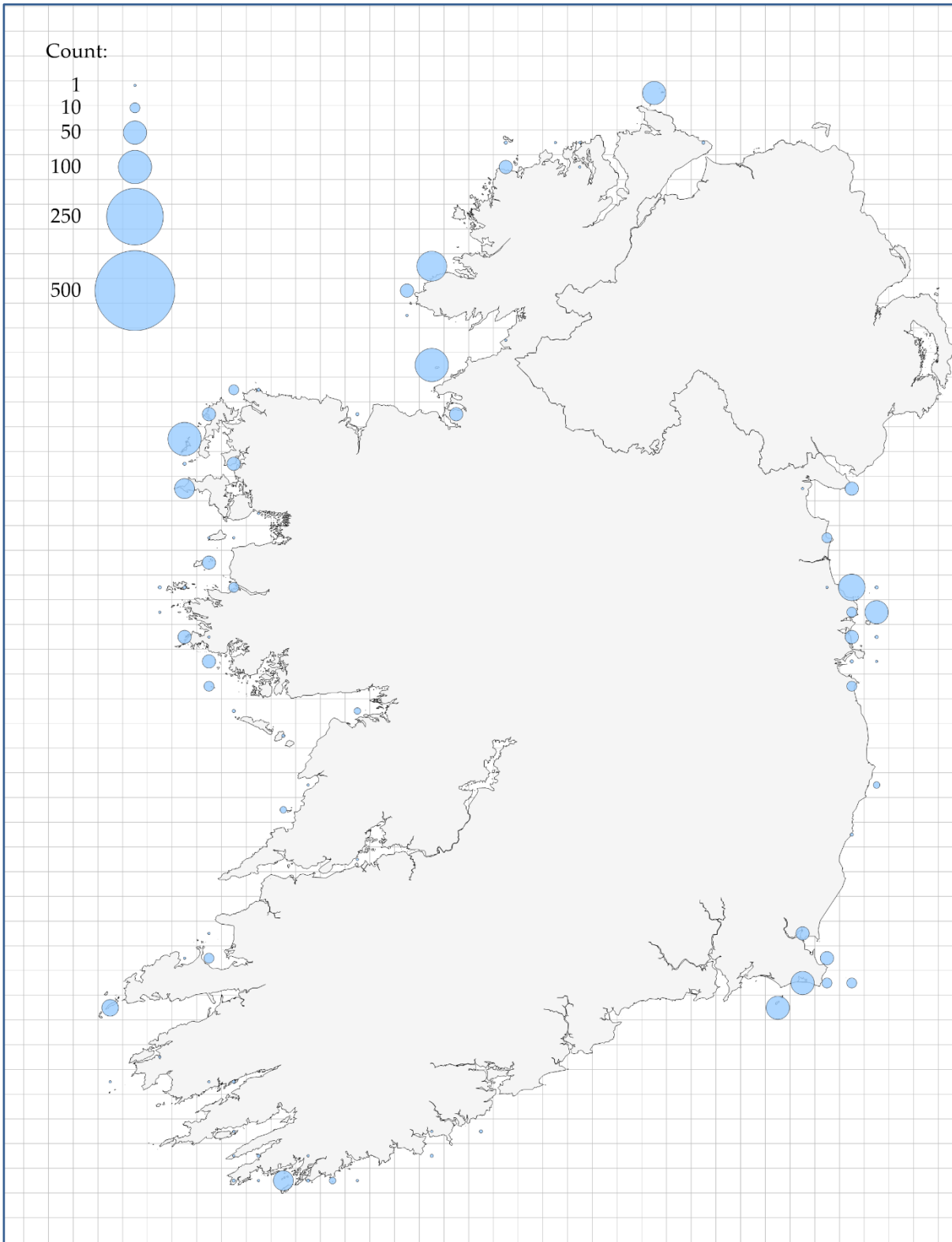


Figure 17 Distribution of Grey Seals in Ireland from aerial surveys carried out in 2003. Counts are aggregated by 10km grid squares. Symbol size is in proportion to numbers counted with size guides given in the Legend (top left).

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