



Rampion Offshore Wind Farm



ES Section 11 – Marine Ornithology - Appendix 11.1 – 11.5

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Appendix 11.1: Aerial Survey Methodology

Transect positioning

A11.1.1 The sampling design comprised a grid of systematically spaced line transects, running north-south across the study area. To provide as high resolution as possible, but to avoid double-counting as a result of birds disturbed by the aircraft moving into the search area for adjacent transects (aerial survey in Denmark has suggested that scoter rarely fly more than 1km when disturbed), transects were flown at 2km separation.

Aircraft, survey height and speed

A11.1.2 A high-winged, twin-engined plane is essential to conform to legal requirements and provide optimal viewing. A Partenavia PN68 was used. Following test flights in the Kattegat, Denmark, in August 1999 using this type of plane, flight altitude during surveys was standardised at 78m (250 feet) at a cruising speed approximately 185 km (100 knots, Kahlert et al., 2000). This enables rapid approach to birds sitting on the sea, causing minimal disturbance. Identification of most species on the sea surface can be made from this height. The flight speed is sufficiently slow to allow a reasonable time to identify and count birds, but sufficiently fast that, for any species prone to disturbance by the plane, the point at which any displaced birds are first detected will not be greatly different from the location from which they were displaced.

Navigation

A11.1.3 A navigator sat alongside the pilot and guided the pilot along the intended transect route, advising the observers of the points at which to begin and stop counting along each transect (it is not possible to count during turns between transects due to the angle of tilt of the plane).

A11.1.4 Navigation was achieved using a hand-held GPS. The navigator advised the pilot of any notable deviation from the transect route (the plane can normally be kept within 50m of the intended route unless, for example, ships or oil rigs dictate temporary detours) and ensured the pilot kept to the intended survey altitude. The precise location was downloaded from the GPS onto a laptop computer every 5 seconds as an accurate record of the precise flight path taken.

A11.1.5 On a small number of occasions satellite coverage by the handheld GPS was lost preventing an accurate positional fix. The backup system employed was to navigate between the end points of the transects using the plane's onboard GPS (which was always functional, although it operated using latitude/longitude co-ordinates and data were not downloadable). The navigator identified, using the GPS, the point at which the start and end points of the transect were crossed and these times were recorded by the observers. Thus, the flight path could still be interpolated but with a lesser degree of accuracy than provided by 5 second intervals.

Recording protocol

A11.1.6 Two observers were used, each covering one side of the aircraft. All observations were recorded onto a dictaphone. The general objective was to obtain as accurate position for all birds encountered as possible under the circumstances. The position of each record was determined in two ways:

A11.1.7 Firstly, the perpendicular distance of the bird or group of birds from the line of the transect was determined. Because birds are encountered so rapidly, it is simply not possible to estimate and record the precise distance for each record. Consequently, records were assigned to distance classes for simplicity (a minimum of three distance categories are required to meet the requirements of distance sampling techniques). In studies carried out by NERI in Denmark, where very high densities of common scoter are encountered, this technique is used based on three standardised distance intervals out from the track-line taken by the aircraft: 49-174m (band A), 175-459m (band B) and 460m-1km (band C). Observers cannot observe a band of width 49 m on either side of the flight track since this is obscured by the body of the plane. The limits of each band were determined using a clinometer which enabled the measurement of predetermined angles below the horizontal measured abeam (at 85m altitude, the 49m cut-off is an angle of 60° from the horizontal, 174m is 25° and 459m represents 10° declination, angles that can be confirmed with relative ease by use of the clinometer).

A11.1.8 Secondly, the position along the transect was recorded by noting the precise time (to the nearest second) at which the bird or flock of birds is perpendicular to the observer using watches synchronised with the GPS. The time at which each observation along the transect was made can be converted into a position by interpolating the data from the GPS and placing observations into a predetermined distance from the track-line according to the band in which the bird was recorded.

A11.1.9 For each observation, the following information was recorded:

Species:

A11.1.10 As far as possible, all waterbird species were recorded. In cases where identification to species was not possible they were recorded to the best level of identification, e.g. auk species, cormorant species, gull species. All cetaceans and seals were also recorded. In addition, all human activities, both mobile and static, were also recorded, e.g. boats, gas platforms, gill net markers. Species on the shore close to the high water mark were omitted since these are best monitored by other methods.

Number:

- A11.1.11 The count (usually estimated for larger flocks) was recorded. Where groups of birds straddle two or more transect bands, the number in each was recorded separately.

Behaviour:

- A11.1.12 The behaviour of individual birds has a considerable effect on the detectability of the individual. Since distance sampling makes the assumption that birds are recorded undisturbed at the point at which they are first detected, it is important that if the need arises, it is possible to carry out analysis on data that exclude, for example, birds flushing or flying. Consequently, four different behaviours were recognised and recorded: sitting; diving; flushing; and flying. In addition, two additional categories were used for the surveys: sat on a buoy, and sat on a sand bank, in so far as these features are likely to affect the distribution of birds (to separate, for example, groups of feeding Cormorants from those loafing on a buoy). For marine mammals and mobile human activities, the direction of travel was recorded under behaviour.

Transect band:

- A11.1.13 The distance from the plane to the bird, mammal or human activity was recorded, assigned to one of the three distance bands A, B or C (see above).

Time:

- A11.1.14 Time was read from the watch, attached to the window of the plane in an appropriate position to allow the observer unhindered access to read the time whenever necessary. Time was recorded to the nearest second as the observation is perpendicular to the plane. Where birds were detected either in front of or behind the plane, an allowance was made when recording the time on the dictaphone.

Additional information:

- A11.1.15 Where possible, the age of the bird, i.e. juvenile, immature, near adult and adult, and sex (the precise information recorded being dependent on the plumage characteristics of the individual species) was recorded, although this information was only recorded where time permitted and did not compromise the collection of priority data outlined above.

Observation conditions:

- A11.1.16 Sea state conditions, cloud cover and the viewing conditions were recorded at regular intervals and whenever conditions changed, along with the time of the observation. Sea state conditions denoted the swell and number of whitecaps to the waves (worsening conditions are likely to affect the ability to detect birds) using a standard scoring system, cloud cover was also recorded

using a standard scoring system, and viewing conditions (affected by any combination of glare, haze, rain and reflection on the water) were recorded using a subjective assessment of good, poor or bad with the transect bands affected.

Data transcription and validation

A11.1.17 Data were transcribed from the dictaphone tapes either direct into an Excel spreadsheet or onto paper and then into the spreadsheet. The speed of dictation allowed species, number, behaviour, age (juveniles, immatures or adults) and transect band to be transcribed on a first play of the tape. A second play allowed both visual validation of these data and time to be input. Data were input using alphanumeric codes (which, having meaning, reduced the likelihood of transcription error and simplify the identification of errors). Date, observer initials and the observer's position in the plane were also input. Start and end times of counting, crossing of transect way points, crossing over any areas of exposed sand were input on a separate worksheet, and codified information for sea state and visibility onto another.

A11.1.18 Data were visually inspected to ensure only valid codes had been used, and that all necessary information had been input for each observation. Times were checked by sorting the data according to time and then checking the sequence of a numerical ID field corresponding to the order in which observations were input (any anomalies in the ID field sequence, which corresponded to an incorrect time entry, were readily identified). Data were converted to numeric codes using look-up tables, thereby also providing a further means of validation that all data matched valid codes.

Assigning locations to observations

A11.1.19 The NERI system uses a combination of GIS and bespoke software to add a position to each record of observation data. Using the observation file and the track file, every record in the observation file can have a position calculated, with time as the link field. Records were distributed to either side of the track line, according to the observer and the transect band in question.

Position accuracy of observations

A11.1.20 Using the methods defined above, the NERI experience has been that the majority of observations can be considered to be accurate to within 4 seconds. That is to say, an observation and all the spoken information relating to the visual encounter generally coincide to within that time period. In situations where high densities of birds have been encountered, multiple observations may have necessitated amalgamation, such that discrete observations were all recorded with a common time reference. Such grouping of observations (by virtue of extremely high bird densities) very rarely extended over a period of more than 10 seconds. Hence, overall, it should be anticipated that the positional accuracy along the axis of the transect should, in most cases,

fall within less than 206 m (4 seconds travelling at a speed of 51.4m s⁻¹) of the true position, but in the case of grouped observations, this could extend to 515m accuracy. As noted above, however, such amalgamation of data was very rarely required.

Appendix 11.2: Collision Risk Modelling

EXAMPLE BAND 2011 INPUT SPREADSHEET (KITTIWAKE):

COLLISION RISK ASSESSMENT		used in overall collision risk sheet	used in available hours sheet
Sheet 1 - Input data		used in migrant collision risk sheet	used in large array correction sheet
		used in single transit collision risk sheet or extended model	not used in calculation but stated for reference
	Units	Value	Data sources
Bird data			
Species name		Kittiwake	
Bird length	m	0.39	
Wingspan	m	1.08	
Flight speed	m/sec	13.1	
Nocturnal activity factor (1-5)		1	
Flight type, flapping or gliding		flapping	
			Data sources
Bird survey data			
Daytime bird density	birds/sq km		Jan 0.5302 Feb 0.57204 Mar 0.10954 Apr 0.06314 May 0.01674 Jun 2.2121 Jul 0.10041 Aug 0.48456 Sep 0.01674 Oct 0.40469 Nov 0.20995 Dec 0.48837
Proportion at rotor height	%	14.0%	AERIAL SURVEY
Proportion of flights upwind	%	50.0%	
			Data sources
Birds on migration data			
Migration passages	birds		0 0 0 0 0 0 0 0 0 0 0 0 0
Width of migration corridor	km	8	
Proportion at rotor height	%	0%	
Proportion of flights upwind	%	50.0%	
	Units	Value	Data sources
Windfarm data			
Name of windfarm site		Rampion	
Latitude	degrees	50.65	
Number of turbines		175	
Width of windfarm	km	16	
Tidal offset	m	0	
	Units	Value	Data sources
Turbine data			
Turbine model		4MW turbine	
No of blades		3	
Rotation speed	rpm	10	
Rotor radius	m	65	
Hub height	m	100	
Monthly proportion of time operational	%		Jan 90% Feb 84% Mar 87% Apr 88% May 85% Jun 80% Jul 79% Aug 77% Sep 83% Oct 81% Nov 90% Dec 82%
Max blade width	m	4.0	
Pitch	degrees	15	
Avoidance rates used in presenting results			
		98.00%	Predicted Collisions: 220.9
		99.00%	110.5
		99.50%	55.3

SPECIES MODEL INPUT DATA:

Monthly flight densities:												
Boat data for wind farm:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Brent Goose	0	0	0	0	0	0	0	0	0	0.0161	0	0
Mediterranean Gull	0	0	0	0	0	0	0	0	0	0	0.0161	0
Common Gull	0.04831	0	0.11272	0	0	0	0	0	0	0	0	0.02415
Herring Gull	0.62802	0.12077	0.32206	0.16103	0.17713	1.13527	0.82126	1.2637	0.41695	0.19324	2.24129	0.17253
Lesser Black-backed Gull	0	0	0	0	0.0161	0	0.04831	0.26806	0	0	0.03586	0
Great Black-backed Gull	0.24155	0	0.03221	0	0.03221	0.02415	0.02415	0.03829	0.05003	0.19324	0.25102	0.06901
Little Gull	0	0	0	0.032206	0	0	0	0	0	0	0	0
Common/Arctic Tern	0	0	0	0	1.932367	0	0	0	0	0.016103	0	0
Guillemot	0.27476	0.36232	0.06039	0	0.03221	0	0.02415	0	0	0.02415	0.1503	0.54897
Swallow	0	0	0	0	0	0	0	0	0.0161	0.04831	0	0
Meadow Pipit	0	0	0	0	0	0	0	0	0.43478	0	0.0161	0
Aerial data for wind farm:												
Gannet	0.02202	0	0	0.1079	0.2158	0.32061	0.24927	0.25147	1.7255	0.266	0.01674	0.04404
Kittiwake	0.5302	0.57204	0.10954	0.06314	0.01674	2.2121	0.10041	0.48456	0.01674	0.40469	0.20995	0.48837
Great Skua	0	0	0	0	0	0	0	0.03803	0	0	0	0
Boat data for whole survey area:												
Common Scoter	0	0	0.01239	0.02272	0.02272	0	0	0	0	0	0.00826	0
Bar-tailed Godwit	0	0	0	0	0.0682	0	0	0	0	0	0	0
Curlew	0	0	0	0	0	0.0031	0	0	0	0	0	0
Sandwich Tern	0	0	0	0.00207	0.0062	0.01549	0	0	0.02685	0	0	0

Nightjar – migrant flights only, modelled on worst case of all regional SPA population (total 402 pairs) flying through wind farm corridor – 804 individuals in spring, 1085 in autumn

Other Species Input Data:								
Species	Length (m)	Wingspan (m)	Flight speed (m/s)	Nocturnal	Flight type	Rotor Ht %	Rotor Ht % source	Flight density source
Brent Goose	0.58	1.15	19	5	flapping	43%	Boat survey	Boat survey
Mediterranean Gull	0.37	0.96	13.1	1	flapping	50%	Boat survey	Boat survey
Common Gull	0.41	1.2	13.1	1	flapping	15%	Boat survey	Boat survey
Herring Gull	0.6	1.44	11.3	1	flapping	26%	Boat survey	Boat survey
Lesser Black-backed Gull	0.58	1.42	11.3	1	flapping	25%	Boat survey	Boat survey
Great Black-backed Gull	0.71	1.58	12.4	1	flapping	36%	Boat survey	Boat survey
Little Gull	0.26	0.78	13.1	1	flapping	5.5%	Cook et al	Boat survey
Common/Arctic Tern	0.33	0.88	10.5	1	flapping	2.8%	Cook et al	Boat survey
Guillemot	0.4	0.67	19.1	1	flapping	1%	Boat survey	Boat survey
Swallow	0.18	0.34	9	1	flapping	5%	Boat survey	Boat survey
Meadow Pipit	0.14	0.24	12	5	flapping	9%	Boat survey	Boat survey
Gannet	0.94	1.72	14.9	1	gliding	13%	Boat survey	Aerial survey
Kittiwake	0.39	1.08	13.1	1	flapping	14%	Boat survey	Aerial survey
Great Skua	0.56	1.36	14.9	1	flapping	16%	Boat survey	Aerial survey
Common Scoter	0.49	0.84	21	5	flapping	1%	Cook et al	Boat (wider survey area)
Bar-tailed Godwit	0.38	0.75	15	5	flapping	33%	Boat survey	Boat (wider survey area)
Curlew	0.55	0.9	15	5	flapping	100%	Boat survey	Boat (wider survey area)
Sandwich Tern	0.38	1	10.5	1	flapping	3.8%	Cook et al.	Boat (wider survey area)
Nightjar	0.27	0.60	10.0	5	flapping	100%	Worst case	Regional SPA populations

Appendix 11.3: Boat-based survey area population estimates for each monthly/twice- monthly survey, March 2010 – February 2012

SPECIES	201003	201004	201005	201006	201007	201008	201009	201010	201011	201012	201101	201102	201103a	201103b	201104a	201104b	201105a	201105b	201106	201107	201108	201109a	201109b	201110a	201110b	201111a	201111b	201112	201201	201202	PEAK	
Mute Swan	0																														3	
Brent Goose	0	0										0	0																		87	
Goose sp	0	4	0									11	0											67	0	87						11
Wigeon	0	0										0	0																		2	
Teal	0	0										0	4	0										7	2	0						7
Eider	6	0						2			2	0	0											0	0						6	
Common Scoter	40	27	73									0	0			47																73
Velvet Scoter	0	0	0				1	0				0	0	0		0										27						1
Red-breasted Merganser	2	1	0				0	0			0	0	0	2		0													1			2
Duck sp	0	2	0				0	0			1	0	0	5		0							2	0	0	0						5
Red-throated Diver	7	0	0				0	0			0	0	0	91	0	0							0	0	0	0				7		91
Black-throated Diver	0	1	0				0	0			0	0	0	0	1	0							0	0	0	0						1
Red/Black-throated Diver	0	2	0				0	0			0	0	0	0	0	0							0	0	1	0						2
Diver sp	0	0	0				0	0	1	0	0	0	0	3	0	1	1						0	0	0	0		1	0	0	0	3

SPECIES	201003	201004	201005	201006	201007	201008	201009	201010	201011	201012	201101	201102	201103a	201103b	201104a	201104b	201105a	201105b	201106	201107	201108	201109a	201109b	201110a	201110b	201111a	201111b	201112	201201	201202	PEAK
Great Crested Grebe	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	150
Slavonian Grebe	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Fulmar	123	216	380	972	550	212	216	0	7	33	153	13	80	778	445	362	1774	458	617	1387	265	7	20	13	80	45	60	47	136	189	1774
Manx Shearwater	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	40	67	13	0	0	0	0	0	0	0	0	0	0	67
Balearic Shearwater	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	7	0	0	0	0	0	0	0	27
European Storm-petrel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	7	0	0	0	0	0	0	7	0	0	0	0	27
Gannet	28	100	250	1392	553	263	395	274	182	61	2861	150	385	107	229	334	1559	1361	1303	1502	670	199	828	1468	6524	324	190	372	744	181	6524
Cormorant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	7	0	0	0	0	0	7
Shag/Cormorant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
Grey Heron	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Marsh Harrier	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3
Kestrel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	7
Merlin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
Peregrine	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

SPECIES	201003	201004	201005	201006	201007	201008	201009	201010	201011	201012	201101	201102	201103a	201103b	201104a	201104b	201105a	201105b	201106	201107	201108	201109a	201109b	201110a	201110b	201111a	201111b	201112	201201	201202	PEAK
Falcon sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	7
Coot	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
Grey Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5
Dunlin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
Bar-tailed Godwit	0	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	187	0	0	0	0	0	0	0	0	0	0	0	0	0	187
Whimbrel	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	1	0	0	0	0	0	0	0	0	0	0	0	0	11
Curlew	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	7
Curlew/Whimbrel	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Turnstone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	10
Large wader sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Medium wader sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
Grey Phalarope	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Small wader	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3	0	0	0	0	0	3
Wader sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	6

SPECIES	201003	201004	201005	201006	201007	201008	201009	201010	201011	201012	201101	201102	201103a	201103b	201104a	201104b	201105a	201105b	201106	201107	201108	201109a	201109b	201110a	201110b	201111a	201111b	201112	201201	201202	PEAK
Pomarine Skua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53	0	0	0	0	0	0	0	0	0	0	0	0	53
Arctic Skua	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Long-tailed Skua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Great Skua	0	27	13	13	0	10	27	7	7	0	0	0	0	0	90	7	43	13	20	20	23	0	148	43	20	20	20	7	13	10	148
Arctic/Pomarine Skua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	1
Skua sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Mediterranean Gull	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Common Gull	528	1534	0	0	0	0	0	0	79	200	27	251	192	2510	246	30	13	0	33	33	0	7	0	13	20	13	67	13	76	343	2510
Lesser Black-backed Gull	79	30	13	73	113	60	10	0	13	0	0	53	319	76	20	120	99	33	66	123	93	30	227	0	13	20	20	13	7	0	319
Yellow-legged Gull	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0
Herring Gull	1769	659	90	2524	1623	914	90	7	1133	2144	995	919	1108	729	404	230	4170	1717	3682	17820	253	253	926	80	251	840	1713	2640	336	1182	17820
Great Black-backed Gull	253	23	13	0	13	73	450	742	210	311	3365	425	226	128	121	302	62	40	76	136	1068	238	2724	339	1173	591	948	867	945	689	3365
Little Gull	0	168	0	0	0	0	0	0	0	0	0	7	0	0	157	100	0	0	0	0	0	13	7	0	13	7	0	0	0	0	168
Little Gull/Tern sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11

SPECIES	201003	201004	201005	201006	201007	201008	201009	201010	201011	201012	201101	201102	201103a	201103b	201104a	201104b	201105a	201105b	201106	201107	201108	201109a	201109b	201110a	201110b	201111a	201111b	201112	201201	201202	PEAK
Black-headed Gull	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
Kittiwake	106	139	359	790	367	371	0	7	374	1100	1207	146	624	612	150	232	909	277	1329	410	7	7	0	100	560	703	260	1162	456	772	1329
Common Gull/Kittiwake	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27
Great/Lesser Black-backed Gull	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27
Gull sp	10	3	0	0	1	1	0	0	0	4	0	0	1	6	5	3	2	0	0	1	0	0	0	0	0	0	0	0	0	2	10
Herring/Common Gull	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80
Herring/Lesser Black-backed Gull	13	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
Kittiwake/Fulmar	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
Large gull sp	7	200	1007	1252	160	160	0	0	173	0	2307	23	400	1927	7	300	173	0	0	0	0	0	8065	1073	6288	120	111	6040	1676	4733	8065
Lesser/Great Black-backed Gull	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	908	0	0	0	0	0	0	0	0	0	0	908
Medium gull sp	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Small gull sp	0	0	0	0	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80
Little Tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Black Tern	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	2	0	0	0	0	0	0	0	0	0	3

SPECIES	201003	201004	201005	201006	201007	201008	201009	201010	201011	201012	201101	201102	201103a	201103b	201104a	201104b	201105a	201105b	201106	201107	201108	201109a	201109b	201110a	201110b	201111a	201111b	201112	201201	201202	PEAK
Sandwich Tern	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	7	20	0	0	0	0	27	40	0	0	0	0	0	0	0	40
Common Tern	0	0	67	0	0	27	33	7	0	0	0	0	0	0	0	7	172	0	0	0	0	0	0	0	0	0	0	0	0	0	172
Arctic Tern	0	0	180	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	180
Common/Arctic Tern	0	13	2287	10	0	7	0	0	0	0	0	0	0	0	0	40	27	0	0	0	0	0	13	0	0	0	0	0	0	0	2287
Tern sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	20
Guillemot	765	7792	2501	129	13	0	0	0	622	1102	10143	2515	13326	13109	8900	12682	4470	628	146	222	46	191	20	20	143	106	410	115	1210	3875	18496
Razorbill	184	340	309	0	7	0	0	20	552	929	2843	617	1253	1433	571	814	171	0	0	0	0	14	13	81	247	87	247	1123	474	3883	3883
Guillemot/Razorbill	470	1210	46	0	0	0	0	0	364	121	7877	1494	390	1395	213	1535	1157	0	0	0	0	20	20	20	243	120	58	372	892	10675	10675
Puffin	0	20	0	7	0	0	0	0	0	0	0	0	0	0	0	27	7	0	0	0	0	0	0	0	0	0	0	0	0	0	27
Auk sp	0	0	34	0	0	0	0	0	0	426	3333	20	3782	0	0	7	7	0	0	0	0	0	0	0	7	0	0	7	0	27	3782
Owl sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Feral Pigeon	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Swift	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	13
Skylark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10

SPECIES	201003	201004	201005	201006	201007	201008	201009	201010	201011	201012	201101	201102	201103a	201103b	201104a	201104b	201105a	201105b	201106	201107	201108	201109a	201109b	201110a	201110b	201111a	201111b	201112	201201	201202	PEAK
Sand Martin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	27	0	7	0	0	0	0	0	0	0	0	27
Swallow	0	40	140	0	0	0	260	167	0	0	0	0	0	0	13	0	7	0	0	0	0	233	927	7	0	0	0	0	0	0	927
House Martin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53	13	0	0	0	0	0	0	0	0	53
Hirundine sp	0	12	0	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	15	0	0	0	0	0	0	0	15
Meadow Pipit	0	0	0	0	0	0	0	13	0	0	0	0	0	40	20	13	0	0	0	0	167	447	0	0	13	7	0	0	0	0	447
Meadow/Tree Pipit	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pipit sp	13	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
Yellow Wagtail	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pied Wagtail	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	13	33	7	0	0	0	0	0	0	33
Wren	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	7
Robin	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Black Redstart	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	7
Blackbird	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	13
Fieldfare	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13

SPECIES	201003	201004	201005	201006	201007	201008	201009	201010	201011	201012	201101	201102	201103a	201103b	201104a	201104b	201105a	201105b	201106	201107	201108	201109a	201109b	201110a	201110b	201111a	201111b	201112	201201	201202	PEAK
Song Thrush	0	0	0	0	0	0	0	0	0	0	0	0	293	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	293
Thrush sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3
Whitethroat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Chiffchaff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
Willow Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Willow Warbler/Chiffchaff	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Warbler sp	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Carrion Crow	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Starling	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	60
Chaffinch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	87	0	0	0	0	0	0	87
Goldfinch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Siskin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	18
Linnet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	7
Finch sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	20

SPECIES	201003	201004	201005	201006	201007	201008	201009	201010	201011	201012	201101	201102	201103a	201103b	201104a	201104b	201105a	201105b	201106	201107	201108	201109a	201109b	201110a	201110b	201111a	201111b	201112	201201	201202	PEAK
Passerine sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	220	0	0	0	0	0	0	220
Small passerine sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2

Appendix 11.1: Aerial survey area population estimates for each survey, August 2010 – August 2011.

Species	12/8/10	18/9/10	21/10/10	19/11/10	21/12/10	18/2/11	11/3/11	20/5/11	28/6/11 & 20/7/11	21/7/11	2/8/11	Peak
Common Scoter	0	5	0	196	0	0	210	0	0	0	0	210
Red-breasted Merganser	0	0	0	0	0	35	57	0	0	0	0	57
duck sp.	0	0	0	0	0	0	14	0	0	0	0	14
Red-throated Diver	0	0	0	5	0	0	7	0	0	0	0	7
diver sp.	0	0	0	0	0	0	8	0	0	0	0	8
Fulmar	183	0	10	95	10	35	23	22	60	20	262	262
British Storm-petrel	0	0	0	0	10	0	2	0	0	0	0	10
Gannet	476	847	2,020	62	44	31	69	190	670	923	1,013	2,020
Cormorant	0	0	0	5	0	10	0	2	0	0	16	16
Kestrel	0	0	2	0	0	0	0	0	0	0	0	2
skua sp.	0	0	0	0	0	0	0	0	10	0	10	10
Great Skua	13	0	10	7	0	0	0	0	10	0	17	17
Common Gull	0	0	2	132	69	79	52	2	2	0	0	132
Lesser black-backed Gull	0	24	37	67	57	69	2	10	12	163	64	163
grey gull spp (Herring or Common)	0	22	7	756	509	114	33	0	83	0	9	756
Herring Gull	29	15	71	360	343	393	174	316	2,241	3,449	270	3,449
black-backed gull spp	5	65	14	581	83	129	26	15	2	2	157	581
Great Black-backed Gull	5	2	2	239	88	42	0	2	2	0	17	239
gull sp.	51	84	761	1,150	777	282	126	2,005	120	248	582	2,005
large gull sp.	0	191	27	242	437	26	332	22	50	1,614	768	1,614
Black-headed Gull	0	0	0	21	0	0	0	0	0	0	0	21
Kittiwake	57	208	2,183	2,170	875	876	781	225	923	269	806	2,183
small gull sp.	0	97	155	83	611	126	20	36	63	2	331	611

Species	12/8/10	18/9/10	21/10/10	19/11/10	21/12/10	18/2/11	11/3/11	20/5/11	28/6/11 & 20/7/11	21/7/11	2/8/11	Peak
Sandwich Tern	2	2	0	0	0	0	0	0	0	0	2	2
tern sp.	2	17	0	0	0	0	0	0	23	0	0	23
Arctic/Common Tern	5	34	34	0	0	0	0	188	0	2	45	188
auk sp.	19	31	225	686	3,260	2,122	4,430	113	81	2	60	4,430
Guillemot	0	0	0	0	2	0	0	0	9	2	0	9
Razorbill	0	0	0	0	0	0	9	0	0	0	0	9
Feral Pigeon	0	25	0	0	0	0	0	0	0	0	0	25
Swallow	0	0	0	0	0	0	0	0	2	0	0	2
passerine sp.	0	0	16	0	0	0	2	0	0	0	0	210

APPENDIX 11.5. Distance correction factors for the Rampion Offshore Wind Farm boat-based surveys.

A11.5.1 As noted in the main ES, the raw count data from both the boat-based and the aerial surveys need to be adjusted to take into account the fact that the likelihood of a bird being seen declines with distance from the observer (i.e. detectability is a function of distance from the transect line). Put simply, the chance of seeing a bird close to the observer would be higher than if it were at greater distance. The relationship between detectability and distance can be modelled using software packages such as Distance (Buckland et al. 2001), but for the purposes of this assessment a simpler approach was adopted (mainly because the limited number of distance bands makes modelling of the distance function difficult for many of the species encountered in this study). The approach used here is similar to that used by JNCC in their Seabirds at Sea surveys (e.g. Stone et al. 1995), but correction factors have been calculated for each major species group (auks/seaduck, gannet, and gulls/terns) specifically using the data collected from each of the two survey methods (boat and aerial). Species were assigned to these groups on their similarity of likely detectability and pooled to give a robust sample size for each group. Group compositions are given in Table A11.1. The same process was used to correct both the aerial and the boat data, though as detectability differed between these methods separate correction factors were calculated for each.

Table A11.1. Species groups used in calculation of distance correction factors

Species Group	Species
Auks and seaduck	Guillemot, Razorbill, Puffin, Little Auk, Eider, Common Scoter and other seaduck
Gannet	Gannet
Gulls and terns	Gulls, skuas, terns, shearwaters

A11.5.2 The process in calculating those correction factors was as follows:

- The total numbers of birds of each species group were calculated for each distance band over all of the surveys.
- Differences in the width of the distance bands were taken into account by dividing the total number by the band width, to give a standardised total (density index).
- It was assumed that bird detectability in the closest transect to the observer was 100% (a standard assumption of the Distance sampling methodology).
- As detectability of birds on the sea and flying were different from the boat survey data separate correction factors were used for each of these. In fact detectability of flying birds was so high that no correction factors were necessary for these birds – effectively all of these birds were detected within the main transect.
- For each of the other bands, the percentage difference between that band's standardised total and the closest band to the observer were calculated.
- These differences were then applied as the correction factors, dividing each count by the appropriate factor. For example, auks in band C were divided

by 49%. Hence a count of 100 in that band would be corrected to 204 (=100/0.49).

Table A3.2. Distance correction factors used for the boat survey data

Species group	A [0-50m]	B [50-100m]	C [100-200m]	D [200-300m]
Auks/seaduck	100%	89%	49%	27%
Gannet	100%	100%	86%	86%
Gulls/terns	100%	100%	69%	50%

Note: Data for band E (>300m from the survey vessel, out of transect) were not used in the density calculations or main population estimates but are included in Appendix 11.3.

Table A3.3. Distance correction factors used for the aerial survey data

Species group	A [49-174m]	B [175-459m]	C [460m-1km]
Auks/seaduck	100%	17%	0.4%
Gannet	100%	36%	12%
Gulls/terns	100%	22%	2.8%

Note: values are given in the Table for band C but these were not used in the density calculations or population estimates as detectability in this band was considered too low to provide a reliable population estimate.