Thanet Offshore Wind Farm

Ornithological Monitoring 2011-2012

Thanet Offshore Wind Limited

June 2012

Final Report

VATTENFALL

ROYAL HASKONING

Enhancing Society

A COMPANY OF

ROYAL HASKONING

HASKONING UK LTD.
ENVIRONMENT

Rightwell House
Bretton
Peterborough PE3 8DW
United Kingdom
+44 (0)1733 334455 Telephone
01733 333348 Fax
info@peterborough.royalhaskoning.com E-mail
www.royalhaskoning.com Internet

Document title	Thanet Offshore Wind Farm Ornithological Report
Status	Final Report
Date	September 2012
Project name	Thanet Offshore Wind Farm
Project number	9X1738
Client	Thanet Offshore Wind Limited
Reference	9X1738/R010/SP

Drafted by	Ecology Consulting
Checked by	Royal Haskoning
Date/initials check	
Approved by	
Date/initials approval	

CONTENTS

			Page
1		INTRODUCTION	2
2		PREVIOUS SURVEYS	3
3		STUDY AREA	4
4		SURVEY METHODS	8
5		SURVEY RESULTS	9
	5.1	Study Area Population Estimates	9
	5.2	Seabird Distributions	16
6		FLIGHT HEIGHTS	26
7		CONSERVATION EVALUATION	29
8		COMPARISON OF BIRD NUMBERS	32
	8.1	Analysis Methods	32
	8.2	Analysis Results	33
9		MARINE MAMMALS	37
10		CONCLUSION	40
	10.1	Comparison with ES Predictions	40
	10.2	Further Analysis	41
11		REFERENCES	41

1 INTRODUCTION

This report presents the results of the second winter of bird surveys that have been undertaken for the post-construction phase monitoring as part of the Thanet Offshore Wind Farm FEPA monitoring programme. The surveys reported here cover the monitoring work carried out between October 2011 and March 2012.

The main aim of the FEPA monitoring program is to determine the distribution and abundance of seabirds using the Thanet Offshore Wind Farm site and its surrounds before, during and after the construction phase of the wind farm. Standard survey methodologies have been used, following Camphuysen et al. (2004) and have remained consistent throughout the pre, during and post-construction monitoring.

The Thanet Offshore Wind Farm (Thanet) project is located in the Thames Estuary Strategic Environmental Assessment (SEA) area, approximately 11km off Foreness Point, within the Outer Thames Estuary. The Thanet project received consent in December 2006, with the most recent FEPA license being dated July 2010 (33119/10/1).

The Thanet project consists of 100 Vestas V90 3MW wind turbines located in water depths of 15-25m below chart datum, and extends over an area of 35km^2. Each turbine is 115m tall at its highest point, with a minimum clearance above sea level of 22m. The turbine separation is approximately 500m along rows and 800m between rows.

The 2011-12 surveys are considered to be post construction as the installation of the 100 turbines and the offshore substation has now been completed. Additional construction activities continue to take place on site but are not considered to have a significant influence on the bird species using the Thanet site due to the nature of the works being underwater. These activities included the replacement of a faulty joint close to the intertidal zone near Pegwell Bay (October 2011), and the replacement of 300m of the export cable close to the offshore substation (ongoing), and cable protection through rock placement (late January 2012 - March 2012).

The FEPA Licence conditions relevant to ornithological monitoring are summarised in Section 4 of the Environmental Monitoring Plan for Thanet (Royal Haskoning 2011) and reported in the construction phase annual report (Royal Haskoning 2010). A number of conditions were imposed as part of the consents for the Thanet project, one of which relates to continued ornithological monitoring of the site, with the project's FEPA Licence (33119/10/1) stating:

"9.11 Ornithological monitoring must be carried out as outlined in Annex 2 attached to this Schedule. The full specification for the monitoring programme will be subject to separate written agreement with the Licensing Authority following consultation with Natural England prior to the proposed commencement of the monitoring work; and

9.12 Post-construction monitoring during the operational phase of the wind farm must be undertaken annually for three years. The level of any subsequent ornithological monitoring, during the lifetime of the wind farm's operation, will be determined, in consultation with Natural England, having regard to the magnitude of any change in bird populations observed during the initial monitoring period."

Further to this, Annex 2 of the FEPA Licence 33119/10/1 states that:

"Monitoring will comprise a Before and After Control Impact (BACI) design and will be undertaken at the survey areas consisting of the windfarm site, a 1km and 2–4km buffer zone surrounding the windfarm and the selected reference site. The monitoring programme will be implemented in advance of construction and continue through the construction phase. There is also a requirement to conduct post-construction monitoring to provide a minimum of three years data from the operating phase. These data will need to be empirically comparative with baseline data provided within the project's Environmental Statement. The detailed specification for the monitoring programme, including the location and extent of the reference site, will be subject to separate written agreement with the Licensing Authority following consultation with Natural England prior to the proposed commencement of the monitoring work (see licence condition 9.11).

The need for additional ornithological monitoring, on-going during the lifetime of the wind farm's operation, will be determined, in consultation with Natural England and DEFRA and reviewed at agreed periods. This will have regard to the magnitude of any change in bird populations observed during the initial three years operational monitoring period (as per licence condition 9.12). The ornithological monitoring programme may have to be adapted and amended as new technologies and research findings become available, as determined by Natural England and the Licensing Authority. Ornithological monitoring reports will be provided to Natural England on a quarterly basis as a draft report update and as a final annual report. This may be more frequent where the results of the data may trigger further, more intensive monitoring work. Monitoring of the agreed reference site will also continue parallel to the wind farm site and the 1km and 2 – 4km buffer zones surrounding the wind farm. Monitoring will need to fulfil the following objectives:

1. Determine whether there is change in bird use and passage, measured by species (with particular reference to red-throated diver), abundance and behaviour, of the wind farm site, 1km and 2 – 4km buffer zones and the reference site;

2. Determine whether there is a barrier effect to movement of birds through the wind farm site and the 1km and 2–4km buffer zones;

3. Continue to determine the distribution of wildfowl and divers in the Greater Thames estuary, covering the Thanet windfarm site, 1km and 2–4km buffer zones and the reference site; and

4. If objectives 1 or 2 reveal significant change of use of the wind farm site and 1km and 2–4km buffer zones by populations of conservation concern, at heights that could incur collision, a programme of collision monitoring will be implemented."

2 PREVIOUS SURVEYS

A programme of baseline bird surveys was undertaken for the ornithological impact assessment of the project that was reported in the Environmental Statement for the Thanet application (Royal Haskoning 2005). Surveys were then conducted during the construction phase of the project in February - March 2009 and October 2009 - March 2010, reported by Royal Haskoning (2009, 2010) and the first year post-construction (Percival 2012). The data available for comparison with the second year's post-construction monitoring data therefore comprise:

Pre-construction:

- Boat-based surveys – twelve boat-based surveys were carried out at monthly intervals between November 2004 and October 2005; and
- Aerial surveys – four aerial surveys were carried out between November 2004 and March 2005.

Construction phase surveys:

- Boat-based surveys – one in February and two in March 2009; and
- Boat-based surveys – two per month from October 2009 – March 2010.

Post-construction phase surveys:

- Boat-based surveys – two per month from October 2010 – March 2011.

This report presents the ornithological data collected during the second winter of the post-construction monitoring during the phase completed over the period October 2011 to March 2012.

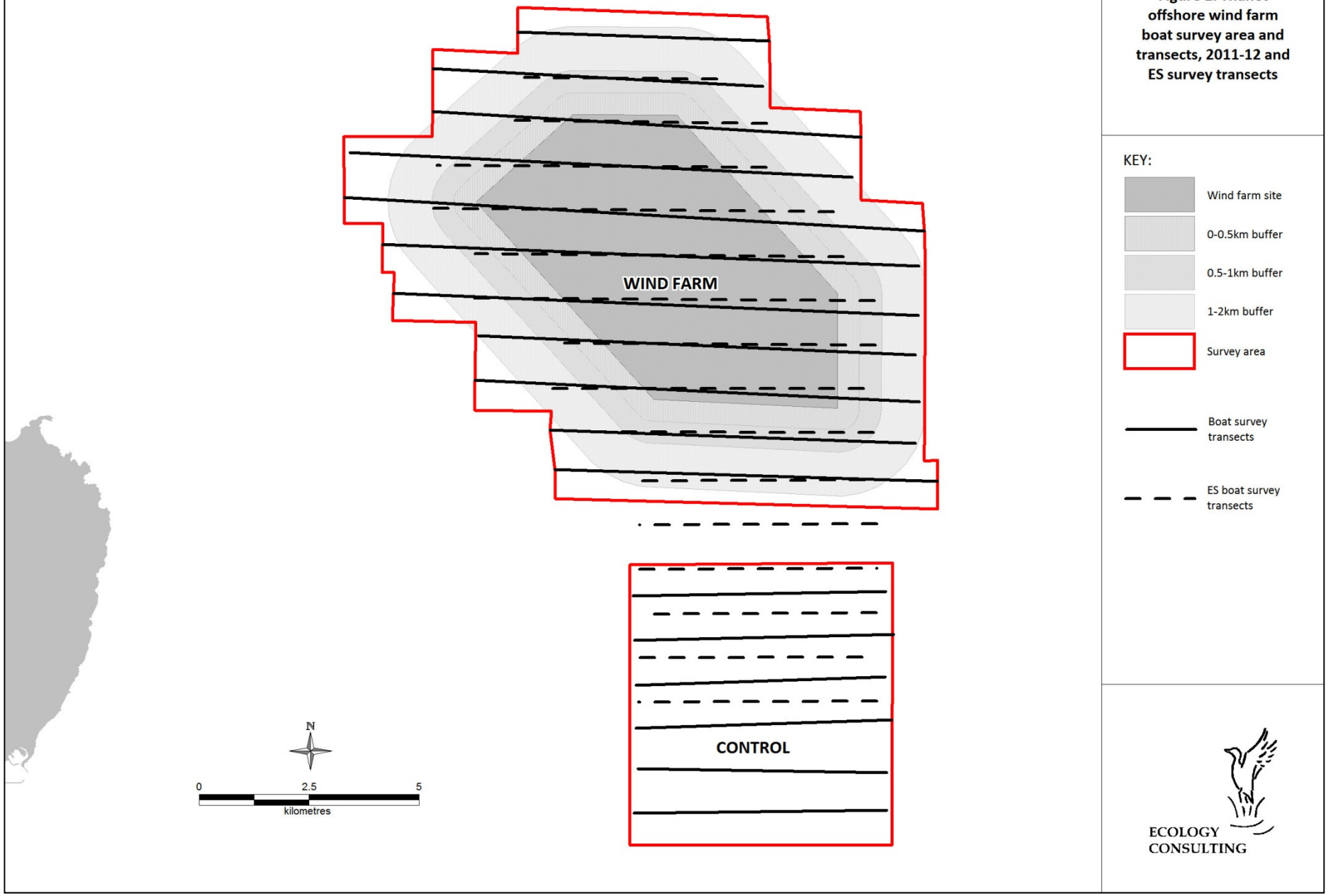
3 STUDY AREA

The pre-construction boat surveys reported in the ES covered a smaller area (100km^2) than that being surveyed in the construction and post-construction periods, comprising the wind farm site plus a 1km buffer (67km^2) and a control area to the south (33km^2). The transects used for those surveys are shown in Figure 1.

The survey area was expanded in 2009 to a total area of 149km^2, to include the wind farm site plus a 2km buffer (111km^2) and a separate control area of 38km^2 to the south (see Figure 1), as agreed with DEFRA[1].

[1] Gary James, DEFRA, email of 13/3/09.

Figure 1. Thanet offshore wind farm boat survey area and transects, 2011-12 and ES survey transects



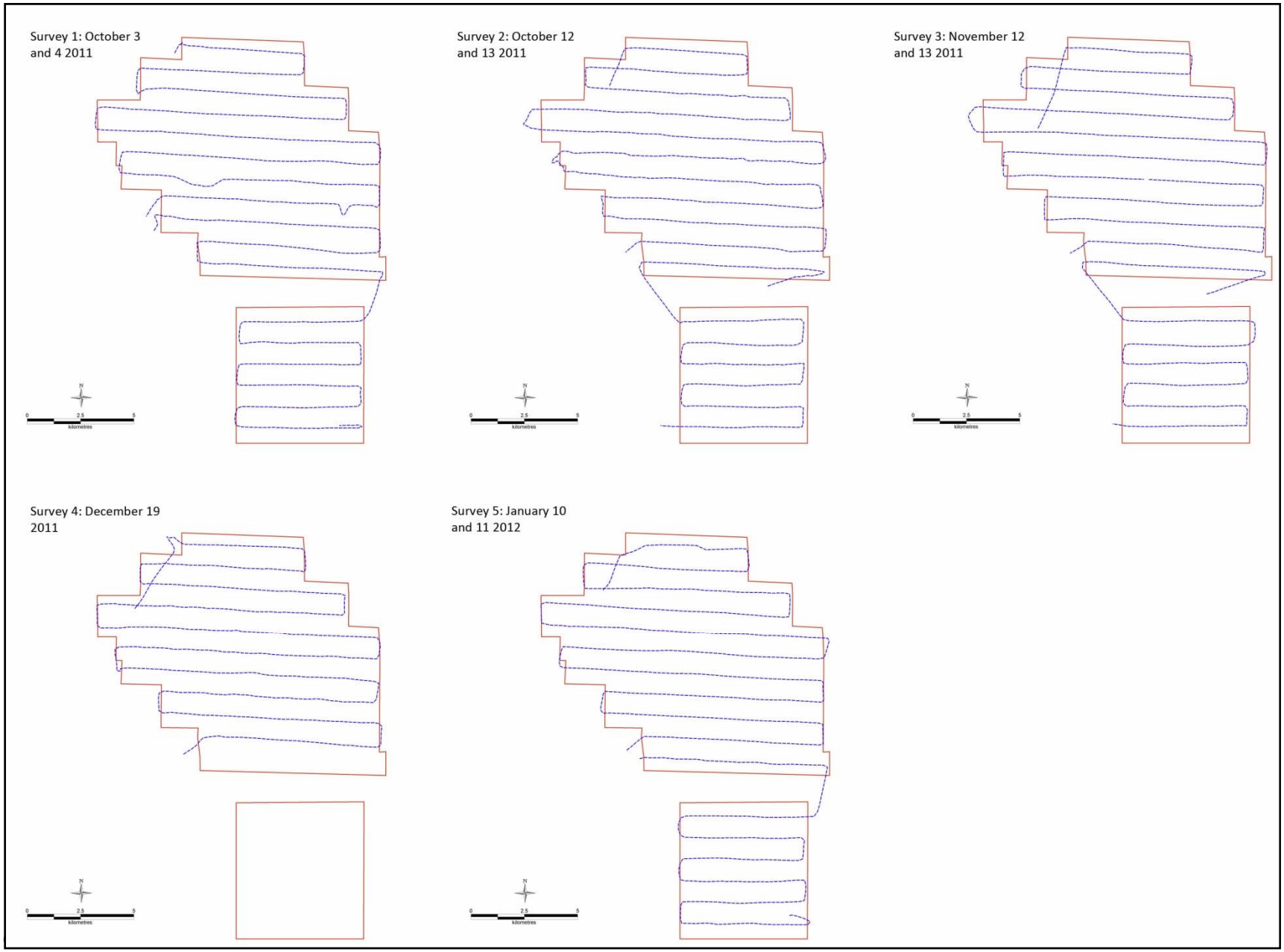


Figure 2a. GPS tracks from Thanet Offshore boat surveys, October 2011 – early January 2012.

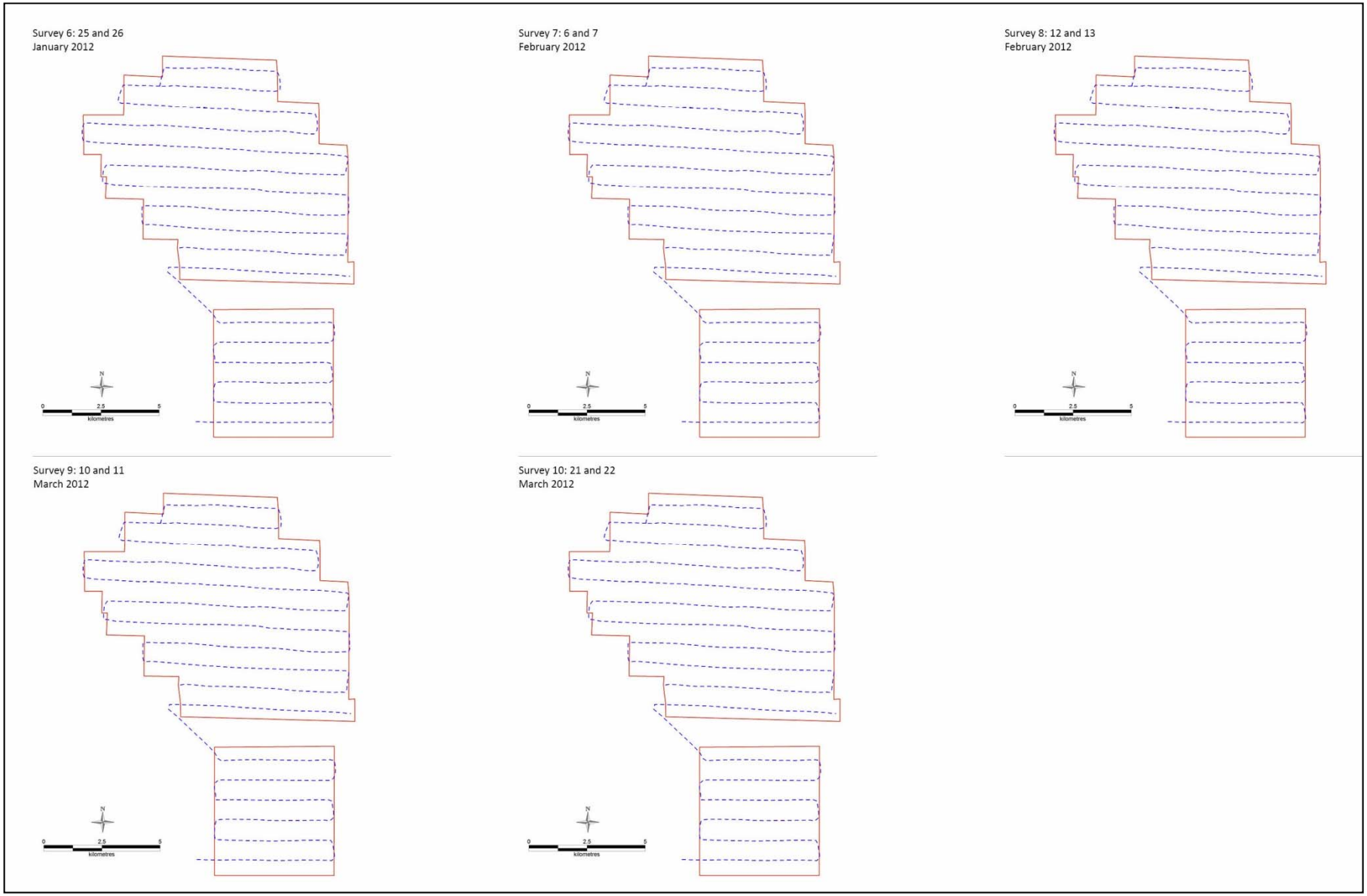


Figure 2b. GPS tracks from Thanet Offshore boat surveys, late January - March 2012

4 SURVEY METHODS

The survey methods follow those detailed in the Thanet Offshore Wind Farm – During and Post-Construction Bird Monitoring Protocol ('the Protocol') (Thanet Offshore Wind Limited (TOW), 2009). The Protocol was developed in consultation with Natural England and the Marine and Fisheries Agency (MFA) (now the Marine Management Organisation (MMO)) in order to meet the requirements of the Thanet FEPA licence. Further details of the survey methodology are provided in the Protocol.

The surveys comprise boat-based line transects of the study area, broadly following the methodology recommended in Camphuysen et al., (2004). The surveys in the second year of the post-construction phase were carried out using the same protocol as for the construction phase works, twice-monthly during the October – March period. Monitoring surveys will continue for a further (third) year during the project's operation, continuing the pattern of two surveys per month between October and March.

The same vessel was used for these surveys as for the pre-construction, the construction phase and the first winter's post-construction surveys, the 'Arie Dirk'. This vessel cruises the transects at about 8 knots and has a viewing height of about 5m above the level of the sea. It is ideal for the work being of a size and a manoeuvrability (with an experienced local crew) to enable safe operation close inshore and around busy shipping channels.

The same survey transects were used as for the pre-construction baseline surveys and construction phase surveys (Figure 1). The survey route was designed to provide approximately a 1km interval between transects; a total of 17 transects were surveyed, all running approximately east-west. This separation distance was chosen to ensure that an adequate 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 hence double-counted).

A GPS record of the precise route was taken on each trip, so that the location at all times was known. The GPS tracks for each survey are shown in Figure 2. A total of 10 surveys were undertaken during the 2011 -2012 winter on the following dates. Following a long period of inclement weather in November and December 2011 (during which only single surveys each month were possible, with the December survey only covering the wind farm site not the control area – see Figure 2), it was agreed with Natural England that surveys for the remaining part of the winter should continue at two per month through to the end of March.

- 3 and 4 October 2011;
- 12 and 13 October 2011;
- 12 and 13 Nov 2011;
- 19 December 2011 (incomplete survey due to deteriorating weather conditions);
- 10 and 11 January 2012;

- 24 and 25 January 2012;
- 6 and 7 February 2012;
- 12 and 13 February 2012;
- 10 and 11 March 2012;
- 21 and 22 March 2012.

The observation team in 2011 -2012 comprised Jon Ford, Ian Harding and Peter Dodds, who were each involved in both observation and recording. Three surveyors were deployed at all times in order to allow rotation of duties and to enable one surveyor to be free to undertake continual forward scanning for the detection of species that may be flushed from the sea surface. The team are experienced ornithologists, well able to identify all the species encountered accurately. All observers also have a good knowledge of the area and its ornithological interests, and are also trained Marine Mammal Observers.

All birds encountered, their behaviour, flight height and approximate distance from the boat were recorded. Following the JNCC Seabirds at Sea recommendations, birds were recorded into five distance bands (0-50m, 50-100m, 100-200m, 200-300m and 300+m). Birds were recorded continuously, at a steady speed of approximately 8 knots, with the precise time of each observation recorded where possible to give as accurate a position as possible (linking to the GPS position information being recorded simultaneously). All records of birds observed flying as well as those on the sea were recorded. All sightings of marine mammals were also recorded during the surveys.

The approximate height above the sea of all flying birds was recorded. Flying birds were recorded using snapshot counts at one-minute intervals. Whilst all birds observed were recorded, a note of those “in transect” was made to facilitate later analysis. The flight height categories were as follows:

- <20m
- 20-120m (equivalent to the approximate height of the wind turbine rotors)
- >120m

5 SURVEY RESULTS

5.1 Study Area Population Estimates

The total population estimates within the study area for each survey, based on counts from the main survey transect sampling area (within 300m of the survey vessel) corrected for distance sampling and survey coverage, are shown in Table 1.

Table 1. Survey Area total population estimates corrected for distance sampling and survey coverage, October 2011 – March 2012.

Species	3-4 Oct	12-13 Oct	12-13 Nov	19 Dec	10-11 Jan	24-25 Jan	6-7 Feb	12-13 Feb	10-11 Mar	21-22 Mar
Brent goose	0	68	2	0	0	65	0	0	0	0
Shelduck	0	0	2	0	0	0	0	0	0	0
Common scoter	0	8	0	0	2	0	0	0	0	0
Red-throated diver	0	0	12	0	43	46	67	262	26	4
Black-throated diver	0	0	2	0	0	3	5	2	2	0
diver sp	0	0	7	0	6	8	8	33	23	3
Great crested grebe	0	0	0	0	0	0	0	2	0	0
grebe sp	0	0	0	0	0	0	2	0	0	0
Fulmar	2	0	0	0	11	71	17	28	28	10
Gannet	40	60	514	50	27	28	9	181	132	83
Cormorant	0	2	0	0	0	0	0	0	0	0
Shag	0	0	0	0	0	0	0	0	0	2
Ringed plover	0	2	0	0	0	0	0	0	0	0
Great Skua	7	26	3	2	0	0	0	0	0	0
skua sp	0	0	0	0	0	2	0	0	0	0
Common gull	8	0	33	14	20	10	130	231	24	45
Lesser black-backed gull	209	406	103	17	34	53	40	109	219	54
Glaucous gull	0	0	0	0	0	2	0	0	0	0
Herring gull	1,670	129	111	37	110	59	50	157	426	79
Great black-backed gull	510	727	412	68	139	103	60	156	189	171
Little gull	0	0	2	2	0	0	0	0	0	0
Black-headed gull	3	0	0	2	3	0	3	0	0	0
Kittiwake	7	177	290	210	335	301	159	274	58	0
small gull sp	2	0	0	2	0	0	0	0	0	0
large gull sp	913	347	29	63	54	29	18	31	306	42
black-backed gull sp	0	23	69	5	16	24	5	0	32	2
Sandwich tern	3	2	0	0	0	0	0	0	0	3
Guillemot	30	18	146	169	1,031	1,067	1,553	991	40	2
Razorbill	3	0	20	270	285	211	249	91	0	0
Guillemot/Razorbill	2	0	0	0	0	0	0	0	0	0

Species	3-4 Oct	12-13 Oct	12-13 Nov	19 Dec	10-11 Jan	24-25 Jan	6-7 Feb	12-13 Feb	10-11 Mar	21-22 Mar
auk sp	3	0	72	131	646	588	737	477	7	5
Short-eared owl	0	2	0	0	0	0	0	0	0	0
Skylark	0	0	18	0	0	0	0	0	0	0
Sand martin	3	0	0	0	0	0	0	0	0	0
hirundine sp	25	0	0	0	0	0	0	0	0	0
Swallow	8	0	0	0	0	0	0	0	0	0
Meadow pipit	0	0	0	0	0	0	0	0	5	0
Pied wagtail	0	0	0	0	0	0	0	0	0	2
Whinchat	3	0	0	0	0	0	0	0	0	0
Blackbird	0	65	3	0	0	0	0	0	0	0
Fieldfare	0	7	0	0	0	0	0	0	0	0
thrush sp	0	15	0	0	0	0	0	0	0	0
Song thrush	0	2	0	0	0	0	0	0	0	0
Redwing	0	185	0	0	0	0	0	0	0	0
Starling	2	0	182	0	0	0	0	0	0	0
Chaffinch	0	33	0	0	0	0	0	0	0	0
finch sp	0	43	0	0	0	0	0	0	0	0
passerine sp	0	0	0	0	0	0	0	0	0	2

The distribution of the birds in relation to the wind farm area has been summarised into 1km bands in Table 2. This Table gives the mean and peak counts recorded during 2011 - 2012 within the wind farm site, within a 1km buffer around the site, within the 1-2km zone and in the control area (6-11km from the nearest wind turbine). These areas cover 35, 27, 33 and 38 km^2 respectively.

Table 2. Mean and peak population estimates for main species zones within and around the wind farm corrected for distance sampling and survey coverage in 2011-12.

	Mean estimate for each zone				Peak estimate for each zone			
Species	**Wind farm site**	**0-1km**	**1-2km**	**Control**	**Wind farm site**	**0-1km**	**1-2km**	**Control**
Red-throated diver	2	7	11	23	13	23	106	156
Black-throated diver	0	0	0	1	0	2	2	3
diver sp	0	3	1	3	2	16	13	8
Fulmar	0	1	4	8	2	7	44	32
Gannet	6	15	17	65	28	67	167	347
Common gull	15	10	10	13	67	45	102	70
Lesser black-backed	22	35	30	27	81	153	298	45

	Mean estimate for each zone				Peak estimate for each zone			
Species	**Wind farm site**	**0-1km**	**1-2km**	**Control**	**Wind farm site**	**0-1km**	**1-2km**	**Control**
gull								
Herring gull	31	168	35	27	102	1437	355	62
Great black-backed gull	40	110	27	66	79	546	273	233
Black-headed gull	1	0	0	0	3	0	3	0
Kittiwake	32	31	45	57	84	67	453	138
black-backed gull sp	5	4	2	5	25	26	21	19
large gull sp	39	9	14	34	294	30	137	210
Guillemot	56	90	128	172	187	234	1281	552
Razorbill	24	29	30	22	91	84	304	71
auk sp	21	48	59	125	63	145	594	529

The bird numbers recorded in each of these zones in the previous construction phase (2009-10) and post-construction (2010-11) surveys are given in Table 3a and 3b for comparison of the mean and peak counts respectively. Statistical analysis of these differences in bird numbers and a comparison with the pre-construction numbers are given in Section 8 of this report below.

Table 3a. Comparison of mean population estimates for main species zones within and around the wind farm based on 'in-transect' counts corrected for distance sampling and survey coverage in 2009-10 (construction phase), and 2010-11 and 2011-12 (post-construction).

Species	**Wind farm site**			**0-1km**			**1-2km**			**Control**		
	09-10	**10-11**	**11-12**	**09-10**	**10-11**	**11-12**	**09-10**	**10-11**	**11-12**	**09-10**	**10-11**	**11-12**
Red-throated Diver	1	2	2	1	5	7	3	7	11	2	8	23
Gannet	2	2	6	4	4	15	7	9	17	21	34	65
Common Gull	119	40	15	68	20	10	56	26	10	41	17	13
Lesser Black-backed Gull	25	14	22	13	14	35	23	31	30	16	42	27
Herring Gull	19	32	31	15	28	168	84	88	35	27	69	27
Great Black-blacked Gull	12	14	40	4	71	110	7	24	27	13	141	66
Kittiwake	29	54	32	15	26	31	44	27	45	10	44	57
Guillemot	10	14	56	20	38	90	28	62	128	22	58	172
Razorbill	1	1	24	3	3	29	6	3	30	8	15	22

Table 3b. Comparison of peak population estimates for main species zones within and around the wind farm based on 'in-transect' counts corrected for distance sampling and survey coverage in 2009-10 (construction phase), and 2010-11 and 2011-12 (post-construction).

Species	Wind farm site			0-1km			1-2km			Control		
	09-10	10-11	11-12	09-10	10-11	11-12	09-10	10-11	11-12	09-10	10-11	11-12
Red-throated Diver	6	7	13	3	41	23	8	24	106	10	27	156
Gannet	22	12	28	16	12	67	32	31	167	95	99	347
Common Gull	716	150	67	430	55	45	222	71	102	342	58	70
Lesser Black-backed Gull	132	28	81	66	27	153	125	200	298	43	253	45
Herring Gull	52	56	102	36	32	1437	663	276	355	116	167	62
Great Black-blacked Gull	56	72	79	13	716	546	22	111	273	53	1,508	233
Kittiwake	141	287	84	43	52	67	302	62	453	33	145	138
Guillemot	95	79	187	93	130	234	99	213	1281	70	175	552
Razorbill	6	9	91	21	7	84	54	11	304	61	94	71

The bird densities recorded in each of these zones in 2011-12 are compared in Table 4. This takes into account the differing extents of these zones (standardising for area by presenting the data as densities). Densities of divers and auks were clearly lower within the wind farm site than elsewhere (as had been noted in the 2010-11 surveys but were broadly similar across the buffers zones and in the control area. Gull densities across these zones were variable, with no clear relationship to distance from the wind farm, as had been found in 2010-11. Statistical analysis of the differences in bird numbers and a comparison with the pre-construction numbers are given in Section 8 of this report below.

Table 4. Mean and peak bird densities for zones within and around the wind farm based on counts corrected for distance sampling and survey coverage in 2011-12.

	Mean density for each zone				Peak density for each zone			
Species	Wind farm site	0-1km	1-2km	Control	Wind farm site	0-1km	1-2km	Control
Red-throated diver	0.06	0.25	0.32	0.61	0.37	0.83	3.22	4.10
Black-throated diver	0	0.01	0.01	0.02	0	0.06	0.06	0.09
diver sp	0.01	0.11	0.04	0.07	0.05	0.59	0.39	0.20
Fulmar	0	0.05	0.13	0.21	0.05	0.25	1.34	0.84
Gannet	0.17	0.57	0.51	1.72	0.81	2.47	5.05	9.12
Common gull	0.42	0.37	0.31	0.35	1.90	1.67	3.08	1.84
Lesser black-backed gull	0.62	1.29	0.90	0.71	2.32	5.68	9.04	1.20
Herring gull	0.87	6.23	1.08	0.70	2.92	53.21	10.75	1.62
Great black-backed gull	1.16	4.06	0.83	1.73	2.25	20.22	8.26	6.14

	Mean density for each zone				Peak density for each zone			
Species	**Wind farm site**	**0-1km**	**1-2km**	**Control**	**Wind farm site**	**0-1km**	**1-2km**	**Control**
Black-headed gull	0.02	0	0.01	0	0.10	0	0.10	0
Kittiwake	0.92	1.14	1.37	1.50	2.40	2.48	13.72	3.62
black-backed gull sp	0.14	0.14	0.06	0.13	0.72	0.97	0.63	0.50
large gull sp	1.10	0.33	0.42	0.89	8.39	1.11	4.15	5.52
Guillemot	1.59	3.35	3.88	4.53	5.33	8.68	38.82	14.52
Razorbill	0.68	1.08	0.92	0.57	2.61	3.10	9.23	1.88
auk sp	0.61	1.78	1.80	3.30	1.81	5.36	18.00	13.93

The bird densities recorded in each of these zones in 2009-10 and 2010-11 are given in Table 5a and 5b for comparison.

Table 5a. Mean and peak bird densities for zones within and around the wind farm based on 'in-transect' counts corrected for distance sampling and survey coverage in 2009-10.

	Mean density for each zone				Peak density for each zone			
Species	**Wind farm site**	**0-1km**	**1-2km**	**Control**	**Wind farm site**	**0-1km**	**1-2km**	**Control**
Red-throated diver	0.03	0.01	0.08	0.05	0.17	0.11	0.24	0.26
Gannet	0.07	0.14	0.20	0.55	0.63	0.59	0.97	2.50
Common gull	3.39	2.51	1.68	1.07	20.46	15.93	6.73	9.00
Lesser black-backed gull	0.71	0.50	0.70	0.41	3.77	2.44	3.79	1.13
Herring gull	0.55	0.57	2.53	0.72	1.49	1.33	20.09	3.05
Great black-blacked gull	0.33	0.15	0.21	0.33	1.60	0.48	0.67	1.39
Kittiwake	0.81	0.56	1.34	0.27	4.03	1.59	9.15	0.87
Guillemot	0.29	0.73	0.84	0.57	2.71	3.44	3.00	1.84
Razorbill	0.02	0.09	0.19	0.21	0.17	0.78	1.64	1.61

Table 5b. Mean and peak bird densities for zones within and around the wind farm based on counts corrected for distance sampling and survey coverage in 2010-11.

	Mean density for each zone				Peak density for each zone			
Species	**Wind farm site**	**0-1km**	**1-2km**	**Control**	**Wind farm site**	**0-1km**	**1-2km**	**Control**
Red-throated diver	0.06	0.20	0.20	0.22	0.19	1.50	0.72	0.72
Black-throated diver	0.00	0.06	0.03	0.08	0.00	0.19	0.10	0.50
diver sp	0.02	0.15	0.05	0.06	0.10	0.86	0.17	0.54
Fulmar	0.00	0.03	0.03	0.14	0.05	0.12	0.15	0.35
Gannet	0.05	0.16	0.28	0.89	0.33	0.43	0.93	2.62

	Mean density for each zone				Peak density for each zone			
Species	**Wind farm site**	**0-1km**	**1-2km**	**Control**	**Wind farm site**	**0-1km**	**1-2km**	**Control**
Common gull	1.15	0.75	0.80	0.46	4.30	2.04	2.14	1.53
Lesser black-backed gull	0.40	0.53	0.93	1.11	0.81	0.99	6.06	6.67
Herring gull	0.90	1.03	2.67	1.81	1.60	1.18	8.36	4.39
Great black-backed gull	0.39	2.63	0.74	3.72	2.05	26.52	3.37	39.68
Black-headed gull	0.02	0.04	0.04	0.05	0.10	0.19	0.25	0.48
Kittiwake	1.55	0.97	0.81	1.17	8.19	1.93	1.88	3.82
large gull sp	0.43	0.68	2.00	0.77	1.37	2.22	14.77	4.43
Guillemot	0.39	1.43	1.89	1.52	2.25	4.80	6.46	4.60
Razorbill	0.03	0.11	0.08	0.38	0.25	0.25	0.32	2.47
auk sp	0.16	0.48	0.80	1.69	1.02	2.81	3.14	7.03

A comparison between the densities of the main species found during the pre-construction (ES) surveys in 2004 -2005, the construction phase (2009 -2010) and the first two year's post-construction surveys (2010-11 and 2011-12) is shown in Table 6. Data from 1-2km buffer are not included as that zone was not fully surveyed in the ES surveys (though some sample areas were covered enabling some analysis of that area to be undertaken – see Section 8 below). Statistical analysis comparing the differences in bird numbers between the pre-construction, construction and post-construction periods are given in Section 8 of this report below.

Table 6. Densities of the main seabird species present in the survey area during Oct-Mar in the pre-construction (ES), construction (2009-10) and post-construction (2010-11 and 2011-12) surveys. Densities are given as mean numbers per km^2.

	Wind Farm				0-1km Buffer				Control			
	ES	**09-10**	**10-11**	**11-12**	**ES**	**09-10**	**10-11**	**11-12**	**ES**	**09-10**	**10-11**	**11-12**
All Divers	0.29	0.03	0.08	0.07	0	0.01	0.41	0.38	0.04	0.05	0.36	0.70
Gannet	0.05	0.07	0.05	0.17	0	0.14	0.16	0.57	0.06	0.55	0.89	1.72
Common Gull	1.70	3.39	1.15	0.42	0	2.51	0.75	0.37	0.03	1.07	0.46	0.35
Lesser Black-backed Gull	0.33	0.71	0.41	0.62	1.44	0.5	0.53	1.29	0.76	0.41	1.11	0.71
Herring Gull	1.95	0.55	0.90	0.87	0.30	0.57	1.04	6.23	0.97	0.72	1.81	0.70
Great Black-blacked Gull	0.02	0.33	0.39	1.16	0.11	0.15	2.63	4.06	0.08	0.33	3.72	1.73
Kittiwake	0.20	0.81	1.56	0.92	0.15	0.56	0.98	1.14	0.14	0.27	1.17	1.50
All Gulls	4.32	5.79	4.83	5.24	2.81	4.29	6.59	13.5	1.98	2.80	9.02	6.01
Guillemot	0.69	0.29	0.39	1.59	0.65	0.73	1.43	3.35	1.32	0.57	1.53	4.53
Razorbill	0.22	0.02	0.03	0.68	0.22	0.09	0.11	1.08	0.14	0.21	0.39	0.57
All Auks	1.00	0.31	0.58	2.88	0.26	0	2.01	6.21	0.1	0	3.60	8.40

5.2 Seabird Distributions

The distributions of the main bird species observed during the 2011–12 surveys are shown in **Figures 3 - 11**. These show all of the data obtained during the surveys, not just those that were used to derive the population estimates presented above. They also show the extent of the wind farm site, the 1km and 2km buffers, the control reference area and the study area as a whole. Each of the main species is discussed in turn.

Divers (Figure 3): divers were widely distributed at low density across most of the study area, including the control area to the south (where several larger flocks were also observed in 2011-12, resulting in considerably higher numbers in that part of the survey area in that winter). As in the previous post-construction winter, a lower density of divers was recorded within the wind farm site itself.

Gannet: (Figure 4): gannets were more frequently recorded in the eastern part of the survey area, as they had been in 2010-11, and again with relatively few records within the wind farm itself.

Common Gull (Figure 5): common gulls were widely distributed over the whole study area, including within the wind farm.

Lesser Black-backed Gull (Figure 6): this was a widely distributed gull species, found in all parts of the study area including the wind farm, largely at quite an even low density but with two particular aggregations to the north (50) and to the south east (25) of the wind farm, both flocks associating with fishing trawlers.

Herring Gull (Figure 7): another widely distributed gull species, found in all parts of the study area including the wind farm, largely at quite an even low density but with one particular aggregations to the north (850) of the wind farm, a flock associating with a fishing trawler.

Great Black-backed Gull (Figure 8): this was a widely distributed gull species, found in all parts of the study area including the wind farm, largely at quite an even low density but with two particular aggregations to the north (200) and to the south east (250) of the wind farm, both flocks associating with fishing trawlers.

Kittiwake (Figure 9): this was another widely distributed gull species, found in all parts of the study area including the wind farm, which, as in 2010-11, held several of the larger aggregations of this species.

Guillemot (Figure 10): guillemots were widely distributed across the survey area, though with relatively few records within the wind farm. Numbers were higher in the eastern part of the survey area.

Razorbill (Figure 11): this species was more abundant and more widespread in 2011-12 than in the previous surveys, found in all parts of the study area including the wind farm.

As in previous surveys a small number of records of land-based species were also seen over-flying the study area, including brent goose, shelduck, ringed plover, short-eared owl, skylark, sand martin, swallow, meadow pipit, pied wagtail, whinchat, blackbird, fieldfare, song thrush, redwing, starling and chaffinch.

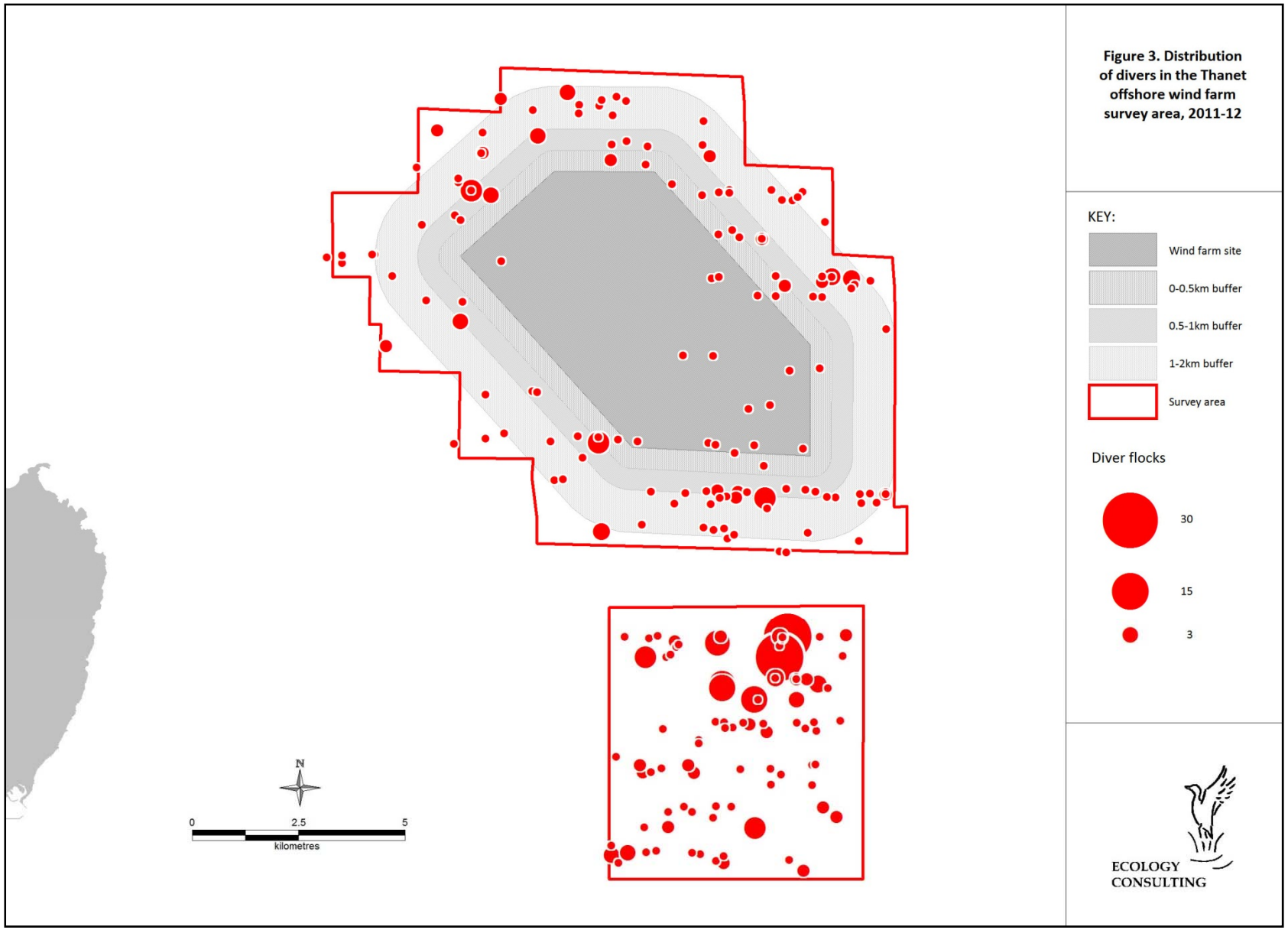


Figure 3. Distribution of divers in the Thanet offshore wind farm survey area, 2011-12

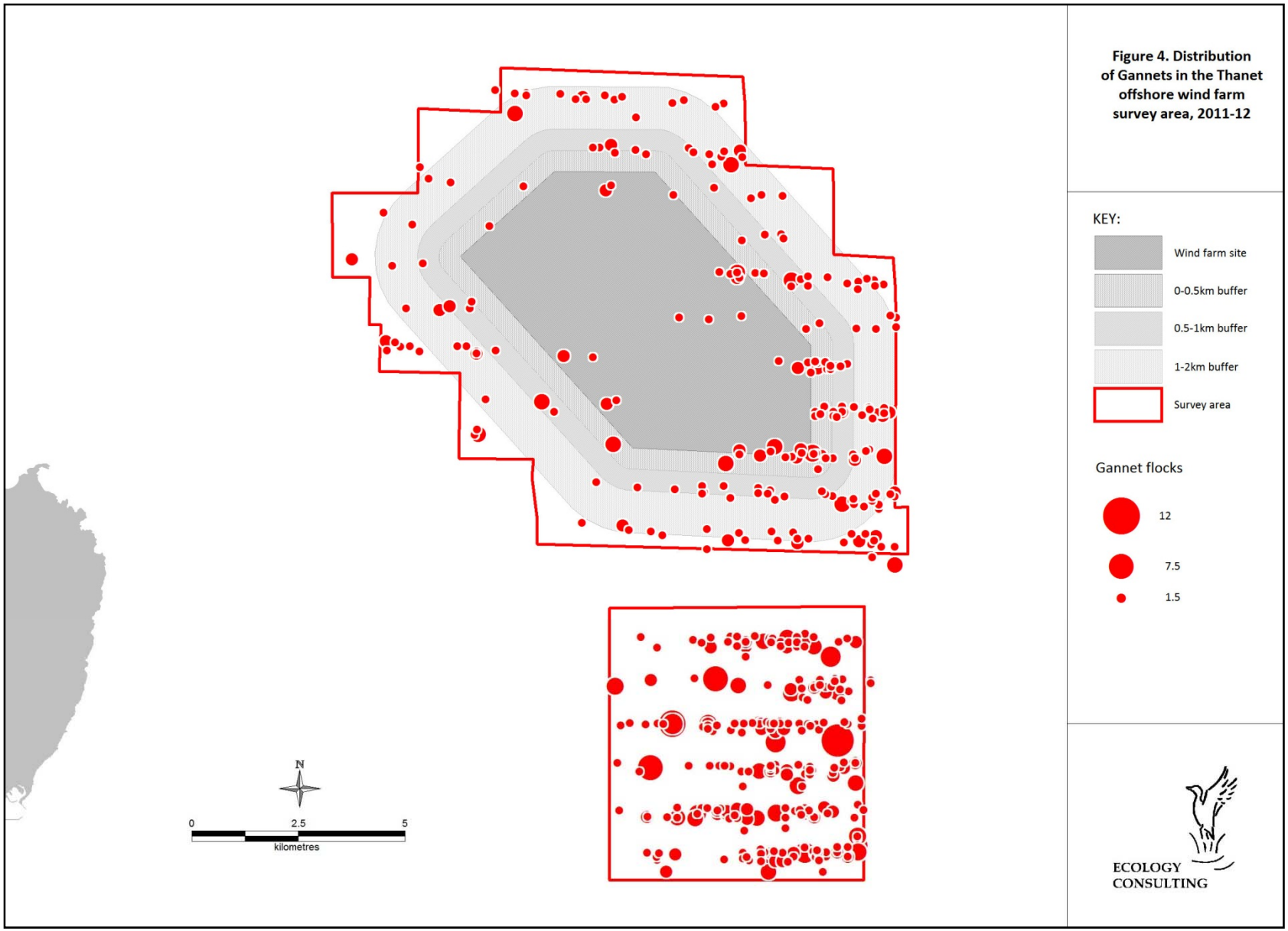


Figure 4. Distribution of Gannets in the Thanet offshore wind farm survey area, 2011-12
KEY:
Wind farm site
0-0.5km buffer
0.5-1km buffer
1-2km buffer
Survey area
Gannet flocks
12
7.5
1.5
N
0
2.5
5
kilometres
ECOLOGY CONSULTING

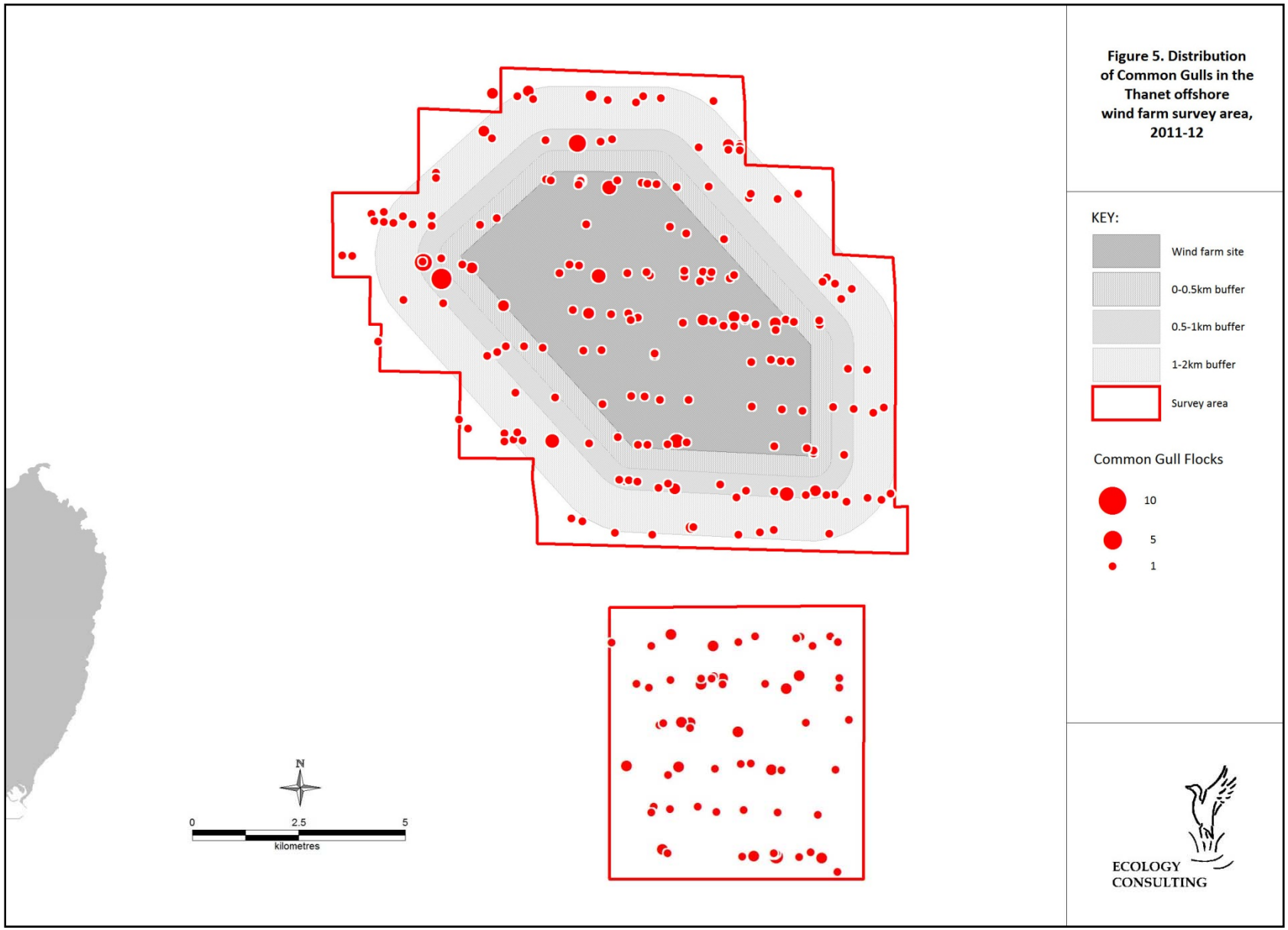


Figure 5. Distribution of Common Gulls in the Thanet offshore wind farm survey area, 2011-12
KEY:
Wind farm site
0-0.5km buffer
0.5-1km buffer
1-2km buffer
Survey area
Common Gull Flocks
10
5
1
N
0
2.5
5
kilometres
ECOLOGY CONSULTING

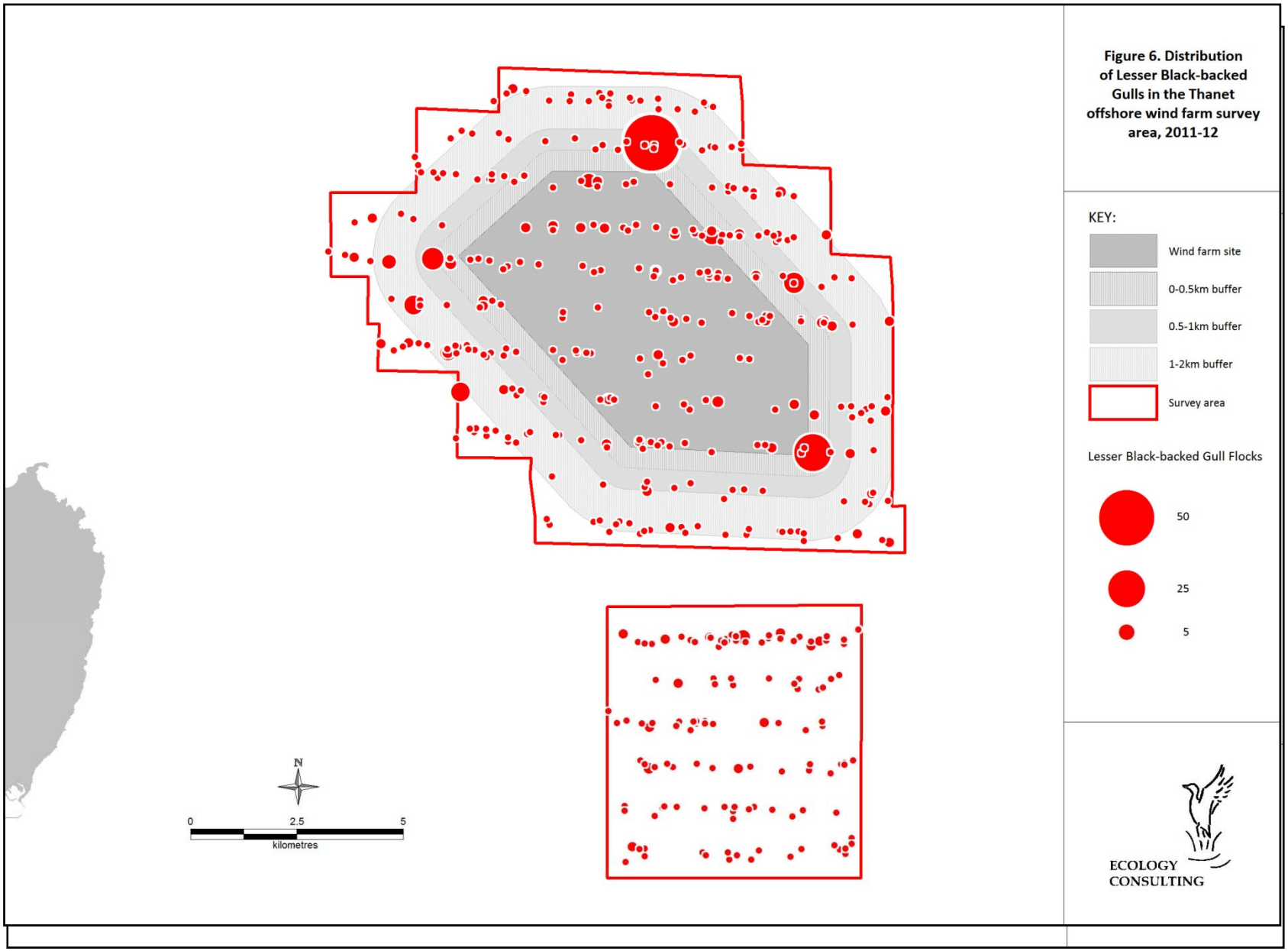


Figure 6. Distribution of Lesser Black-backed Gulls in the Thanet offshore wind farm survey area, 2011-12
KEY:
Wind farm site
0-0.5km buffer
0.5-1km buffer
1-2km buffer
Survey area
Lesser Black-backed Gull Flocks
50
25
5
N
0
2.5
5
kilometres
ECOLOGY CONSULTING

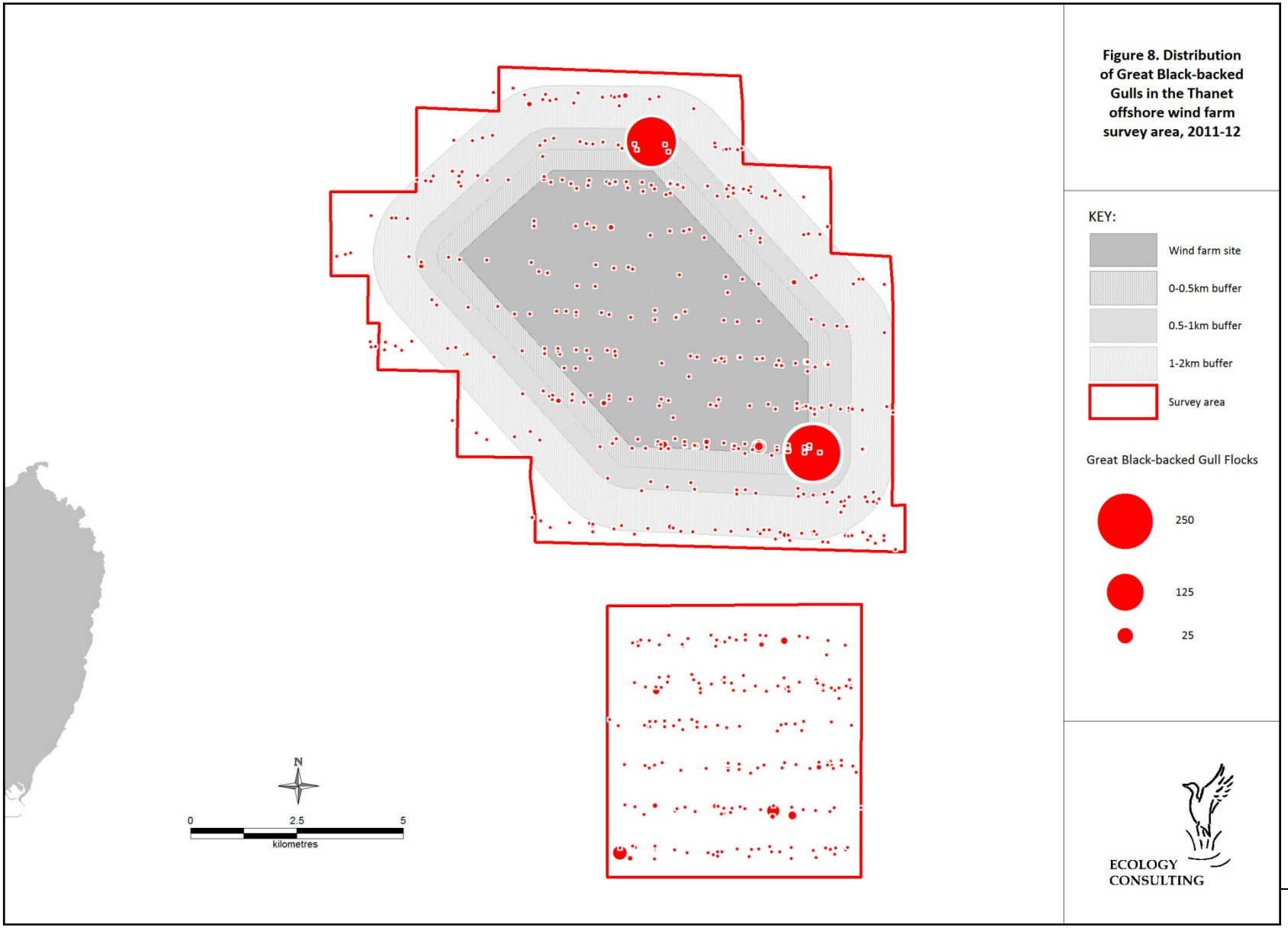


Figure 8. Distribution of Great Black-backed Gulls in the Thanet offshore wind farm survey area, 2011-12

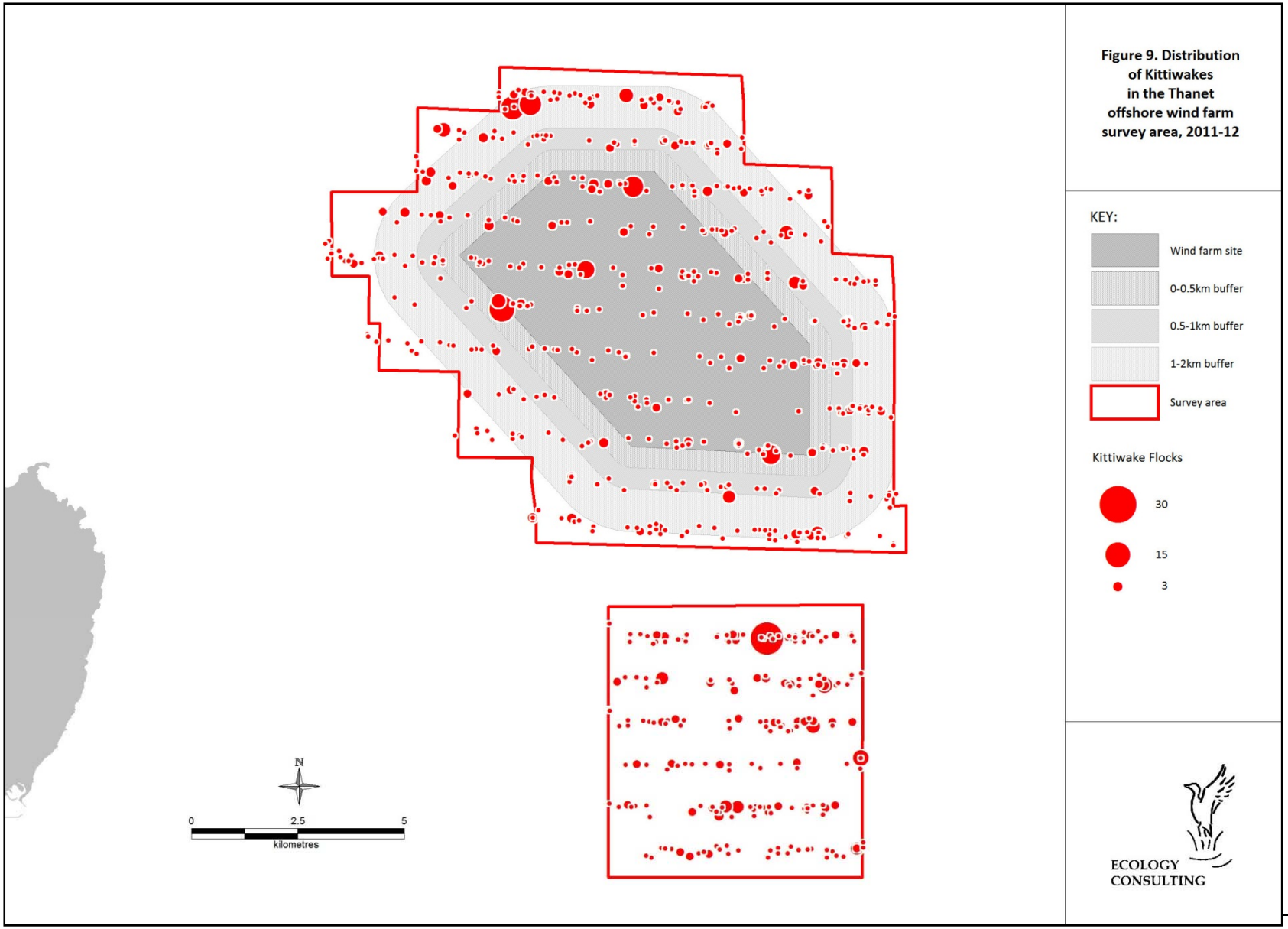


Figure 9. Distribution of Kittiwakes in the Thanet offshore wind farm survey area, 2011-12
KEY:
Wind farm site
0-0.5km buffer
0.5-1km buffer
1-2km buffer
Survey area
Kittiwake Flocks
30
15
3
N
0
2.5
5
kilometres
ECOLOGY CONSULTING

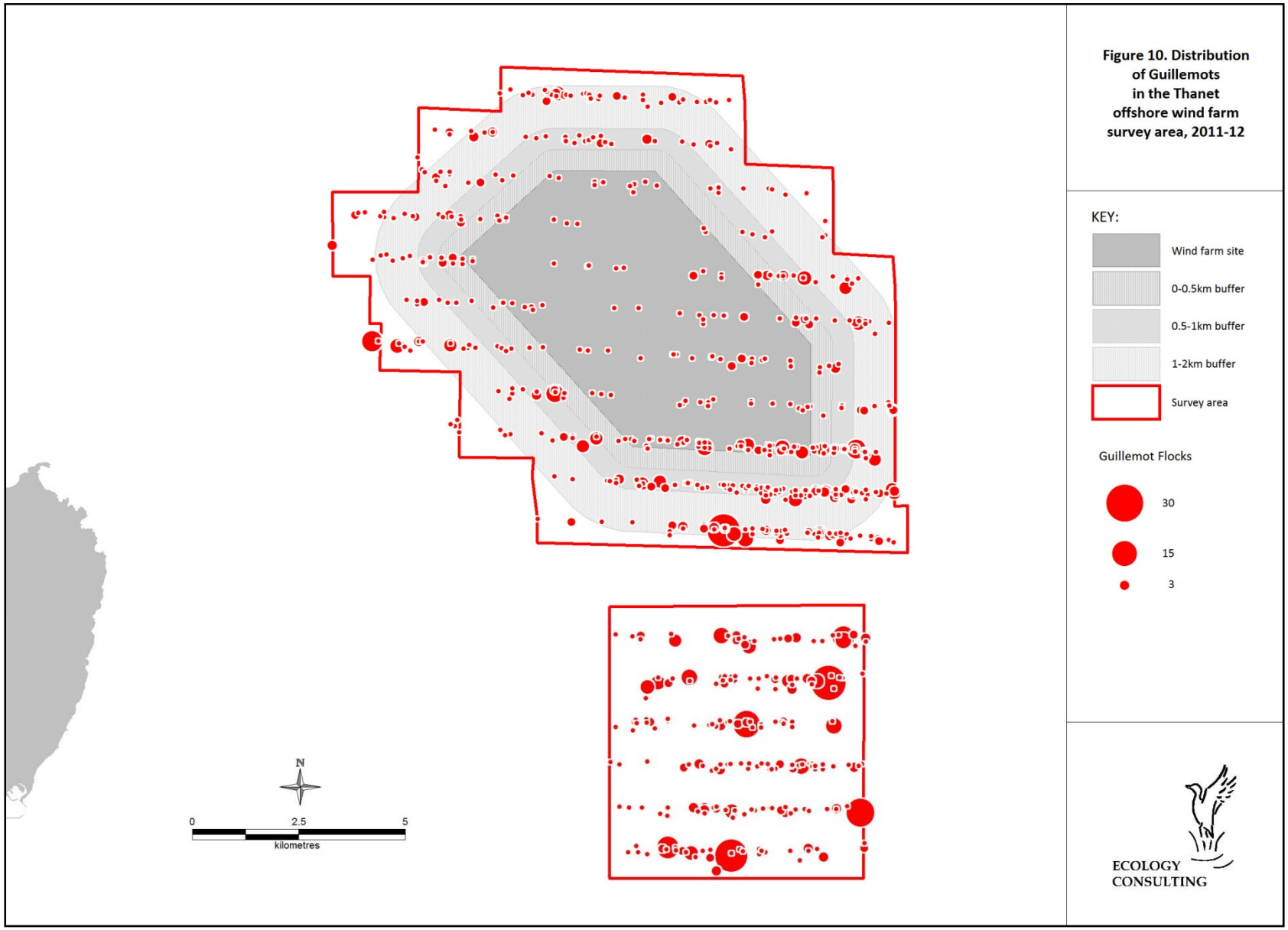


Figure 10. Distribution of Guillemots in the Thanet offshore wind farm survey area, 2011-12
KEY:
Wind farm site
0-0.5km buffer
0.5-1km buffer
1-2km buffer
Survey area
Guillemot Flocks
30
15
3
N
0
2.5
5
kilometres
ECOLOGY CONSULTING

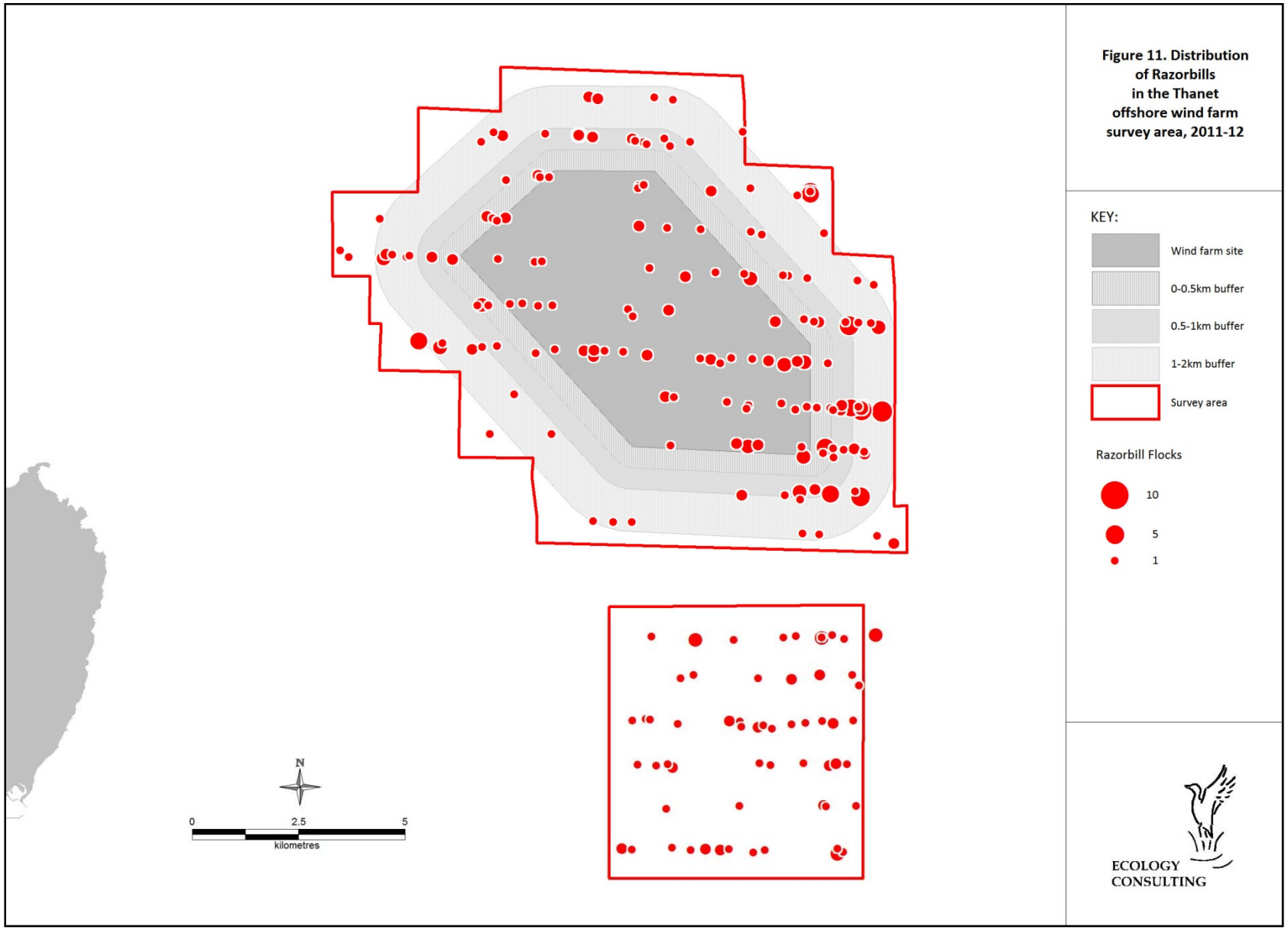


Figure 11. Distribution of Razorbills in the Thanet offshore wind farm survey area, 2011-12
KEY:
Wind farm site
0-0.5km buffer
0.5-1km buffer
1-2km buffer
Survey area
Razorbill Flocks
10
5
1
N
0
2.5
5
kilometres
ECOLOGY CONSULTING

6 FLIGHT HEIGHTS

The flight heights recorded during the 2011-12 surveys are summarised in Table 7. This Table gives the flight height distribution (by band) for each species seen over-flying, and the percentage of flights at rotor height (taken as all flights between 20m and 120m). The sample unit was taken as the flock rather than the individual as individuals within a flock do not provide an independent sample.

Table 7. Flock flight height distribution observed in 2011-12. Values indicate the number of flocks in each category and the approximate percentage of flying flocks at rotor height.

	On sea	<20m	20-120m	>120m	% at rotor height
Brent goose	0	6	0	0	0%
Shelduck	0	2	0	0	0%
Common scoter	0	4	0	0	0%
diver sp	15	28	1	0	3%
Red-throated diver	52	121	8	0	6%
Black-throated diver	3	3	1	0	25%
Great crested grebe	0	1	0	0	0%
grebe sp	0	1	0	0	0%
Fulmar	11	76	0	0	0%
Gannet	116	364	23	0	6%
Cormorant	0	0	0	1	0%
Shag	0	1	0	0	0%
Ringed plover	0	1	0	0	0%
Arctic skua	0	2	0	0	0%
Great Skua	5	13	1	0	7%
Common gull	23	161	71	1	30%
small gull sp	0	2	0	0	0%
Lesser black-backed gull	123	225	146	1	39%
Glaucous gull	0	1	0	0	0%
Herring gull	95	318	129	1	29%
large gull sp	44	89	59	1	40%
black-backed gull sp	21	19	21	0	53%
Great black-backed gull	244	300	110	1	27%
Little gull	1	1	0	0	0%
Black-headed gull	0	6	0	0	0%
Kittiwake	99	559	119	0	18%
Sandwich tern	0	3	0	0	0%
auk sp	185	145	0	0	0%
Guillemot	674	117	1	0	1%
Guillemot/Razorbill	0	1	0	0	0%

	On sea	<20m	20-120m	>120m	% at rotor height
Razorbill	195	24	0	0	0%
Short-eared owl	0	0	1	0	100%
Skylark	0	2	1	0	33%
Sand martin	0	1	0	0	0%
hirundine sp	0	1	0	0	0%
Swallow	0	3	0	0	0%
Meadow pipit	0	1	0	0	0%
Whinchat	0	1	0	0	0%
Blackbird	0	10	1	0	9%
Fieldfare	0	3	0	0	0%
thrush sp	0	2	0	0	0%
Song thrush	0	1	0	0	0%
Redwing	1	9	2	0	18%
Starling	1	5	0	0	0%
Chaffinch	0	3	0	0	0%
finch sp	0	4	0	0	0%
passerine sp	0	1	0	0	0%

The specific flights within the wind farm at rotor height (i.e. those where the birds would be at risk of colliding with the turbine rotors) are summarised in Table 8, with allowance made for the survey area coverage to produce an estimate for the whole of the wind farm. Much of the greatest bird flight activity within this zone was of gulls, as previously noted in the ES and the subsequent survey reports, with a very low number of diver and gannet flights in this zone.

Table 8. Bird flight activity at rotor height within the Thanet offshore wind farm site, 2011-12 (population estimate for each survey).

Species	3-4 Oct	12-13 Oct	12-13 Nov	19 Dec	10-11 Jan	24-25 Jan	6-7 Feb	12-13 Feb	10-11 Mar	21-22 Mar	Mean	Peak
Gannet	0	0	3	0	0	0	0	0	0	0	0.3	3
Common gull	0	0	12	0	2	3	8	23	0	0	4.8	23
Lesser black-backed gull	3	13	15	7	3	2	5	8	7	0	6.3	15
Herring gull	2	8	7	3	10	0	7	8	12	7	6.3	12
large gull sp	0	2	5	13	2	2	5	0	2	5	3.5	13
black-backed gull sp	0	3	7	0	2	0	0	0	3	0	1.5	7
Great black-backed gull	5	2	12	8	5	0	3	10	13	0	5.8	13
Kittiwake	0	0	0	12	13	18	8	12	0	0	6.3	18
Guillemot	0	0	0	0	0	0	0	2	0	0	0.2	2

One of the objectives of the bird monitoring programme is to determine whether the collision risk might be significant (testing the conclusions reached in the ES that it would not) . Table 9a compares the mean numbers within the wind farm over the pre-construction (ES – 2004 - 2005), construction (2009 - 2010) and post-construction (2010 - 2011) periods and Table 9b the mean number in flight at rotor height (i.e. those at risk of collision with the wind turbine rotors), to make a relative comparison of the likely collision risk[2]. Diver and auk numbers in this zone declined during construction and the first post-construction winter, but auk numbers were higher than recorded previously in 2011-12. Collision risk to auks would still be only negligible however, given the very low proportion of flights observed at rotor height (1% - see Table 7). Gull numbers have been broadly similar during post-construction and construction as assessed in the pre-construction surveys carried out for the ES baseline, though with more Kittiwake activity in 2010-11 (an increase in which was seen generally within the Thames in that year, J. Ford pers. comm.; Percival et al. 2011). As a result whilst collision risk is likely to have increased for this species, for the others (and species of higher conservation interest, particularly divers) there has not been any notable increase in flight activity within the wind farm site since the ES assessment. There is no evidence to suggest that the conclusion reached in the ES (that there would not be any significant collision risk) would be changed by the recent post-construction data.

Table 9a. Mean count for each winter within the wind farm site, Oct-Mar

	ES (2004 – 2005)	Construction (2009 – 2010)	Post-construction yr 1 (2010 – 2011)	Post-construction yr 1 (2011 – 2012)
All divers	10	1	3	2

[2] The collision risk will be directly proportional to flight activity in the collision zone at rotor height, so this flight activity can be used to compare the change in risk from the ES to the post-construction phase.

	ES (2004 – 2005)	Construction (2009 – 2010)	Post-construction yr 1 (2010 – 2011)	Post-construction yr 1 (2011 – 2012)
Gannet	2	2	2	6
Common gull	59	119	40	15
Lesser black-backed gull	11	25	14	22
Herring gull	68	19	32	31
Great black-blacked gull	1	12	14	40
Kittiwake	7	28	54	32
All gulls	151	203	169	183
Guillemot	24	10	14	56
Razorbill	8	1	1	24
All auks	35	11	21	101

Table 9b. Mean count in flight at rotor height for each winter within the wind farm site, Oct-Mar.

	ES (2004 – 2005)	Construction (2009 – 2010)	Post-construction yr 1 (2010 – 2011)	Post-construction yr 1 (2011 – 2012)
All divers	0.8	0.1	0.2	0.1
Gannet	0.2	0.1	0.1	0.3
Common Gull	4.9	35.0	13.5	4.2
Lesser Black-backed Gull	3.3	9.1	5.5	6.5
Herring Gull	14.9	5.6	8.6	7.4
Great Black-blacked Gull	0.1	2.0	2.9	6.7
Kittiwake	0.4	4.4	8.7	4.9
All gulls	28.9	43.3	49.3	45.4
Guillemot	0	0.1	0	0.1
Razorbill	0	0	0	0
All auks	0.1	0.1	0	0.2

7 CONSERVATION EVALUATION

The conservation importance of the bird populations recorded during these surveys has been assessed by reference to Table 10 (taken from Percival 2007) and by using the standard 1% criterion method (Holt et al., 2011); (>1% national population = nationally important, >1% international population = internationally important). The national baseline populations have been taken from Baker et al. (2006) and Musgrove et al. (2011). A further category of 'local importance' has been used for species that are not considered to be of regional importance, but were still of some ecological value. This included all species on the red or amber lists of the RSPB et al.'s (Eaton et al., 2009) 'Birds of Conservation Concern'.

Table 10. Sensitivity (Conservation Importance) of bird species

Sensitivity	Definitions
Very High	Species for which at site is designated (Special Protection Areas (SPAs) / Special Areas of Conservation (SACs)) or notified (Sites of Special Scientific Interest (SSSIs)). A local population of more than 1% of the international population of a species.
High	Other species that contribute to the integrity of an SPA or SSSI. A local population of more than 1% of the national population of a species. Any ecologically sensitive species, e.g. large birds of prey or rare birds (<300 breeding pairs in the UK). EU Birds Directive Annex 1, EU Habitats Directive priority habitat/species and/or Wildlife and Countryside Act 1981 (as amended) Schedule 1 species (if not covered above). Other specially protected species.
Medium	Regionally important population of a species, either because of population size or distributional context. UK Biodiversity Action Plan (BAP) priority species (if not covered above).
Low	Any other species of conservation interest, e.g. species listed on the Birds of Conservation Concern not covered above.

The evaluation of the conservation importance of the bird populations observed in the survey area during the 2011-12 surveys has been summarised in Table 11. This included:

- Seven very high sensitivity species (SPA/SSSI qualifying/assemblage species; brent goose, shelduck, red-throated diver, great crested grebe, cormorant, ringed plover and Sandwich tern). There were no records of wigeon, teal, lapwing, curlew, and common tern in 2011-12 (all of these had been recorded in 2010-11);

- Four high sensitivity species (black-throated diver, great black-backed gull, little gull and short-eared owl) that are EU Birds Directive Annex 1 species (black-throated diver and little gull) or present in the survey area in nationally important numbers (great black-backed gull). Short-eared owl had not been seen in 2010-11 – the single record was of a migrant on 12/10/11;

- Eleven medium sensitivity species (UK BAP priority species and/or present in regionally important numbers; common scoter, gannet, common gull, lesser black-backed gull, herring gull, kittiwake, guillemot, razorbill, skylark, song thrush and starling); and

- Eleven low sensitivity species (Birds of Conservation Concern amber-listed species and/or present in locally important numbers).

Table 11. Evaluation of the conservation importance of the bird populations using the Thanet Offshore Wind Farm site and its surrounds, 2011-12. Species in red seen in 2011-12 but not in 2010-11. Species seen in 2010-11 but not in 2011-12 are shown in blue.

Species	SPA sp[3]	Population Importance[4]	EU Birds Directive Annex 1	Red [R]/ Amber [A] List	UK BAP Priority Species	Sensitivity
Brent goose	Q	Regional		A	✓	Very high
Shelduck	Q	Local		A		Very high
Wigeon	Q	Local		A		Very high
Teal	Q	Local		A		Very high
Mallard		Local		A		Low
Common scoter		Local		R	✓	Medium
Red-breasted merganser		Local				Low
Red-throated diver	Q	Regional	✓	A		Very high
Black-throated diver		Regional	✓	A	✓	High
Great crested grebe	A	Local				Very high
Fulmar		Local		A		Low
Gannet		Regional		A		Medium
Cormorant	A	Local				Very high
Shag		Local		A		Low
Ringed Plover	Q	Local		A		Very high
Lapwing	A	Local		R	✓	Very high
Curlew	Q	Local		A	✓	Very high
Great Skua		Local		A		Low
Common gull		Regional		A		Medium
Lesser black-backed gull		Regional		A		Medium
Herring gull		Regional		R	✓	Medium
Great black-backed gull		National		A		High
Little gull		Regional	✓	A		High
Black-headed gull		Local		A		Low
Kittiwake		Regional		A		Medium

[3] Q = SPA qualifying species, A = SPA assemblage species

[4] On the basis of peak numbers in whole survey area and the 1% threshold (Baker et al. 2006, Holt *et al*., 2009, Musgrove et al. 2011).

Species	SPA sp[3]	Population Importance[4]	EU Birds Directive Annex 1	Red [R]/ Amber [A] List	UK BAP Priority Species	Sensitivity
Sandwich tern	Q	Local	✓	A		Very high
Common tern	Q	Local	✓	A		Very high
Guillemot		Regional		A		Medium
Razorbill		Regional		A		Medium
Short-eared owl		Regional	✓	A		High
Skylark		Local		R	✓	Medium
Sand martin		Local		A		Low
Swallow		Local		A		Low
Meadow pipit		Local		A		Low
Pied wagtail		Nil				Nil
Robin		Nil				Nil
Whinchat		Local		A		Low
Black redstart		Local		A		Low
Blackbird		Nil				Nil
Fieldfare		Local		A		Low
Song thrush		Local		R	✓	Medium
Redwing		Local		A		Low
Starling		Local		R	✓	Medium
Chaffinch		Nil				Nil
Goldfinch		Nil				Nil

8 COMPARISON OF BIRD NUMBERS BETWEEN THE PRE-CONSTRUCTION, CONSTRUCTION AND POST-CONSTRUCTION PHASE SURVEYS

8.1 Analysis Methods

This Section presents a statistical analysis comparing the differences in bird numbers between the pre-construction, construction and post-construction periods. The ES pre-construction baseline did not cover as large a buffer zone around the wind farm as the later construction and post-construction phase surveys, limiting the sample from the 1-2km buffer zone in particular. This comparative analysis across the full survey period presented in this Section was therefore limited to those parts of the main survey area covered during all surveys (Figure 1).

The species included in this analysis are all those present in sufficient numbers/frequency for a meaningful analysis to be undertaken: red-throated diver,

gannet, common gull, lesser black-backed gull, herring gull, great black-backed gull, kittiwake, guillemot and razorbill.

The analysis was carried out on a grid square basis, overlaying a 500x500m grid onto survey area (aligned with the survey transects) as the sample unit. The 500m grid was chosen as an initial grid size for the analysis but further testing of the optimum grid size will be included in the final report at the end of the third year once the full post-construction data set is available. A GIS (MapInfo) was used to extract bird numbers in each grid square from the main survey database, summed over each period (pre-construction, construction and post-construction) and standardised as the mean count per survey visit (to take into count different numbers of surveys in each period - there were 9 surveys during the pre-construction period during the Oct-Mar period, 10 during the construction phase in 2009-10, 12 in 2010-11 in the first of the post-construction winters and 10 in 2011-12 - though only 9 for the control zone - the second post-construction winter).

Three contrasts were then made for each grid square, calculating the change in bird numbers between the pre-construction and the construction phase, the pre-construction with the post-construction and construction with the post-construction phases.

The key null hypothesis tested was that there was no difference between bird numbers for each two-way comparison, i.e. the difference in bird numbers in the grid squares was not significantly different from zero.

The distance from each square to the nearest wind turbine was also calculated and used as a factor in the second part of the analysis. This enabled investigation of any changes in bird numbers in relation to distance from wind farm. These calculated distances were used to classify each grid square as (a) within wind farm (where there was a wind turbine within the grid square), (b) outside the wind farm but within 1km of a turbine, (c) 1-2km from a turbine or (d) more distant.

8.2 Analysis Results

The grid square count difference data were normally distributed so parametric tests have been used through this section. There is additionally a potential issue with spatial auto-correlation as the sample units (grid squares) are located adjacent to each other, which will be further investigated when the full data set is available. Given this and that the main analysis is based on a preliminary 500m grid size, the significance values attached to these tests should be treated with caution at this stage.

The first tests undertaken were to determine whether there was a statistically significant difference in each species' numbers for each of the three comparisons being drawn (pre-construction versus construction, pre-construction versus post-construction and construction versus post-construction. The post-construction period now includes data from both the 2010-11 and 2011-12 winters. The results (the mean differences for each of these comparisons) are summarised in Table 12, which also shows the statistical significance of each t-test. The spatial coverage of the grid squares used in these analyses was restricted to those squares that had been surveyed across all of survey periods from pre-construction through to the two post-construction years.

Table 12. Thanet Offshore wind farm mean grid square count differences for key bird species between wind farm periods.

Species		Mean change per grid square[5]	
	Pre-construction v. Construction	Pre-construction v. Post-construction	Construction v. Post-construction
Red-throated Diver	-0.023 *	0.051 **	0.074 ***
All divers	-0.026 **	0.077 **	0.103 ***
Gannet	0.093 ***	0.084 ***	-0.009 ns
Common gull	0.615 ***	-0.0001 ns	-0.615 ***
Lesser black-backed gull	-0.021 ns	-0.114 **	-0.093 ns
Herring gull	-0.274 **	-0.223 ns	0.051 ns
Great black-backed gull	0.061***	0.309 **	0.248 *
Kittiwake	0.092 ns	0.035 ns	-0.057 ns
Guillemot	-0.134 ***	-0.043 ns	0.092 ***
Razorbill	-0.015 ns	0.031 *	0.046 **
All auks	-0.194 ***	0.055 ns	0.249 ***

The second test was to determine whether any difference in abundance between comparison periods was related to distance of the grid squares from the wind farm. It was carried out as a one-way analysis of variance of each set of differences with the distance to turbine class as the factor in the analysis. The results are summarised in Table 13.

Table 13. Thanet Offshore wind farm mean grid square count differences for key bird species between wind farm periods in relation to distance from the wind farm.

Species	Comparison	Wind farm	0-1km buffer	1-2km	Control	Significance test[6]
Red-throated diver	Pre- v. Constr.	-0.061	-0.028	-0.006	-0.008	ns
	Pre- v. Post-	-0.069	0.016	0.058	0.144	***
	Constr. V. Post-	-0.008	0.044	0.063	0.152	**
All divers	Pre- v. Constr.	-0.077	-0.031	0.002	-0.008	ns
	Pre- v. Post-	-0.081	-0.022	0.085	0.249	***
	Constr. V. Post-	-0.004	0.029	0.083	0.257	**
Gannet	Pre- v. Constr.	-0.020	0.058	0.075	0.191	**
	Pre- v. Post-	-0.051	0.054	0.075	0.180	***
	Constr. V. Post-	-0.032	-0.004	0.001	-0.011	ns
Common gull	Pre- v. Constr.	0.479	0.665	1.002	0.464	ns
	Pre- v. Post-	-0.096	0.048	0.074	-0.004	ns
	Constr. V.	-0.571	-0.621	-0.927	-0.468	ns

[5] ns = not significant P>0.05, * = P<0.05, ** = p<0.01, *** = p<0.001

[6] Test of null hypothesis that no change in bird densities across these survey zones

Species	Comparison	Wind farm	0-1km buffer	1-2km	Control	Significance test[6]
	Post-					
Lesser black-backed gull	Pre- v. Constr.	0.012	-0.071	-0.090	0.071	ns
	Pre- v. Post-	-0.124	-0.112	-0.124	-0.103	ns
	Constr. V. Post-	-0.136	-0.040	-0.034	-0.174	ns
Herring gull	Pre- v. Constr.	-0.330	-0.432	-0.009	-0.097	ns
	Pre- v. Post-	-0.363	-0.102	-0.085	-0.347	ns
	Constr. V. Post-	-0.033	0.330	-0.076	-0.250	ns
Great black-backed gull	Pre- v. Constr.	0.060	0.059	0.020	0.089	ns
	Pre- v. Post-	0.095	0.333	0.117	0.629	ns
	Constr. V. Post-	0.035	0.274	0.097	0.540	ns
Kittiwake	Pre- v. Constr.	-0.025	0.133	0.307	0.028	ns
	Pre- v. Post-	0.050	0.059	-0.077	0.041	ns
	Constr. V. Post-	0.075	-0.074	-0.383	0.014	ns
Guillemot	Pre- v. Constr.	-0.135	-0.090	0.024	-0.277	*
	Pre- v. Post-	-0.111	-0.018	0.165	-0.122	ns
	Constr. V. Post-	-0.025	0.071	0.141	0.155	*
Razorbill	Pre- v. Constr.	-0.072	-0.031	0.097	0.009	**
	Pre- v. Post-	-0.005	0.045	0.029	0.047	ns
	Constr. V. Post-	0.068	0.076	-0.068	0.038	**
All auks	Pre- v. Constr.	-0.200	-0.213	-0.008	-0.272	ns
	Pre- v. Post-	-0.030	0.039	0.251	0.049	ns
	Constr. V. Post-	0.170	0.252	0.258	0.321	ns

The results of these tests for each species are examined and interpreted in turn below.

Red-throated diver: this species showed a statistically significant drop in numbers within the survey area between the pre-construction and construction periods, but a statistically significant increase after construction (Table 12). The trend was for the decrease to be higher but the increase lower within the wind farm site (Table 13). With the additional 2011-12 data this was statistically significant for the both the pre- versus post-construction and construction versus post-construction comparisons (largely as a result of a large increase in numbers in the control zone). There does appear to have been a significant drop in diver numbers within the wind farm, equivalent to about a 66% decline during construction within the wind farm, 57% reduction within 0-1km and 32% within 2km (based on an initial analysis comparing grid square mean counts). After

construction was completed, the only zone to show a significant reduction from the pre-construction baseline was within the wind farm, where a 70% reduction in diver density was recorded. Caution does need to be applied to these results at this stage however as the wind farm site has supported only low numbers of this species throughout the surveys, so the sample of birds exposed to potential displacement is only small. A third year's post-construction data, together with further gradient analysis should assist in substantiating the conclusions reached in the final report at the end of the third post-construction year.

Gannet: this species showed a statistically significant increase in numbers across the survey area during the construction and post-construction periods in comparison with the pre-construction baseline. Though there was no significant difference in the change in numbers in relation to distance from the wind farm between the construction and the post-construction phases, for both of the other comparisons gannets generally increased or remained stable outside the wind farm (and more so at greater distance from it) but declined within it. There is therefore some evidence of partial displacement from the wind farm for this species, with densities recorded 24% and 38% lower during the construction and post-construction periods (again, as for the divers, based on an initial analysis comparing grid square mean counts) in comparison with the pre-construction baseline (though no significant displacement was noted outside the wind farm). As for the divers, caution needs to be applied to these results however as the wind farm site has supported only very low numbers of this species throughout the surveys, so the sample of birds exposed to potential displacement is only small.

Common Gull: common gull numbers across the whole survey area increased during the construction phase and decreased post-construction (back to the pre-construction level), with no statistically significant difference between the pre- and post-construction periods. There was no significant difference between these changes within the wind farm, the 0-1km buffer, the 1-2km buffer or the grid squares more distant from the wind farm. This would suggest that this species has not been adversely affected by the wind farm construction or operation, and there is a suggestion that the construction phase may have increased feeding opportunities.

Lesser Black-backed Gull: there was no statistically significant difference in the numbers of this species in the survey area between either the pre-construction and the construction phases, or the construction and the post-construction periods, but there was a significant drop in numbers when comparing pre-construction with post-construction. There was no significant difference between these changes within the wind farm, the 0-1km buffer, the 1-2km buffer or the grid squares more distant from the wind farm. This would suggest that this species has not been affected by the wind farm construction or operation.

Herring Gull: this species showed a statistically significant drop in numbers across the survey area during construction and a slight increase in numbers post-construction. There was no significant difference between these changes within the wind farm, the 0-1km buffer, the 1-2km or the grid squares more distant from the wind farm. This would suggest that this species has not been affected by the wind farm construction or operation.

Great Black-backed Gull: there was a statistically significant increase in numbers of this species in the survey area during construction and the post-construction period. There was no significant difference between these changes within the wind farm, the 0-

1km buffer, the 1-2km buffer or the grid squares more distant from the wind farm. This would suggest that this species has not been affected by the wind farm construction or operation.

Kittiwake: there was no statistically significant difference in the numbers of this species in the survey area between any of the three comparison periods, nor any statistically significant spatial differences between the survey periods. This would suggest that this species has not been affected by the wind farm construction or operation.

Guillemot: this species showed a statistically significant drop in numbers across the survey area during construction but a subsequent increase post-construction. There was no significant difference between these changes within the wind farm, the 0-1km buffer, the 1-2km buffer or the grid squares more distant from the wind farm when comparing the post-construction data with the pre-construction baseline. The more recent post-construction increase observed in 2011-12 however appeared to occur proportionally more in the areas further from the wind farm. Overall there was a 69% reduction in density within the wind farm during construction and a 48% reduction in the 0-1km buffer within that period, and a 26% reduction within the wind farm post-construction in comparison with the pre-construction baseline (based on an initial analysis comparing grid square mean counts), but no reduction apparent beyond those zones.

Razorbill: this species showed a statistically significant increase in numbers across the survey area comparing the pre-construction baseline and the construction phase with the post-construction period. There were significant differences in the changes across the survey area, with declines within the wind farm but increases in the control area, suggesting that some partial displacement from the wind farm may have taken place. The main effect was apparent in the construction phase, when a decrease in density of 96% was recorded within the wind farm and 67% in the 0-1km zone (based on an initial analysis comparing grid square mean counts), though no reduction apparent outside that zone. The post-construction densities were generally higher than the pre-construction baseline, including within the wind farm.

9 MARINE MAMMALS

The numbers of marine mammals recorded during each survey are shown in Table 12. Only very low numbers (1-5) of seals and harbour porpoise were seen during October-December, but in January-March higher numbers of harbour porpoise were recorded (peak 87 in March, compared with a peak of 21 in the previous winter). A similar seasonal pattern of occurrence was observed during the construction phase surveys.

Table 12. Numbers of marine mammals observed during each of the boat surveys during 2011-12.

Species	3-4 Oct	12-13 Oct	12-13 Nov	19 Dec	10-11 Jan	24-25 Jan	6-7 Feb	12-13 Feb	10-11 Mar	21-22 Mar	PEAK
Common seal	2	1	1	0	0	0	0	1	2	0	2
Grey seal	0	0	0	0	1	0	0	1	2	0	2
seal sp	0	0	0	0	0	0	1	1	1	2	2
Harbour	5	4	4	0	8	26	34	47	87	29	87

Species	3-4 Oct	12-13 Oct	12-13 Nov	19 Dec	10-11 Jan	24-25 Jan	6-7 Feb	12-13 Feb	10-11 Mar	21-22 Mar	PEAK
porpoise											

As during the construction phase numbers of porpoises were higher in the control area, though smaller numbers were again seen within the wind farm (Figure 12).

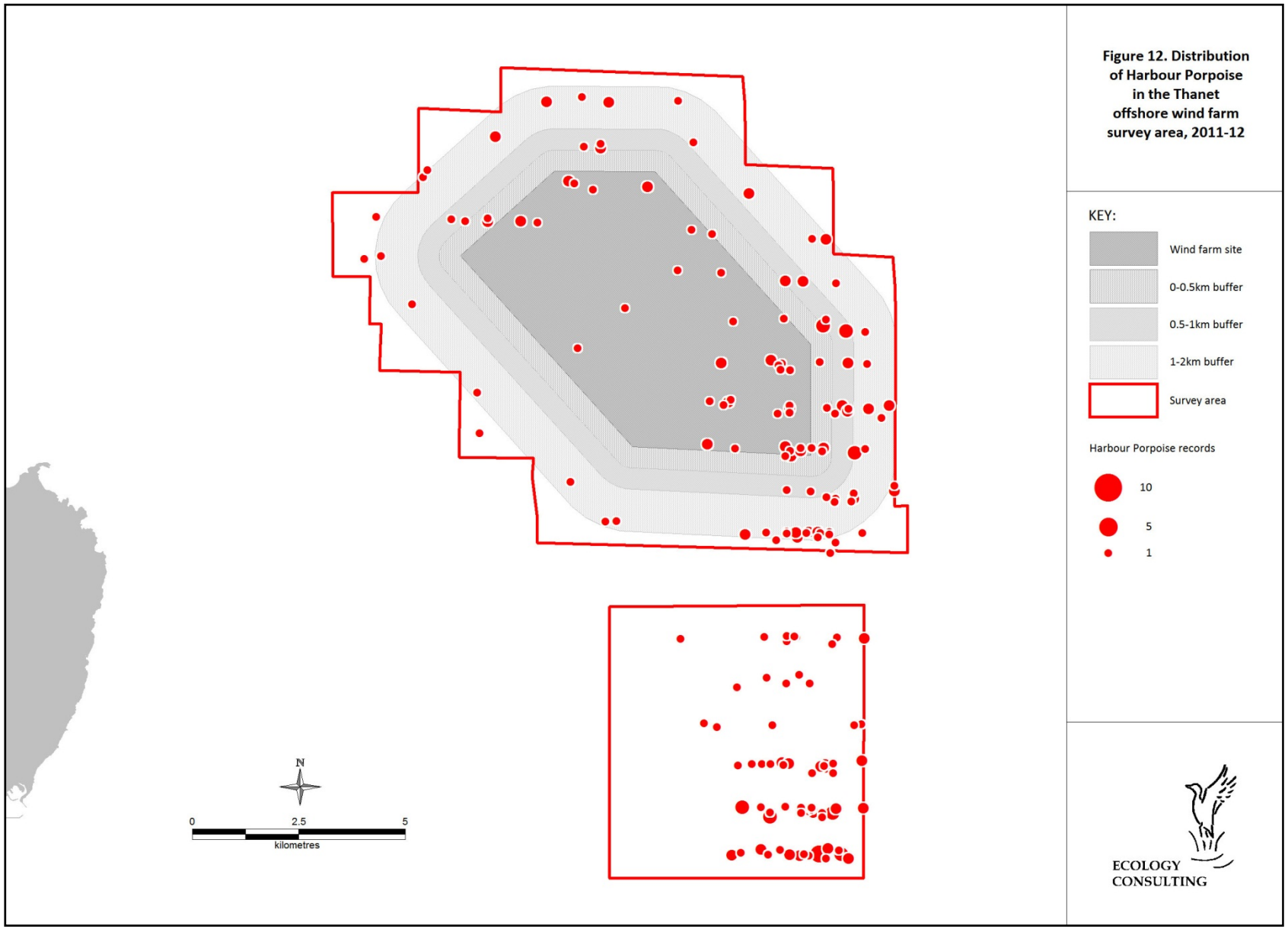


Figure 12. Distribution of Harbour Porpoise in the Thanet offshore wind farm survey area, 2011-12
KEY:
Wind farm site
0-0.5km buffer
0.5-1km buffer
1-2km buffer
Survey area
Harbour Porpoise records
10
5
1
N
0
2.5
5
kilometres
ECOLOGY CONSULTING

10 CONCLUSION

The results presented in this report give preliminary conclusions based on a two year's post-construction monitoring at Thanet, so should therefore be treated with caution. Clearer results should emerge as further post-construction surveys are completed.

The results indicate a decline during construction of divers, gannets and guillemots , though this is generally based on small sample sizes as the overall numbers observed were quite low through the surveys. There is an indication of a recovery to pre-construction levels within the wind farm in the post-construction years in some species. For the divers, the decline was greater within the wind farm and it is likely that the presence of the wind farm did cause that displacement. For guillemots these changes occurred across the survey area with less evidence of a greater effect within the wind farm, so the evidence for displacement of that this is more equivocal. There was some evidence too of displacement of gannets from the wind farm.

These small sample sizes to date and the fact that only preliminary statistical analyses have been completed mean that quantifying the magnitude of these changes should be treated with caution, but the results in relation to divers do contrast with those from the smaller Kentish Flats wind farm. At that site diver densities declined by 94% within the wind farm, 80% within 0-1km and 59% within 1-2km (Percival et al. 2011) after construction, though these values may have been partly confounded by a concurrent general decrease in numbers in this area. Controlling for this by analysing relative numbers gave reductions of 81% within the wind farm, 53% within 500m and 29% in the 500m-1km zone (Percival et al. 2011). At Thanet there have been regular sightings of small numbers of divers within the wind farm (albeit at a lower density than prior to construction) and densities have been maintained post-construction in the buffer zones around the wind farm (even in the 0-1km zone immediately adjacent to the wind farm). The comparative percentage change in density at Thanet was a 70% reduction within the wind farm comparing the pre-construction densities with those post-construction but no effect extending beyond the wind farm apart from during construction.

Gull numbers appear to have been largely unaffected by the construction or first two winters of operation. Indeed several species have increased in number following construction of the wind farm, including within the wind farm, though this increase likely reflected wider population fluctuations rather than any site-specific effects given the wider increase in gull numbers seen in the Outer Thames in 2010-11 (J. Ford, pers. comm.; Percival et al. 2011) and the results of the spatial analysis of changes in gull numbers.

10.1 Comparison with ES Predictions

At this stage there is no evidence to suggest that the conclusion reached in the ES (that there would not be any significant collision risk) would be changed by the recent post-construction data.

In the ES it was predicted that disturbance to and displacement of feeding seabirds during construction would be short term and of minor adverse significance, as a result of overall low densities of birds observed throughout the year and availability of similar feeding areas close by.

The results of the construction phase monitoring supported this conclusion, with some minor displacement observed of some species including divers, gannets, guillemots and razorbills.

Disturbance impacts during the operational phase of the wind farm were also predicted in the ES to result in only minor adverse effects, particularly on divers and auks. No disturbance effects were predicted on gulls This again appears from the results to date to be borne out by the results of the monitoring programme, with evidence of displacement of divers, gannets, guillemots and razorbills, and none for gulls.

In relation to collision risk, the data on bird flight activity collected as part of the post-construction monitoring has not found any evidence to suggest that the conclusion reached in the ES (that there would not be any significant collision risk) would be changed by the recent post-construction data (though no direct monitoring of collision risk has been undertaken).

10.2 Further Analysis

One further year's post-construction data is being collected as part of the bird monitoring programme, and these will enable more robust conclusions to be drawn on the ornithological effects of the wind farm. At the end of the 3-year post-construction monitoring period, the data will be analysed in detail to show trends in abundance and distribution and fully assess the bird responses to the wind farm, and will include analysis of changes in bird numbers and distribution in relation to changes in fish distribution and results from benthic surveys (where the data from those fish and benthic surveys are of an appropriate spatial scale to allow such an analysis). Other available environmental data will also be included, including JNCC Sea Map data, water depth and shipping traffic, to better understand any changes in bird numbers and distribution that have occurred. This will include a full analysis of the raw pre-construction data as well as all of the construction and post-construction surveys.

11 REFERENCES

Baker, H., D. A. Stroud, N. J. Aebischer, P. A. Cranswick, R. D. Gregory, C. A. McSorley, D. G. Noble, and M. M. Rehfisch (2006) Population estimates of birds in Great Britain and the United Kingdom. British Birds 99:25-44.

Camphuysen, C.J., Fox, A.D., Leopold, M.F. and Petersen, I.K. 2004. Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the U.K. A report commissioned by COWRIE. Royal Netherlands Institute for Sea Research.

Eaton, M.A., Brown, A.F., Noble, D.G., Musgrove, A., Hearn, R.D., Aebischer, N., Gibbons, D.W., Evans A. and Gregory, R.D. (2009) Birds of Conservation Concern 3: the population status of birds in the United Kingdom, Channel Islands and Isle of Man. British Birds 102: 296-341.

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

Musgrove, J.A., Austin, G.E., Hearn, R.D., Holt, C.A., Stroud, D.A., and Wotton, S.R. 2011. Overwinter population estimates of British waterbirds. British Birds 104, July 2011, 364-397

Percival, S.M. et al. 2011. Kentish Flats Offshore Wind Farm Extension Environmental Statement: Section 9: Offshore Ornithology.

Percival, S.M. 2012. Thanet Offshore Wind Farm Ornithological Monitoring 2011-2012. Report to Vattenfall.

Royal Haskoning 2005. Thanet Offshore Wind Farm Environmental Statement: Section 8: Ornithology.

Royal Haskoning 2009. Thanet Offshore Wind Farm Annual Ornithological Monitoring Report: 2009 survey season. Report to Thanet Offshore Wind Ltd, October 2009.

Royal Haskoning 2010. Thanet Offshore Wind Farm Annual Ornithological Monitoring Report (During Construction): 2009 – 2010. Report to Thanet Offshore Wind Ltd, July 2010.

Royal Haskoning 2011. Thanet Offshore Wind Farm Post Construction Environmental Monitoring Plan. Section 4 Ornithology.

Thanet Offshore Wind Limited 2009. Thanet Offshore Wind Farm: During and post-construction bird monitoring protocol. February 2009.