

Electronic supplementary material: Avoidance and attraction
responses of kittiwakes to three offshore wind farms in the North Sea

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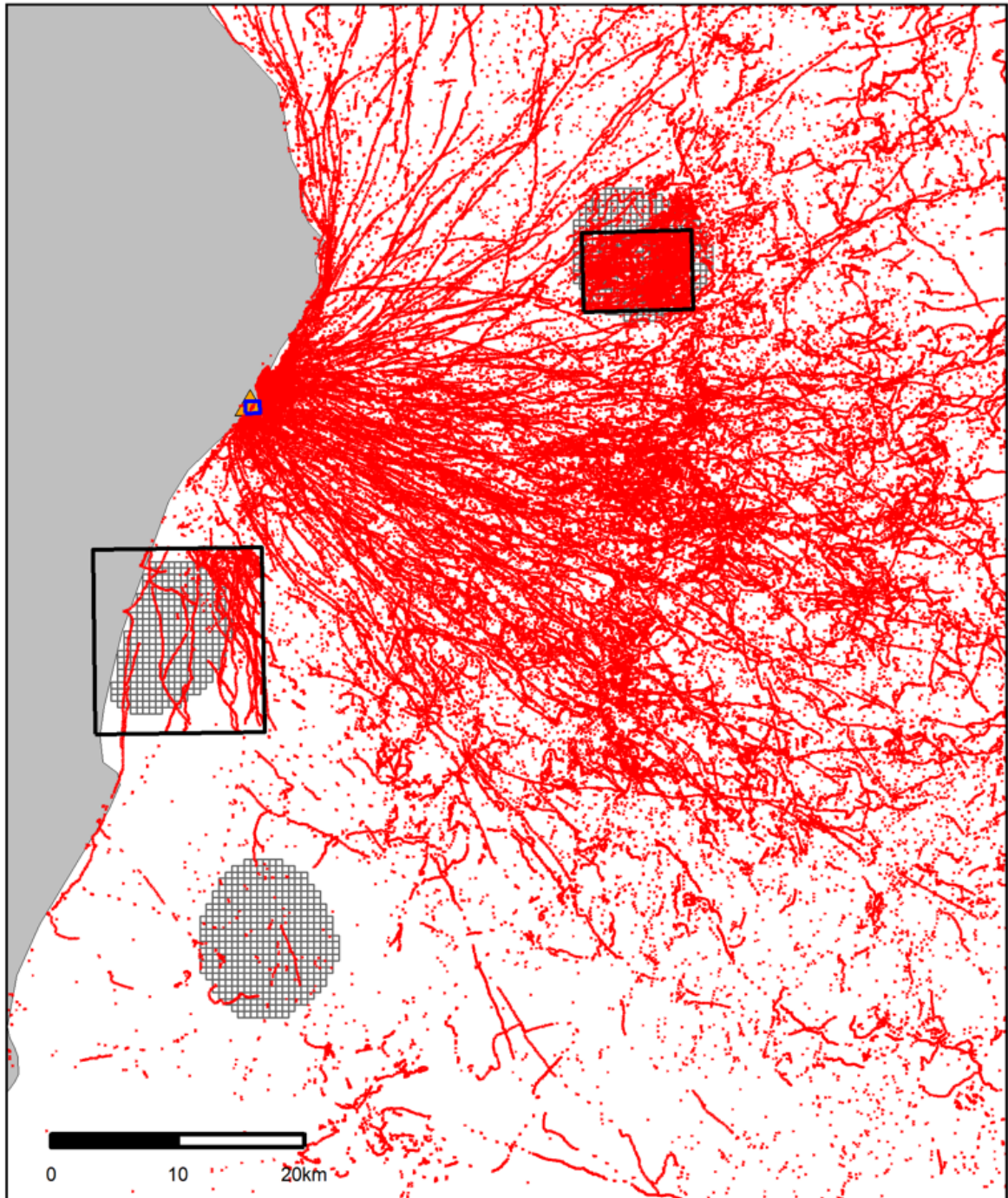


Figure S1: Plot of all fixes with geofences shown in black, square-shaped polygons. The grids used for analyses of macro-scale avoidance behaviour are also displayed to show the overlap of the area around Hywind (top right) which extends beyond the geofence.

Table S1: Avoidance Rate sensitivity analysis results resampled from the subset of data from Hywind, where sensitivity is quantified by what percentage of resampled AR means for each band (n=100) fell within the confidence intervals of the original AR means calculated on all Hywind data.

Band	Approximated number of fixes for 0-1km							
	n=5		n=10		n=25		n=50	
	Mean fixes resampled	% within original CIs	Mean fixes resampled	% within original CIs	Mean fixes resampled	% within original CIs	Mean fixes resampled	% within original CIs
0-1km	4.7 ± 1.7	58	9.8 ± 2.3	58	25.8 ± 3.5	93	51.7 ± 4.7	99
0-2km	11.3 ± 2.5	57	23.8 ± 3.3	77	54 ± 4.5	90	108.6 ± 5.8	100
0-3km	20.2 ± 2.6	58	43 ± 3.4	75	115 ± 4.8	98	172 ± 5.02	99
0-4km	32.1 ± 1.5	23	60.4 ± 1.9	53	161.3 ± 2.6	88	241.3 ± 2.8	97

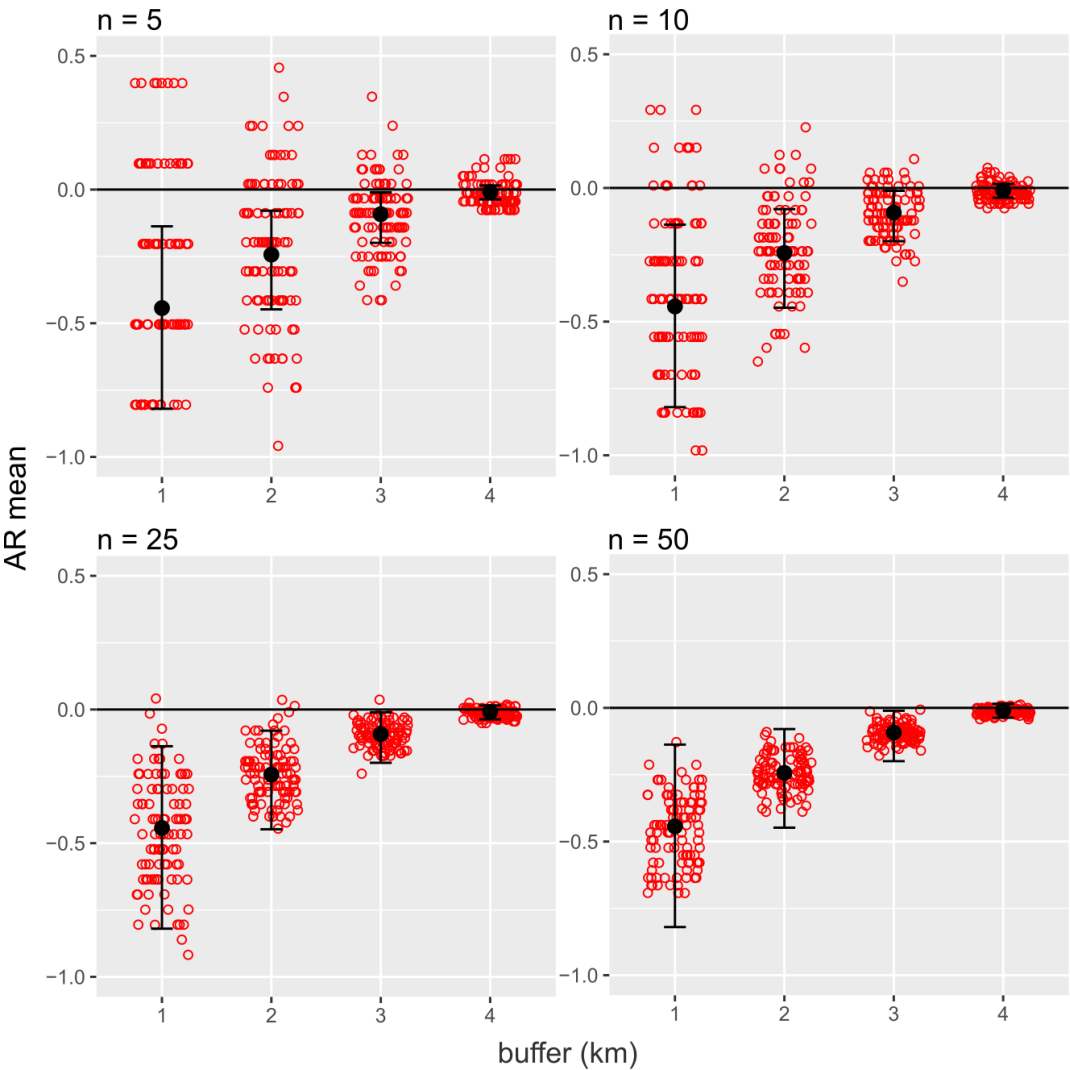


Figure S2: Avoidance Rate (AR) sensitivity analysis results showing resampling for different approximated number of fixes for the initial 0-1km band (shown in top left corner of each panel), with resampling scaled for subsequent bands according to their area. Black points and error bars show the AR mean and associated confidence intervals from the whole Hywind sample, with red points indicating resampled AR calculations (n=100).

34 Table S2: Avoidance-attraction index (AAI) results for macro-response for all OWFs together and each separately. Bold 95%
 35 CI values indicate significant responses (where intervals do not include zero).

OWF	Distance	n	n	Proportion	Proportion	Mean AAI	SD	95% CIs	
	(km)	(observed)	(expected)	(observed)	(expected)			Lower	Upper
All	3-4	23.69	15.90	0.24	0.27	-0.31	0.49	-1.26	0.36
	2-3	25.27	16.03	0.25	0.27	-0.25	0.41	-1.01	0.30
	1-2	31.21	15.97	0.26	0.26	-0.18	0.40	-0.81	0.34
	0-1	42.55	15.76	0.32	0.24	0.12	0.52	-1.18	0.59
Hywind	3-4	52.29	31.69	0.18	0.24	-0.29	0.14	-0.48	-0.04
	2-3	61.42	33.77	0.22	0.26	-0.19	0.11	-0.36	-0.01
	1-2	72.71	33.02	0.25	0.25	0.005	0.09	-0.13	0.15
	0-1	98.66	32.48	0.35	0.25	0.33	0.06	0.22	0.43
Kincardine	3-4	8.40	8.12	0.23	0.27	-0.17	0.39	-0.94	0.38
	2-3	4.98	7.37	0.14	0.25	-0.65	0.57	-1.55	0.10
	1-2	6.27	7.21	0.18	0.24	-0.34	0.28	-0.78	0.08
	0-1	16	7.17	0.46	0.24	0.61	0.16	0.35	0.89
EOWDC	3-4	11.64	7.76	0.41	0.34	0.12	0.36	-0.56	0.51
	2-3	10.16	6.62	0.37	0.29	0.21	0.26	-0.21	0.66
	1-2	5.66	4.79	0.22	0.21	-0.09	0.47	-0.92	0.65
	0-1	0	-	-	-	-	-	-	-

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38 Table S3: Meso-scale mean AAI results for each 20m distance band within and below rotor height range (RHR).

In relation to RHR	Distance (m)	n (observed)	n (expected)	Proportion (observed)	Proportion (expected)	Mean AAI	SD	Upper	Lower
Within	0-20	NA	NA	NA	NA	NA	NA	NA	NA
	20-40	0	1.31	0.00	0.03	-2.00	0.00	-2.00	-2.00
	40-60	0	1.45	0.00	0.03	-2.00	0.00	-2.00	-2.00
	60-80	3	1.73	0.05	0.04	0.49	0.50	1.16	-0.36
	80-100	1	1.71	0.02	0.03	-0.45	0.46	0.27	-1.20
	100-120	3	1.81	0.05	0.03	0.51	0.50	1.21	-0.45
	120-140	NA	NA	NA	NA	NA	NA	NA	NA
	140-160	3	2.56	0.05	0.05	0.14	0.51	1.02	-0.61
	160-180	3	2.79	0.05	0.05	0.07	0.40	0.70	-0.51
	180-200	3	2.71	0.05	0.05	0.09	0.52	0.95	-0.78
	200-220	5	3.11	0.09	0.06	0.42	0.49	1.18	-0.27
	220-240	2	3.47	0.03	0.07	-0.55	0.39	0.24	-1.08
	240-260	5	3.76	0.09	0.07	0.31	0.47	1.03	-0.44
	260-280	4	3.74	0.07	0.07	0.05	0.52	1.05	-0.62
	280-300	4	3.92	0.07	0.08	-0.02	0.46	0.80	-0.67
	300-320	4	4.00	0.07	0.09	-0.07	0.51	0.89	-0.82
	320-340	6	4.32	0.10	0.09	0.28	0.51	1.13	-0.53
	340-360	6	4.58	0.10	0.10	0.18	0.49	1.09	-0.54
	360-380	2	4.80	0.03	0.10	-0.82	0.48	0.04	-1.44
	380-400	4	4.60	0.07	0.11	-0.25	0.54	0.71	-1.10
Below	0-20	0.5	1.20	0.00	0.01	-1.35	0.71	-0.21	-2.00
	20-40	0	1.35	0.00	0.02	-2.00	0.00	-2.00	-2.00
	40-60	1	1.67	0.01	0.02	-0.94	0.36	-0.34	-1.52
	60-80	1	1.99	0.01	0.02	-1.22	0.85	0.14	-2.00
	80-100	1	2.32	0.01	0.03	-1.16	0.34	-0.54	-1.58
	100-120	0.5	2.48	0.00	0.03	-1.61	0.47	-0.60	-2.00
	120-140	3	3.15	0.02	0.04	-0.55	0.51	0.37	-1.26
	140-160	3	3.64	0.02	0.04	-0.68	0.45	0.30	-1.27
	160-180	7	3.80	0.04	0.05	0.01	0.49	0.99	-0.68
	180-200	6	4.32	0.04	0.05	-0.25	0.48	0.54	-0.95
	200-220	10	4.57	0.06	0.06	0.16	0.49	1.16	-0.53
	220-240	9	4.87	0.05	0.06	-0.01	0.46	0.82	-0.75
	240-260	7	5.47	0.04	0.07	-0.33	0.47	0.61	-0.91
	260-280	10	5.52	0.06	0.07	-0.01	0.47	0.90	-0.69
	280-300	14	5.78	0.08	0.07	0.28	0.44	1.02	-0.37
	300-320	14	6.31	0.08	0.08	0.17	0.41	0.88	-0.47
	320-340	18	6.81	0.11	0.08	0.31	0.38	1.07	-0.26
	340-360	16	6.86	0.10	0.08	0.21	0.44	1.07	-0.41
	360-380	26	7.47	0.16	0.09	0.57	0.34	1.12	0.05
	380-400	18	7.91	0.11	0.10	0.18	0.43	0.99	-0.47

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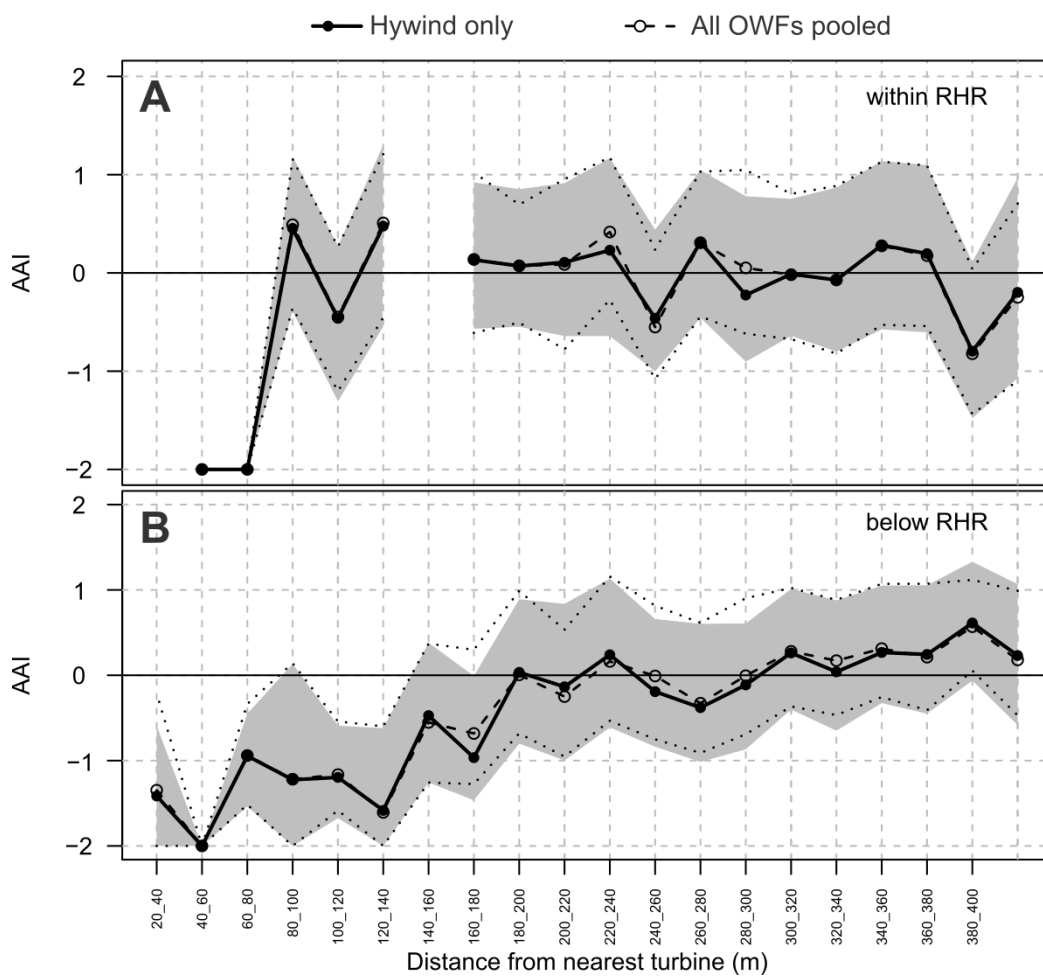


Figure S3: Mean AAI values for 20m distance bands from the nearest turbine for fixes within (panel A) and below (panel B) rotor height range at Hywind only (solid line and points) and for all OWFs pooled together (dashed line and hollow points). Grey shading indicates 95% CI for Hywind only and the dotted lines indicating the equivalent for all OWFs. AAI values calculated for each of 200 random iterations. Positive values of AAI indicate attraction, and negative values indicate avoidance.