E.ON Climate & Renewables

Analysis of Marine Ecology Monitoring Plan Data from the Robin Rigg Offshore Wind Farm, Scotland (Operational Year 3)

Technical Report

Appendix 2: Birds

Report: 1029455
Authors: Dr. Sarah Canning, Dr. Gillian Lye, Deborah Kerr
Issued: 18/09/2013

Natural Power Consultants
The Greenhouse
Forrest Estate
Dalry, Dumfries and Galloway
DG15 7XS
Tel: +44 (0) 1644 430 008

Client: **E.ON Climate & Renewables**

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Appendix 2: Birds

Authors Dr. Sarah Canning, Dr. Gillian Lye, Deborah Kerr

Checked Dr. Jane Lancaster

Approved Dr. Chris Pendlebury

Classification COMMERCIAL IN CONFIDENCE

Distribution E.ON Climate & Renewables

Revision History

Issue	Date	Changes
A	28/08/2013	First Issue to E.ON
B	18/09/2013	Draft 1 released to RRMG for comments

A3. ORNITHOLOGICAL APPENDIX

A3.1. Data collection methods

The survey vessel used for most of the boat surveys was a Fisheries Protection Vessel (16 m length, 18 tonne displacement). This vessel provided an excellent viewing platform and had the combination of speed (to be able to survey across the range of tidal conditions) and the ability to operate in relatively shallow water. Its viewing platform gives a 4 m viewing height above the sea surface. Although this is below the JNCC recommended 5 m, it gave a very suitable viewing platform, especially when taking into account the wind farm site constraints on a larger boat which would not have been able to navigate the sandbanks that run through much of the study area. The maximum wind force for observations was reduced from force 5 to force 4 (see Table A3.1 for full definition of sea states) to further ensure that viewing conditions were optimal and were not compromised by the slightly lower viewing height.

Table A3.1: Definition of sea states used in the collection of environmental data.

Sea State	Definition
0	Mirror calm
1	Slight ripples, no foam crests
2	Small wavelets, glassy crests but no whitecaps
3	Large wavelets, crests begin to break, few whitecaps
4	Longer waves, many whitecaps
5	Moderate waves of longer form, some spray

The survey route was designed to provide a 2 km interval between transects; a total of ten transects were surveyed, each of about 18 km length (see Figure A3.1). This separation distance was chosen to ensure that a good sample of the study area was covered for all species, whilst minimising the likelihood that birds may be displaced from one transect to the adjacent one and double-counted.

The same route was used for all the surveys, though restricted hours of daylight, weather and tidal conditions meant that it was not always possible to cover the whole survey area in a single day. Where complete surveys were not possible the second survey each month was designed to ensure that the whole study area was covered at least once per month and that the potential wind farm area twice per month whenever possible. A GPS record of the precise route was taken on each trip, so that the location at all times was known.

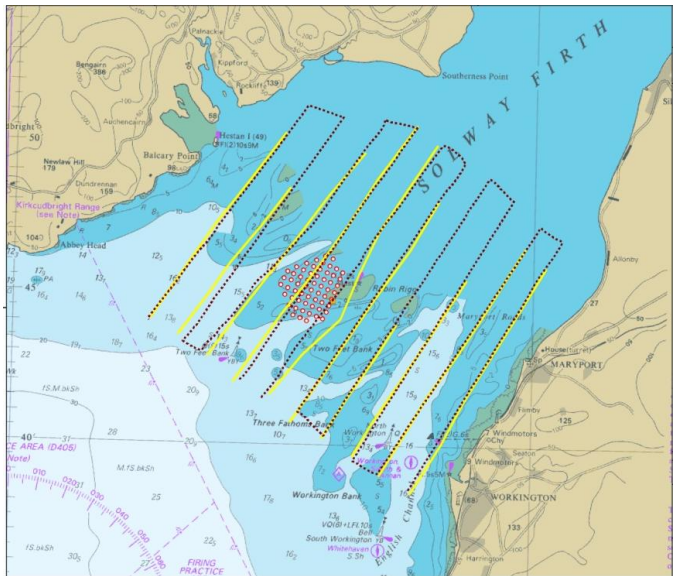


Figure A3.1. Illustration showing the 10 transect lines followed during the bird and marine mammal surveys. The yellow lines represent the area that could be covered at low tide. Red circles represent turbine locations.

Two surveys were completed each month from May 2001 to April 2002, with the exception of May and October 2001, when only one survey was completed. Alternate surveys covered the high tide and the low tide periods. Monthly surveys were conducted in April/May 2003 and between January and September 2004 with an addition survey performed in July 2007, just prior to construction commencing. Construction phase surveys began in January 2008 and continued on a bi-monthly basis until the end of the phase in February 2010. Surveys were completed in all months of the construction phase except November 2009.

All birds encountered, their behaviour, flight height and approximate distance from the boat were recorded.

Two observers worked simultaneously, each observing a 90° angle ahead and to the side of the vessel. Following the JNCC Seabirds at Sea recommendations, birds were recorded into five distance bands (0-50 m, 50-100 m, 100-200 m, 200-300 m and 300+ m). Birds were recorded continuously, at a steady speed of approximately 12 knots, with the time of each observation recorded to the nearest minute (linking to the GPS position information being recorded simultaneously). A range-finder was used to estimate distances of the birds from the ship. All records of birds observed flying as well as those on the sea was recorded.

- ***Operational Year Three***

Data collection methods applied at Robin Rigg differs slightly from those commonly used today. Although a standardised method for collecting seabird data was first proposed in 1984 (Tasker *et al*., 1984), standardised methods for data collection at offshore wind farm developments were not produced until 2004 (Camphuysen *et al*., 2004), three years after data collection began at Robin Rigg.

In order to allow comparisons to be made between the different phases of the development, the methodology originally implemented for the ES has been followed throughout the study. This consistency between phases is essential if they are to be compared statistically.

At the onset of operational year three, additional data collection methods were implemented alongside the existing methods in order to collect data in a manner that corresponds with present best practices and allow comparisons to be made between the two methods.

Two surveyors were employed, each using a different method of data collection in a 90° to either side of the vessel. The first surveyor collected their data following the method followed during previous years.

A second surveyor collected their data following standard ESAS surveying methods considered best practice by the industry today. All birds on the sea were recorded in the same manor in both methods. Flight heights were recorded using the same height bands as for the original method but the distance of flying birds from the vessel are not recorded using the ESAS method.

The primary difference between the two methods is the use of “snap-shots” in the ESAS method for flying birds. Every one minute or 300 m, ‘snapshots’ were undertaken in the zone that is a square block of air extending 300 m to the front and 300 m perpendicular from the boat. The number, height and behaviour of those birds in flight within the snapshot zone were recorded.

A3.2. Bird species recorded during boat-based surveys between 2001 and 2013

Table A3.2: Summary of the raw count data collected to the end of March 2013 during boat-based bird surveys at the Robin Rigg offshore wind farm.

Row Labels	Pre-Construction	During Construction	Operation Year 1	Operation Year 2	Operation Year 3	Total
Arctic Skua	12	60	5	5	8	90
Arctic Tern		75		9	17	101
Arctic/common tern					75	75
Auk species	714	1870	787	807	8	4186
Barnacle Goose					2	2
Bar-tailed Godwit		2		4		6
Black Guillemot	1	4	1			6
Blackbird					1	1
Black-headed Gull	375	1928	201	107	132	2743
Black-tailed Godwit		1				1
Black-throated Diver	6	6			1	13
Buzzard		1				1
Canada Goose		4				4
Carrion Crow		1				1
Collared Dove		1				1
Commic Tern	120	67		90		277
Common Gull	1312	7416	2673	915	1300	13616
Common Scoter	70660	85961	21190	34940	49712	262463
Common Tern	5	24	4	25	2	60
Cormorant	452	3352	1219	970	1454	7447
Cormorant/Shag	2					2
Curlew	11	16				27
Curlew/Whimbrel			2			2
Diver species	471	1569	336	153	159	2687
Duck species			1			1
Dunlin	90	396				486
Eider		4	1			5
Feral Pigeon	1					1
Finch species	5	1				6
Fulmar	120	73	10	6	13	222
Gannet	476	848	124	284	180	1912
Golden Plover	2		1	50		53
Goldeneye	1				3	4
Goosander		12	342	28	435	817
Goose species		5	20			25
Great Black-backed Gull	207	580	218	244	391	1640
Great Crested Grebe	76	29	12	1	1	119
Great Northern Diver	19	25				44
Great Skua	3	4		2	2	11

Row Labels	Pre-Construction	During Construction	Operation Year 1	Operation Year 2	Operation Year 3	Total
Great/Lesser black-backed gull					3	3
Great Black-backed Gull				1		1
Grey Goose			1			1
Grey Heron	1				4	5
Grey Plover	3	4				7
Greylag Goose			1			1
Guillemot	4152	5782	1796	2151	2069	15950
Guillemot/Razorbill					792	792
Gull species	124	1806	599	58	384	2971
Gull species (large)	361	319	124	114	465	1383
Gull species (small)	29	370	145	84	35	663
Gull species (mixed)	120					120
Hen Harrier		1				1
Herring Gull	1294	1727	368	507	1218	5114
Herring/Common gull					17	17
Herring/Lesser Black-backed Gull	10				1	11
Hirundine			1	7		8
Hirundine species		7			1	8
House Martin		1	2			3
Kestrel	1					1
Kittiwake	922	1779	291	733	507	4232
Knot	95	1				96
Lapwing			1			1
Lesser Black-backed Gull	308	1104	120	70	37	1639
Lesser Redpoll				1		1
Little Auk		1				1
Little Gull	14	12	4	3		33
Little Tern	17					17
Long-tailed Duck		2		2		4
Long-tailed Skua					1	1
Mallard		2		2	4	8
Manx Shearwater	1566	1685	160	390	176	3977
Meadow Pipit	29	170		61		260
Merlin	1					1
Mute Swan	4					4
Oystercatcher	20	13	5	2		40
Passerine species	9	75			1	85
Peregrine	1	1	2			4
Pied Wagtail	1	2				3
Pink-footed Goose		703	901	206	237	2047
Pipit species	37	29	19	2	9	96

Row Labels	Pre-Construction	During Construction	Operation Year 1	Operation Year 2	Operation Year 3	Total
Pomarine Skua	3	1		1	2	7
Puffin	4	8	11	4	2	29
Purple Sandpiper			2	1		3
Raptor			1			1
Razorbill	2196	2957	591	1354	1212	8310
Red-breasted Merganser	30	20	29	4		83
Redshank		15				15
Red-throated Diver	548	541	515	444	576	2624
Redwing				1		1
Ringed Plover	21	9				30
Sand Martin	26	11		7		44
Sanderling		3		33		36
Sandwich Tern	121	575	75	114	96	981
Scaup	705	351	2171		1900	5127
Shag				1		1
Shelduck	2	10	1	6	14	33
Skua species		4	1			5
Skylark	14	13			6	33
Song Thrush/Redwing		1				1
Sparrowhawk	1	1				2
Starling		6	15			21
Storm Petrel	20	19				39
Swallow	25	112	12	86	9	244
Swan species	3					3
Swift	4	9				13
Teal	1	3		1		5
Tern species	35	148	13	64	3	263
Turnstone	4	2				6
Unidentified goose					19	19
Velvet Scoter	25	5		1	2	33
Wader (large)		1				1
Wader (small)	6	28				34
Wader species	2	12	15			29
Whimbrel					1	1
White/Pied Wagtail	2	5				7
Whooper Swan	14	12	102	2		130
Wigeon				11		11
Yellowhammer	1					1
Total	**88073**	**124813**	**35240**	**45169**	**63699**	**356994**

A3.2.1. Raw Observations

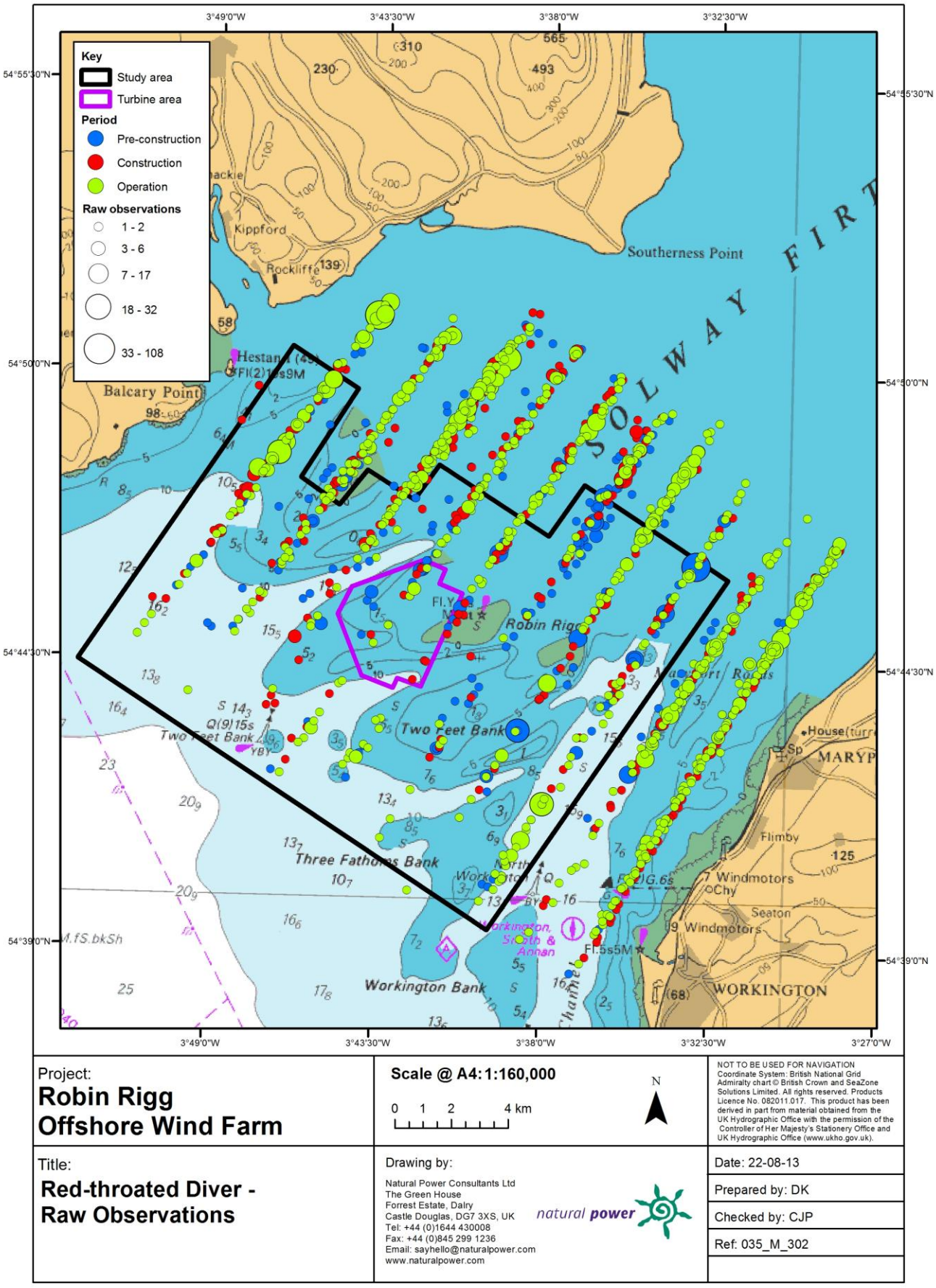


Figure A3.2: Locations of raw observations of red-throated diver during all phases of the development of the wind farm. The size of the symbols represents the size of the group of animals observed.

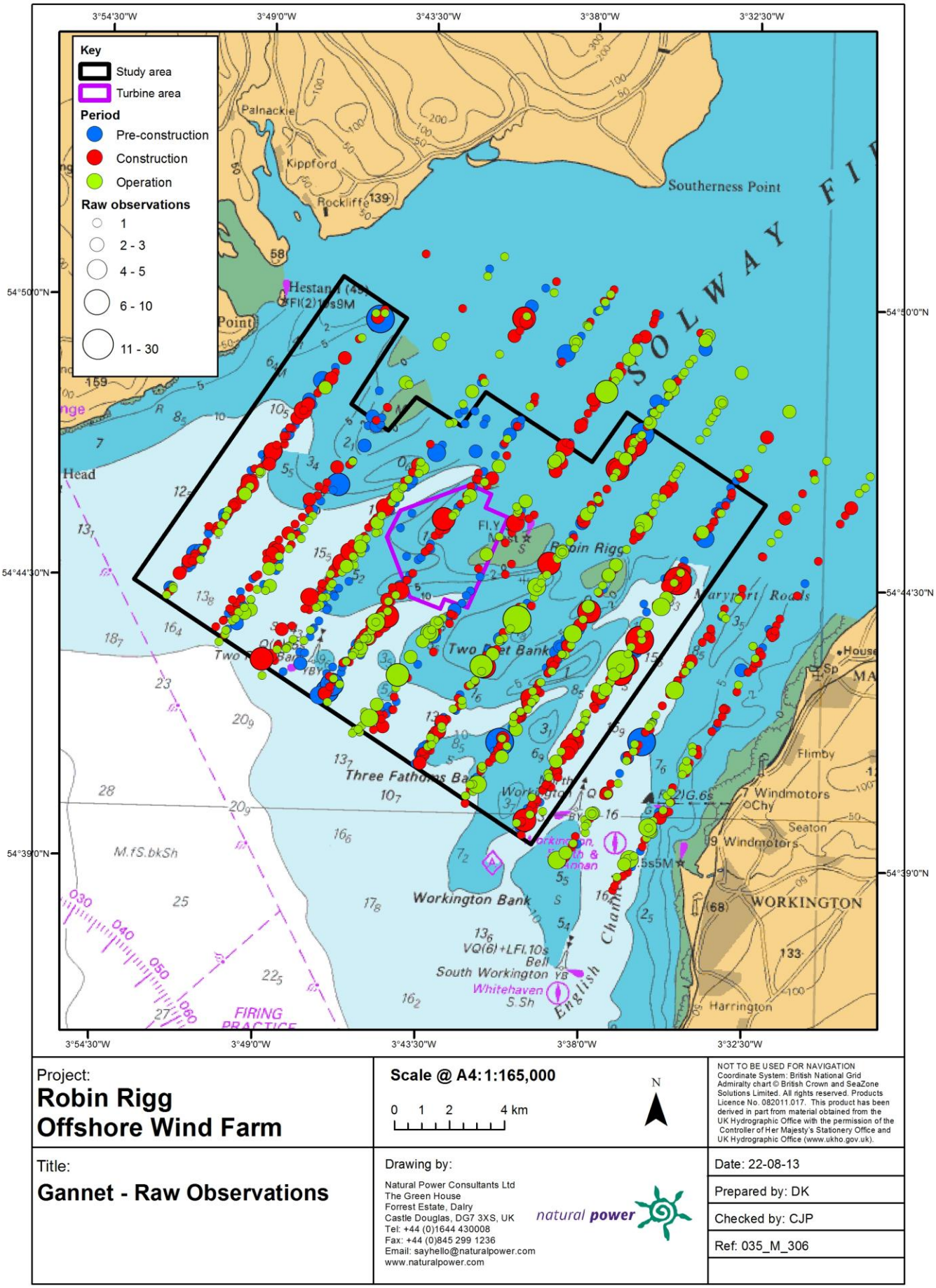


Figure A3.3: Locations of raw observations of gannets during all phases of the development of the wind farm. The size of the symbols represents the size of the group of animals observed.

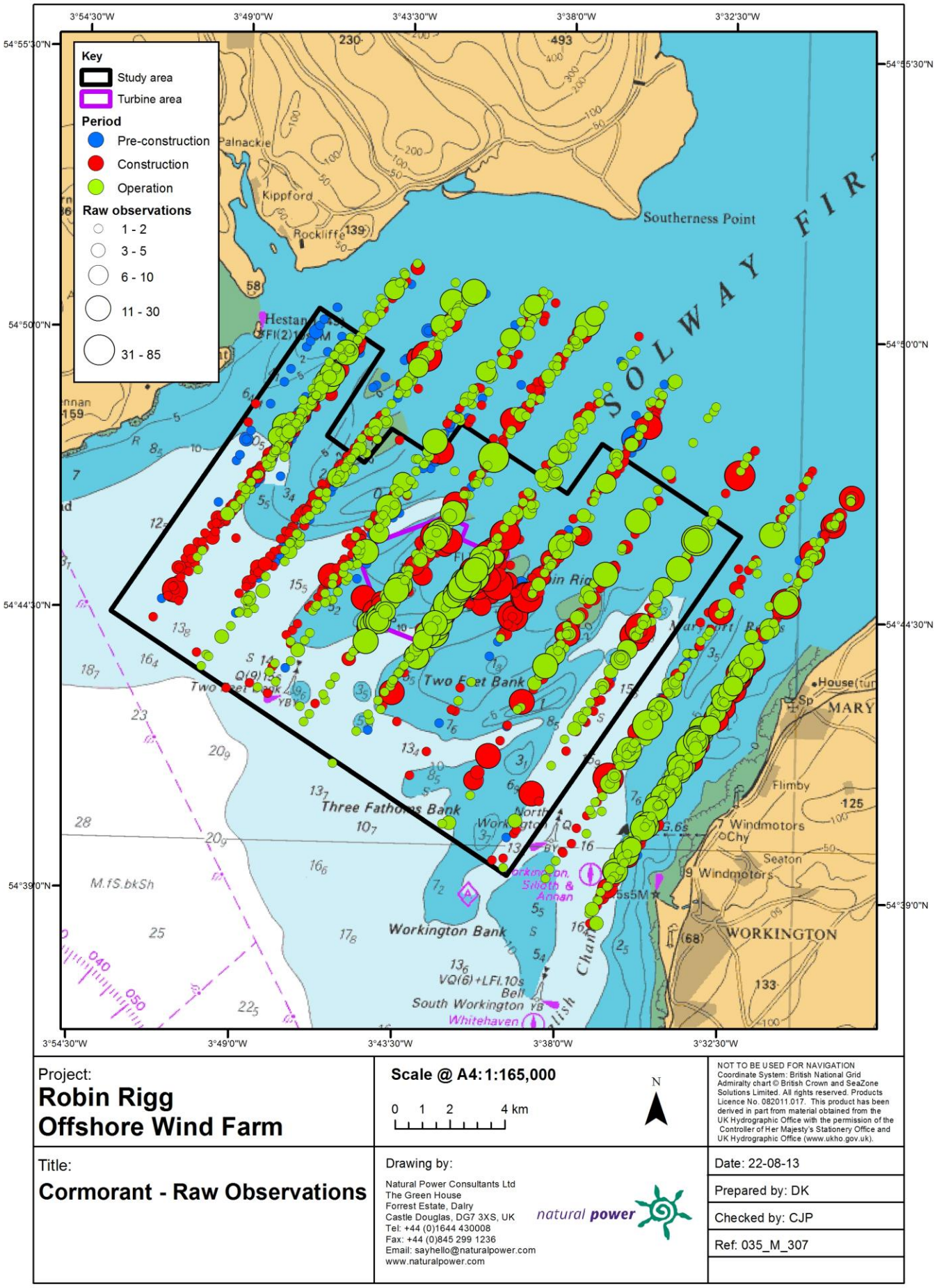


Figure A3.4: Locations of raw observations of cormorants during all phases of the development of the wind farm. The size of the symbols represents the size of the group of animals observed.

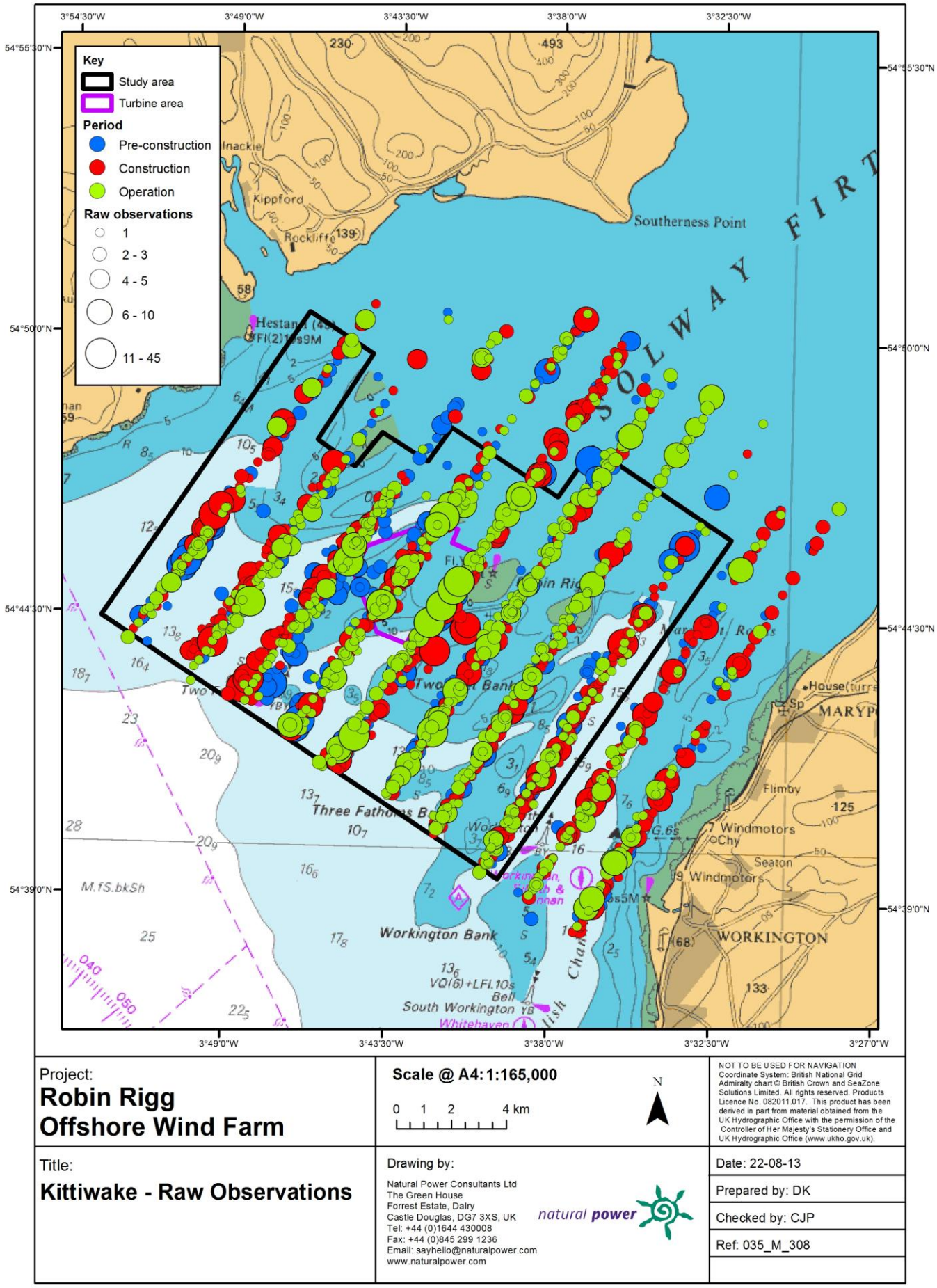


Figure A3.5: Locations of raw observations of kittiwakes during all phases of the development of the wind farm. The size of the symbols represents the size of the group of animals observed.

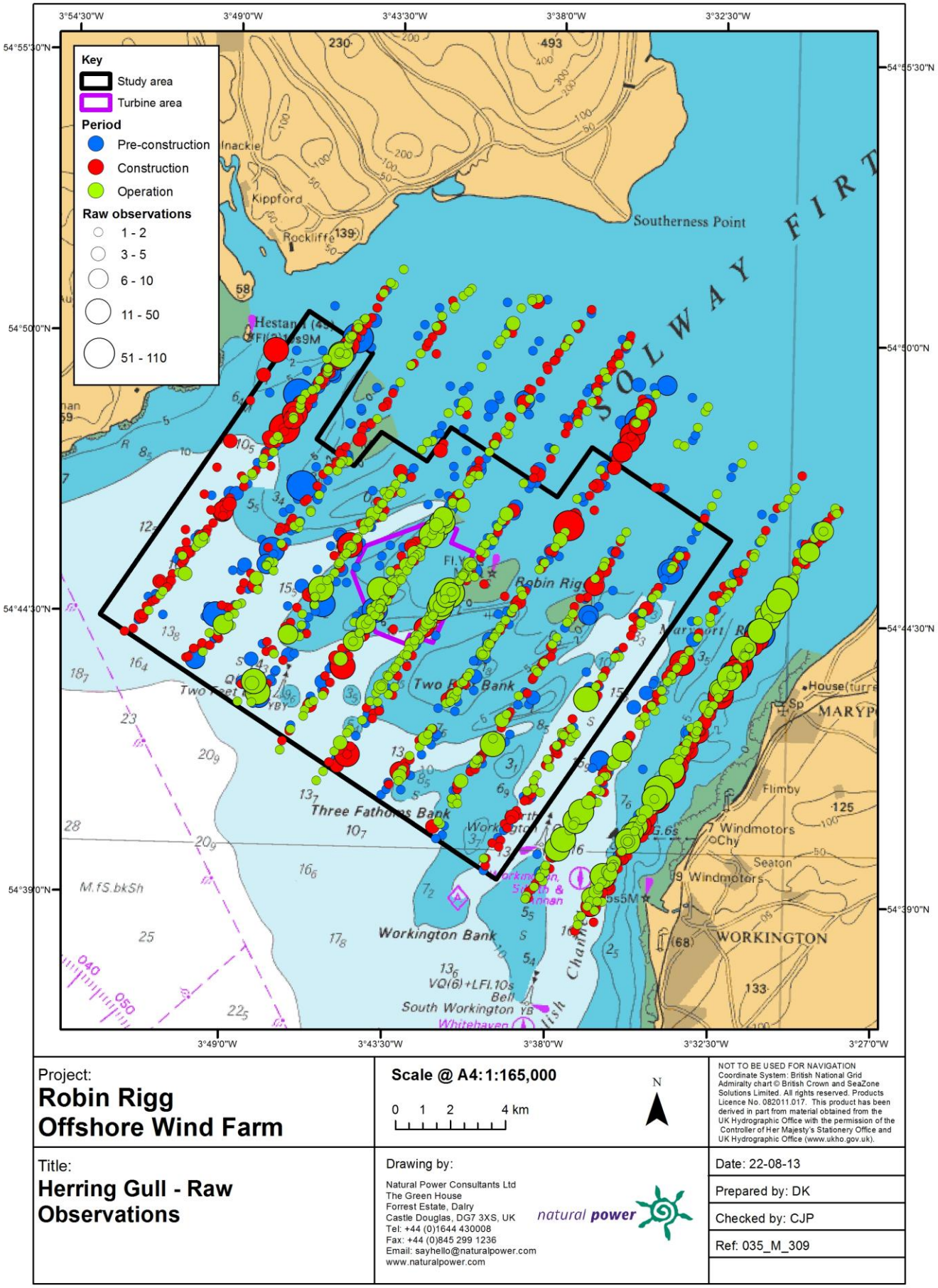
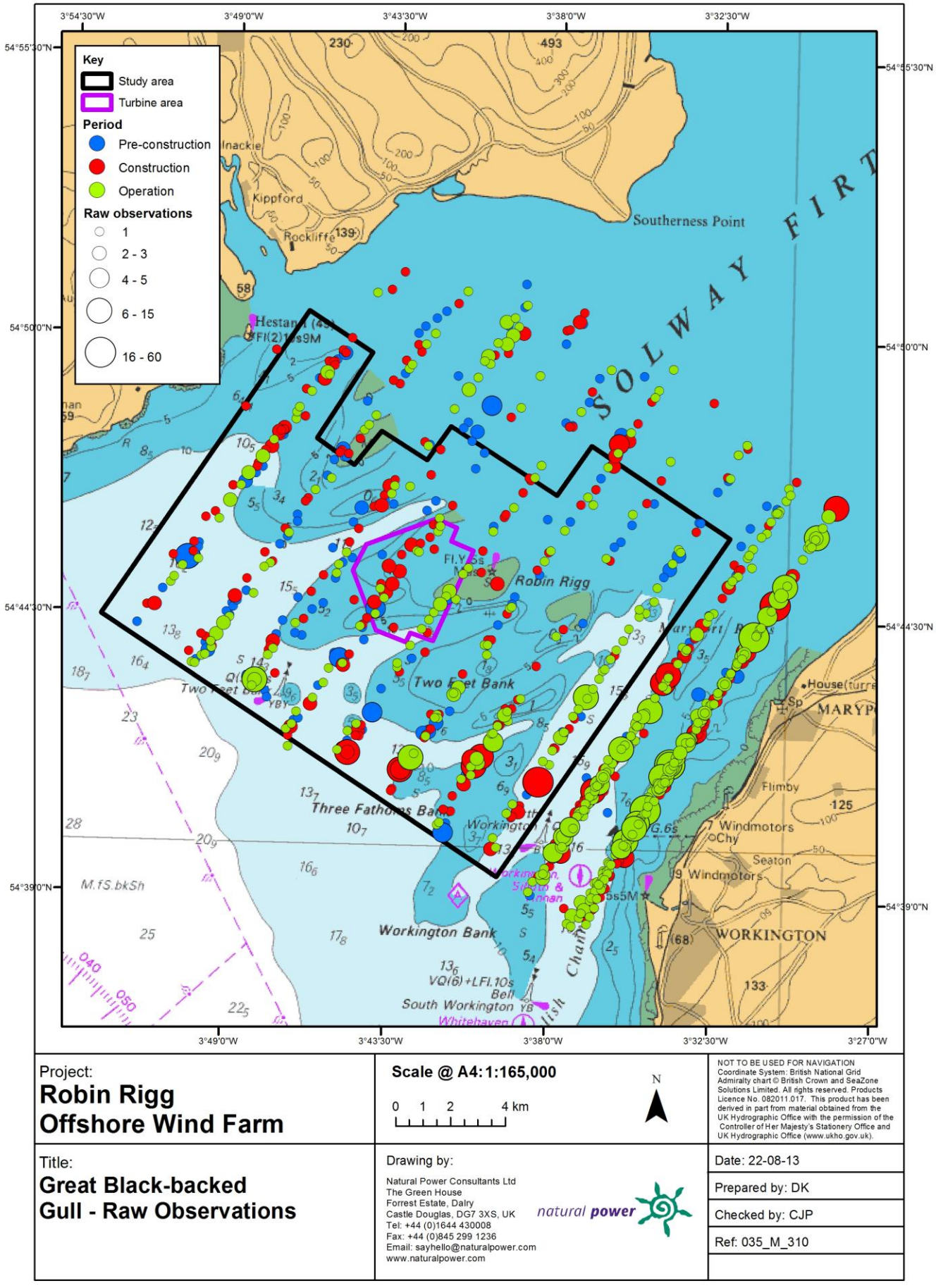


Figure A3.6: Locations of raw observations of herring gulls during all phases of the development of the wind farm. The size of the symbols represents the size of the group of animals observed.



Project: **Robin Rigg Offshore Wind Farm**	**Scale @ A4: 1:165,000** 0 1 2 4 km N	NOT TO BE USED FOR NAVIGATION Coordinate System: British National Grid Admiralty chart © British Crown and SeaZone Solutions Limited. All rights reserved. Products Licence No. 082011.017. This product has been derived in part from material obtained from the UK Hydrographic Office with the permission of the Controller of Her Majesty's Stationery Office and UK Hydrographic Office (www.ukho.gov.uk).
Title: **Great Black-backed Gull - Raw Observations**	Drawing by: Natural Power Consultants Ltd The Green House Forrest Estate, Dalry Castle Douglas, DG7 3XS, UK Tel: +44 (0)1644 430008 Fax: +44 (0)845 299 1236 Email: sayhello@naturalpower.com www.naturalpower.com natural power	Date: 22-08-13 Prepared by: DK Checked by: CJP Ref: 035_M_310

Figure A3.7: Locations of raw observations of great black-backed gulls during all phases of the development of the wind farm. The size of the symbols represents the size of the group of animals observed.

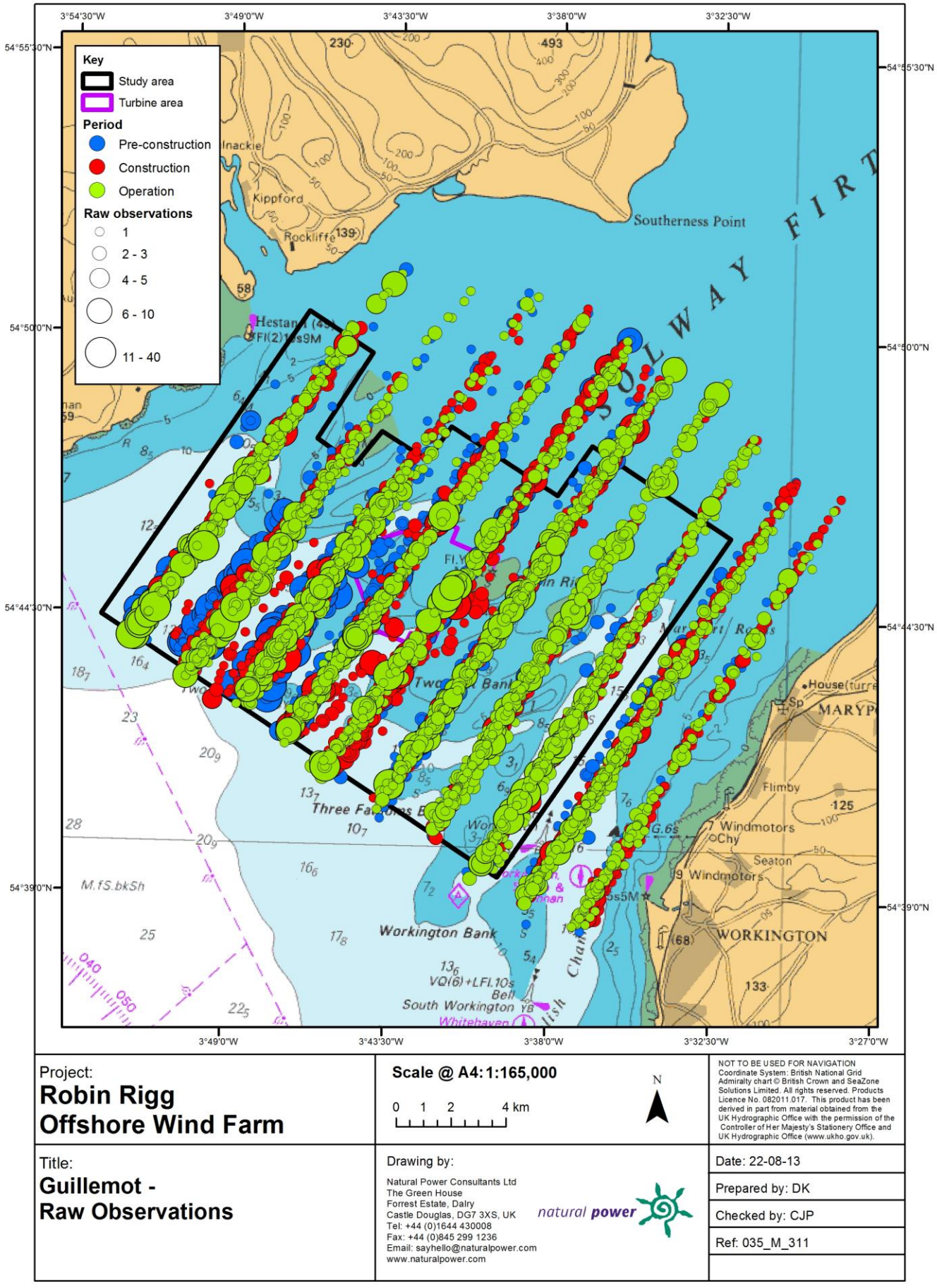


Figure A3.8: Locations of raw observations of guillemots during all phases of the development of the wind farm. The size of the symbols represents the size of the group of animals observed.

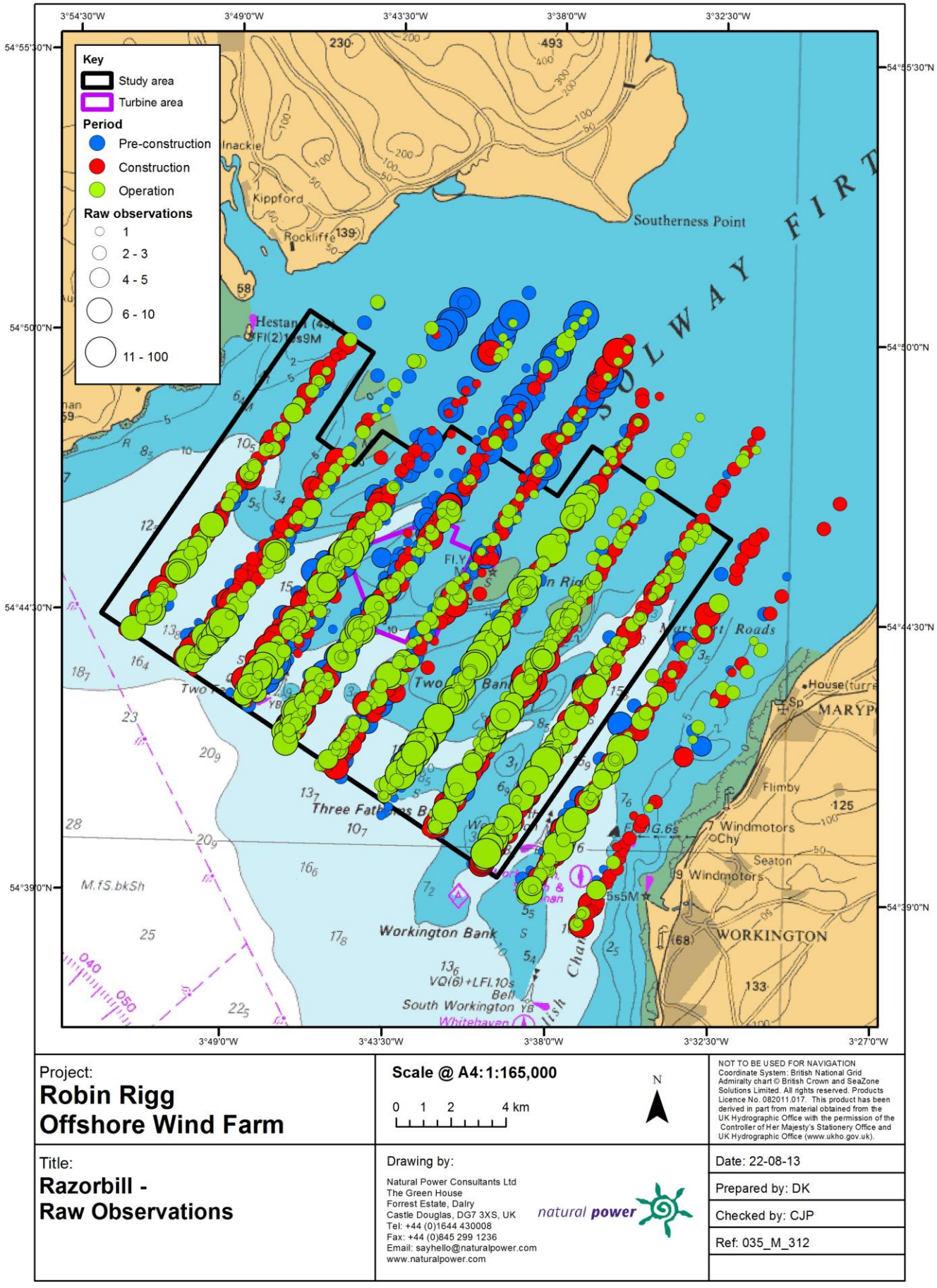


Figure A3.9: Locations of raw observations of razorbills during all phases of the development of the wind farm. The size of the symbols represents the size of the group of animals observed.

A3.3. Data exploration

A3.3.1. Covariates

The following steps were followed for the covariate data. This data exploration is pertinent to both the birds in flight and the birds on the water data sets. Data exploration presented here was carried out using the standardised dataset.

- **Step 1: Check the explanatory variables for outliers**

There are no obvious outliers in continuous variables (longitude, latitude, depth, distance to coast, distance to wind farm). This is as expected given the survey design.

There is also relatively even coverage of the factor variable "month" (Table A3.3) but there is uneven coverage of the factor variable "sediment" (Table A3.4).

Table A3.3: Coverage of factor month during the three wind farm phases

Month	Pre-Construction	Construction	Post-Construction
1	177	315	341
2	323	317	517
3	160	123	505
4	151	169	527
5	132	163	496
6	167	159	509
7	174	168	514
8	157	344	519
9	298	302	468
10	145	341	346
11	339	165	514
12	310	300	493

Table A3.4: Coverage of factor sediment

Segments by sediment type		
Muddy Sand	Sand	Slightly Gravelly Sand
896	9213	1039

The number of segments per survey is similar, ranging of between 122 and 179 segments (data not shown). There is however, uneven coverage of factor variable "period" with much more effort (i.e. number of segments) conducted during the operational phase (Table A3.5). This is to be expected given the different time-tables associated with three phases.

Table A3.5: Coverage of factor "period"

Segments by period		
Pre-construction	Construction	Operation

2533	2866	5749

The spatial distribution of segments was even with same area surveyed among all periods (Figure A3.101); no outliers.

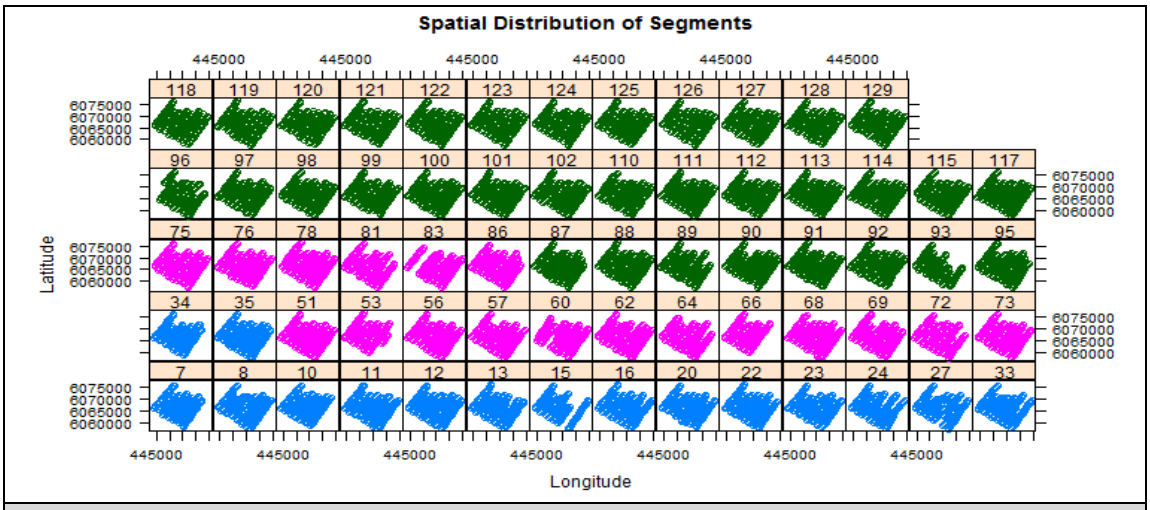


Figure A3.10: Spatial coverage by survey during the pre-construction (blue), construction (pink) and operational (green) phases.

The temporal distribution of segments was uneven among periods with post-construction surveys (red) being carried out earlier and later in the day than during pre- and during construction surveys (Figure A3.12).

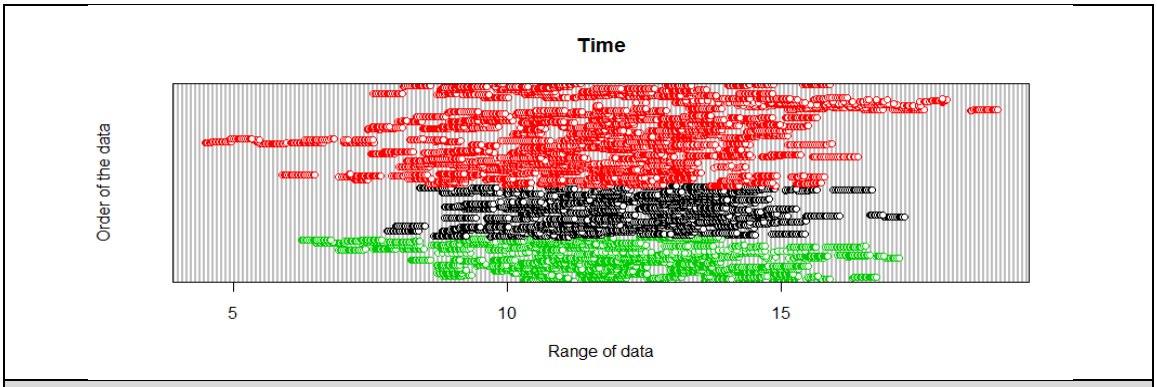


Figure A3.11: Temporal coverage (time of day) during the pre-construction (green), construction (black) and operational (red) phases.

- **Step 2: Check for collinearity**

There was little evidence for collinearity detected using Pearson's correlation coefficients among continuous covariates (Figure A3.12). Greater than 0.8 is considered strong collinearity.

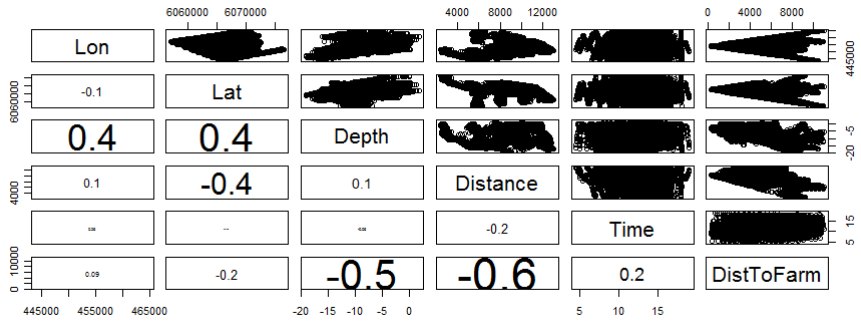


Figure A3.12: Pearsons correlation coefficients and plots for relationships among continuous covariates.

When plotted by transect, there was strong collinearity was found among all continuous covariates as would be expected with this type of dataset (an example is shown below: Figure A3.14).

Two potential approaches: use x-y smooth to visualise change in distribution among phases or use only distance to wind farm as a continuous covariate and investigate an interaction effect between distance to wind farm and wind farm phase.

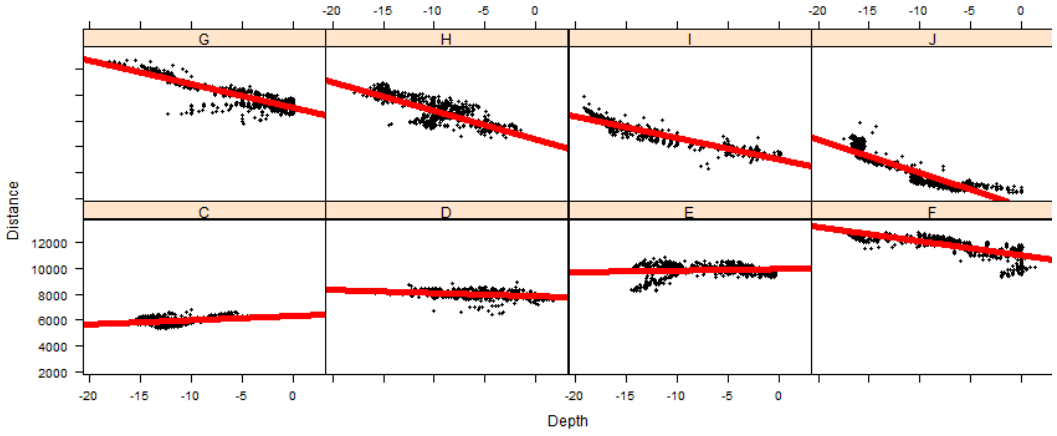


Figure A3.13: Relationship between sea depth and distance to coast plotted by transect.

No obvious collinearity was found between the factor variables and the continuous covariates, except for survey with time (Figure A3.15), and for sediment type which is collinear with most continuous covariates (Figure A3.15 A3.16).

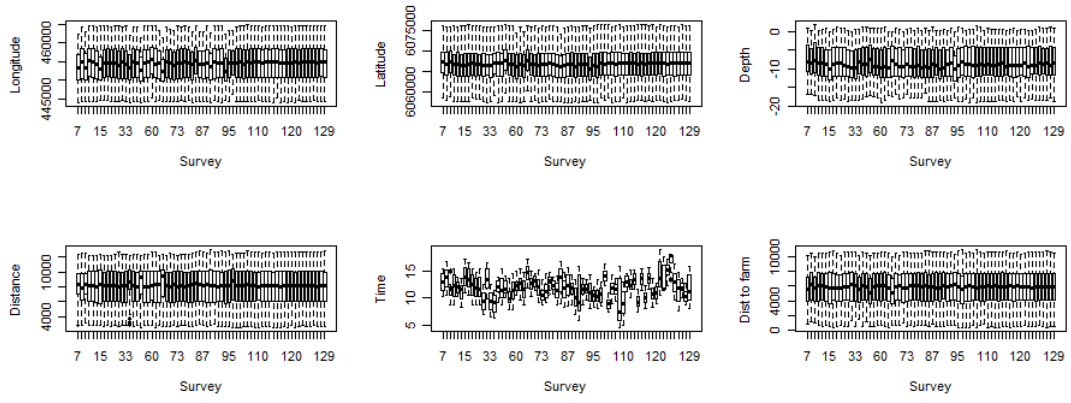


Figure A3.14: Boxplots looking for collinearity with survey and continuous covariates.

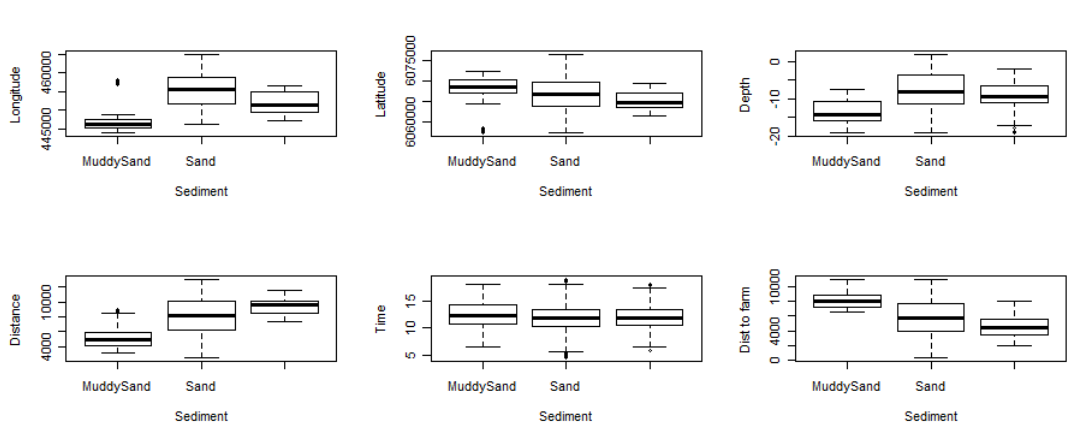


Figure A3.15: Collinearity with sediment type and continuous covariates.

Neither was there obvious collinearity of factor variables with other factor variables (Table A3.6 and Table A3.7).

Table A3.6: Number of segments surveyed at different sediment types per month

Month	Muddy Sand	Sand	Slightly Gravelly Sand
1	64	697	72
2	91	962	104
3	64	650	74
4	66	698	83
5	66	652	73
6	67	690	78
7	65	714	77
8	79	846	95
9	95	865	108
10	72	678	82

11	84	847	87
12	83	914	106

Table A3.7: Number of segments surveyed at different sediment types per wind farm phase

Sediment	Pre-Construction	Construction	Post-Construction
Muddy Sand	207	244	445
Sand	2120	2340	4753
Slightly Gravelly Sand	206	282	551

A3.3.2. Response variables

The following steps were followed for the response data:

Step 1: Check the response variables for outliers

Step 2: Check the response variables for zero inflation

This data exploration has been conducted independently for the on sea and in flight data sets for each of the 11 target species.

- **Scaup**

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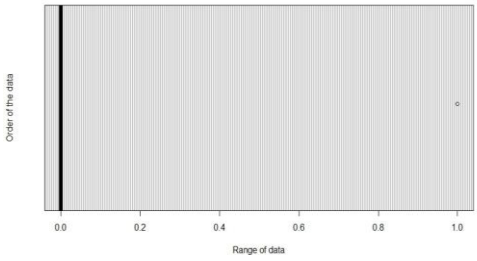
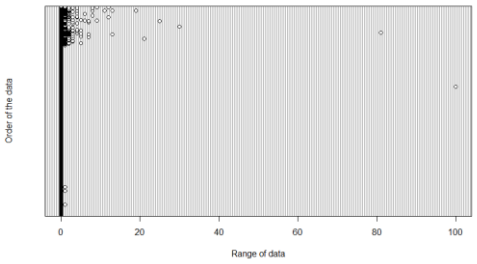
<tr><td>Outliers</td><td colspan="3"> 
</td><td colspan="3"> 
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</table>

- **Common Scoter**

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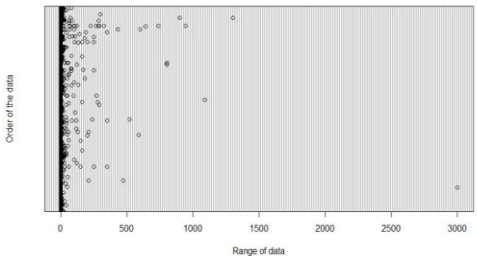
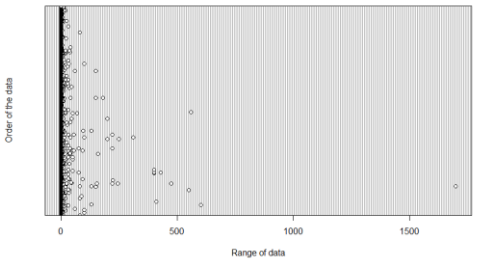
<tr><td>Outliers</td><td colspan="3"> 
</td><td colspan="3"> 
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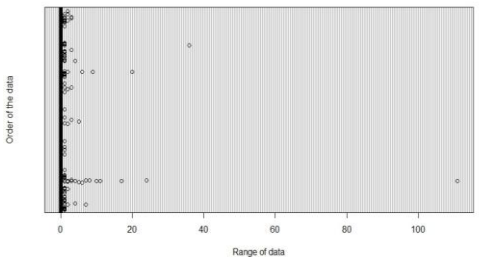
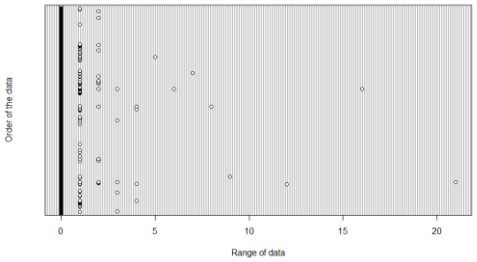
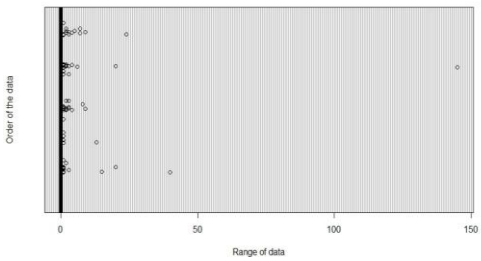
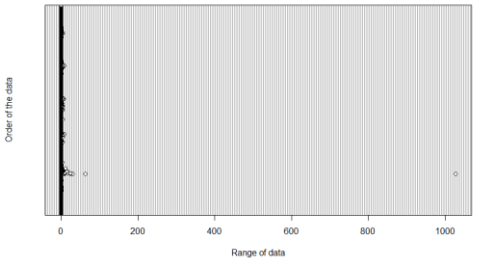
</table>

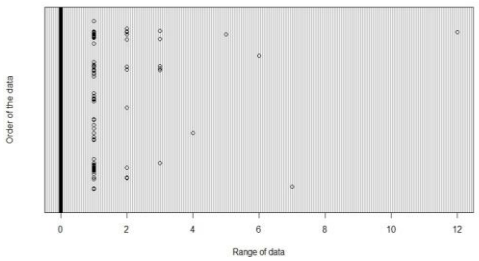
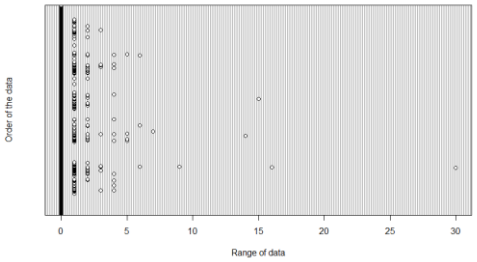
- **Red-throated diver**

	On the sea			In flight		
Outliers						
Zero inflation	Zero Observations	Total observations	% Zero Observations	Zero Observations	Total observations	% Zero Observations
	11024	11148	98.89	11008	11148	98.74

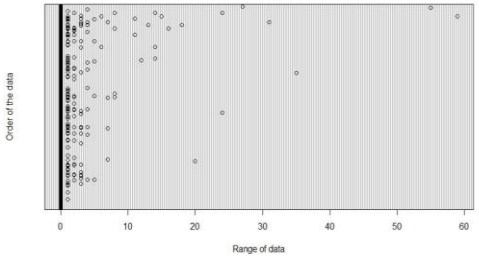
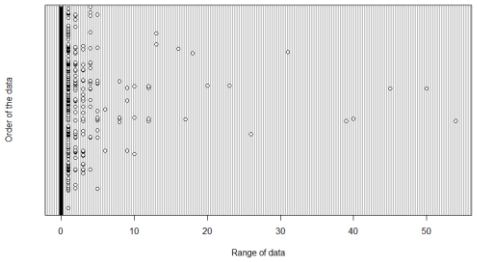
- **Manx shearwater**

	On the sea			In flight		
Outliers						
Zero inflation	Zero Observations	Total observations	% Zero Observations	Zero Observations	Total observations	% Zero Observations
	11078	11148	99.37	10963	11148	98.34

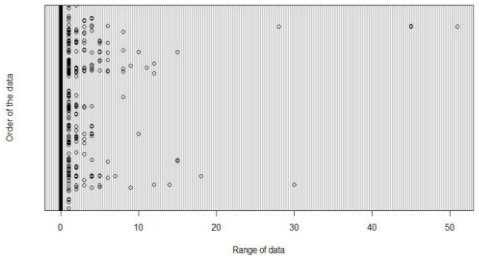
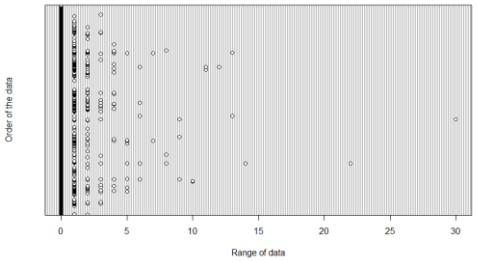
- **Gannet**

	On the sea			In flight		
Outliers						
Zero inflation	Zero Observations	Total observations	% Zero Observations	Zero Observations	Total observations	% Zero Observations
	11039	11148	99.02	10817	11148	97.03

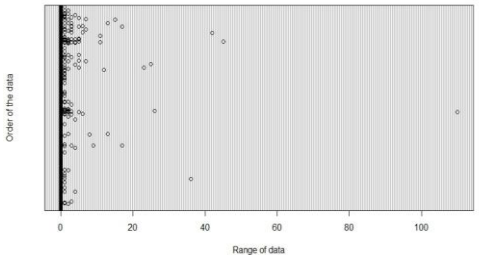
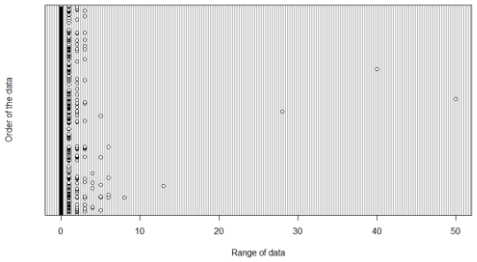
- **Cormorant**

	On the sea			In flight		
Outliers						
Zero inflation	Zero Observations	Total observations	% Zero Observations	Zero Observations	Total observations	% Zero Observations
	10921	11148	97.96	10764	11148	96.56

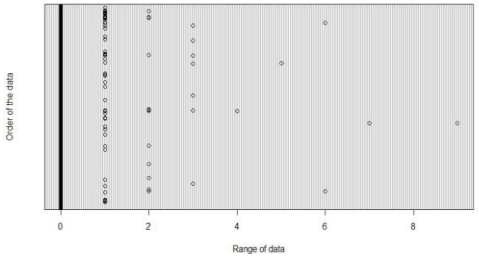
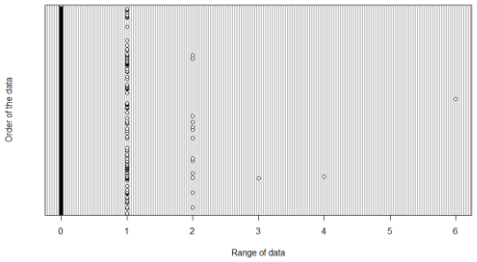
- **Kittiwake**

	On the sea			In flight		
Outliers						
Zero inflation	Zero Observations	Total observations	% Zero Observations	Zero Observations	Total observations	% Zero Observations
	10822	11148	97.08	10662	11148	95.64

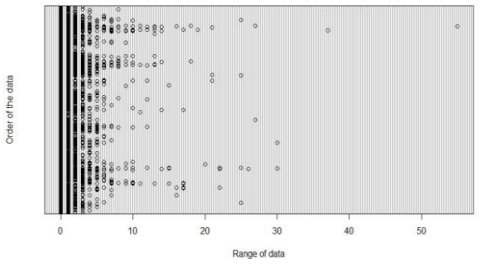
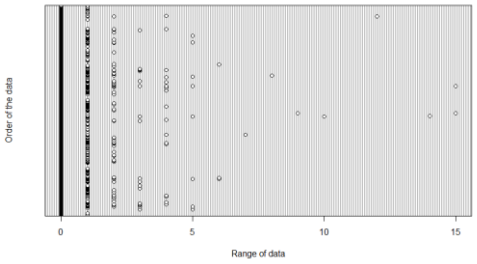
- **Herring gull**

	On the sea			In flight		
Outliers						
Zero inflation	Zero Observations	Total observations	% Zero Observations	Zero Observations	Total observations	% Zero Observations
	10978	11148	98.48	10720	11148	96.16

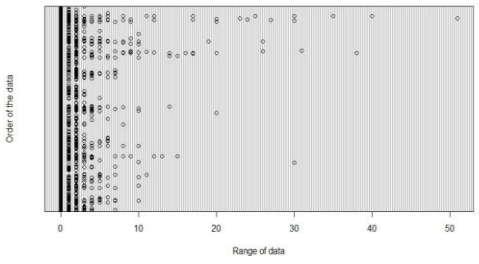
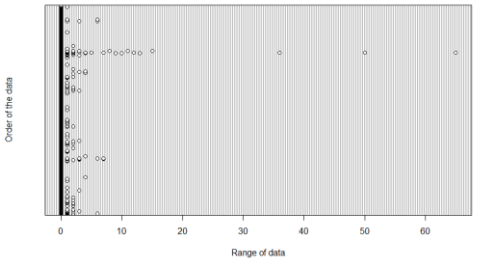
- **Great black-backed gull**

	On the sea			In flight		
Outliers						
Zero inflation	Zero Observations	Total observations	% Zero Observations	Zero Observations	Total observations	% Zero Observations
	11065	11148	99.26	11017	11148	98.82

- **Guillemot**

	On the sea			In flight		
Outliers						
Zero inflation	Zero Observations	Total observations	% Zero Observations	Zero Observations	Total observations	% Zero Observations
	8328	11148	74.70	10587	11148	94.97

- **Razorbill**

	On the sea			In flight		
Outliers						
Zero inflation	Zero Observations	Total observations	% Zero Observations	Zero Observations	Total observations	% Zero Observations
	10192	11148	91.42	10972	11148	98.42