Appendix S2: Supplementary Results

Table S1. Summary of tracking data obtained during the study

Species	Site				Size (AON)†	Year	No. birds tracked	No. birds tracked ≥24 hrs	Median tracking duration, h (IQR)	Median trip length, h (IQR)
	Name	Code	Longitude	Latitude						
Shag	Sumburgh Head	SUM	-1.277	59.856	270	2014	2	2	48.0 (47.8 - 47.8)	2.2 (1.1 - 1.1)
	Fair Isle	FAI	-1.644	59.534	663	2010	2	2	55.5 (47.7 - 47.7)	2.0 (1.2 - 1.2)
						2012	9	9	52.5 (46.2 - 46.2)	1.9 (0.9 - 0.9)
	Copinsay	COP	-2.674	58.901	4	2010	3	3	49.4 (46.8 - 46.8)	0.7 (0.5 - 0.5)
						2012	7	6	77.9 (67.8 - 67.8)	1.0 (0.6 - 0.6)
						2013	2	2	67.1 (57.0 - 57.0)	0.9 (0.6 - 0.6)
						2014	3	3	47.8 (44.4 - 44.4)	0.8 (0.7 - 0.7)
	Muckle Skerry	MKS	-2.918	58.69	25	2010	2	2	51.4 (49.2 - 49.2)	1.0 (0.7 - 0.7)
						2011	14	14	76.8 (66.3 - 66.3)	1.1 (0.7 - 0.7)
						2012	6	5	75.1 (64.9 - 64.9)	1.2 (0.6 - 0.6)
						2013	1	1	75.6 (75.6 - 75.6)	1.0 (0.7 - 0.7)
						2014	2	2	51.3 (51.2 - 51.2)	0.8 (0.5 - 0.5)
	Lunga	LUN	-6.426	56.492	22	2014	11	10	69.8 (61.5 - 61.5)	3.5 (2.2 - 2.2)
	Isle of May	IOM	-2.548	56.182	734	2012	18	16	32.7 (30.5 - 30.5)	1.9 (1.6 - 1.6)
						2013	16	16	146.0 (141.8 - 141.8)	1.9 (1.5 - 1.5)
	Colonsay	CSY	-6.232	56.095	44	2010	17	17	50.0 (46.8 - 46.8)	2.6 (1.5 - 1.5)
						2011	6	5	95.4 (85.4 - 85.4)	3.5 (1.6 - 1.6)
						2012	11	11	91.7 (86.7 - 86.7)	2.3 (1.2 - 1.2)
						2013	7	7	94.5 (90.5 - 90.5)	2.3 (1.3 - 1.3)
	Rathlin	RAT	-6.193	55.26	20	2013	1	1	89.8 (89.8 - 89.8)	1.8 (1.0 - 1.0)
	Lambay	LAM	-6.001	53.496	189	2010	10	10	98.2 (76.3 - 76.3)	1.8 (0.8 - 0.8)
						2011	10	9	67.7 (52.2 - 52.2)	1.8 (1.1 - 1.1)

	Puffin Island	PUF	-4.021	53.321	89	2010	20	18	69.6 (66.5 - 66.5)	1.9 (1.2 - 1.2)
						2011	19	13	74.8 (42.8 - 42.8)	1.2 (0.9 - 0.9)
						2012	21	21	91.8 (75.2 - 75.2)	1.7 (1.2 - 1.2)
	Great Saltee	GTS	-6.626	52.111	240	2013	5	5	73.1 (54.5 - 54.5)	1.7 (1.1 - 1.1)
	Samson	SAM	-6.35	49.928	1	2010	2	2	70.0 (68.0 - 68.0)	1.6 (0.7 - 0.7)
						2011	3	3	71.5 (58.9 - 58.9)	1.5 (0.9 - 0.9)
						2012	1	1	71.2 (71.2 - 71.2)	0.7 (0.5 - 0.5)
	Annet	ANN	-6.373	49.896	28	2010	1	1	76.2 (76.2 - 76.2)	1.8 (1.7 - 1.7)
						2011	4	4	81.7 (76.4 - 76.4)	0.9 (0.5 - 0.5)
						2012	1	1	80.7 (80.7 - 80.7)	1.7 (1.4 - 1.4)
Kittiwake	Fair Isle	FAI	-1.645	59.534	8,204	2010	2	1	41.3 (41.3 - 41.3)	20.6 (16.0 - 16.0)
						2011	1	1	44.4 (44.4 - 44.4)	1.8 (1.2 - 1.2)
						2012	2	2	45.4 (45.1 - 45.1)	7.0 (4.7 - 4.7)
						2014	2	2	43.7 (42.0 - 42.0)	2.6 (2.3 - 2.3)
	Sule Skerry	SUS	-4.406	59.084	1275	2011	4	4	44.6 (41.9 - 41.9)	1.9 (0.8 - 0.8)
	Copinsay	COP	-2.666	58.9	183	2010	11	6	24.5 (22.6 - 22.6)	5.5 (3.3 - 3.3)
						2011	7	4	24.7 (23.8 - 23.8)	2.7 (1.5 - 1.5)
						2012	8	7	48.2 (39.2 - 39.2)	2.0 (1.4 - 1.4)
						2014	3	2	45.5 (43.8 - 43.8)	1.8 (1.2 - 1.2)
	Muckle Skerry	MKS	-2.917	58.689	219	2010	9	5	26.3 (24.6 - 24.6)	2.2 (1.2 - 1.2)
						2011	9	4	32.8 (25.9 - 25.9)	2.6 (1.1 - 1.1)
						2012	12	12	46.0 (42.7 - 42.7)	2.0 (0.9 - 0.9)
						2013	8	6	48.1 (35.0 - 35.0)	1.9 (0.9 - 0.9)
						2014	12	8	31.2 (23.8 - 23.8)	1.1 (0.8 - 0.8)
	Cape Wrath	CAW	-4.77	58.602	365	2014	5	5	32.0 (31.9 - 31.9)	2.2 (1.0 - 1.0)
	Bullers of Buchan	BOB	-1.816	57.43	709	2012	5	5	67.9 (67.5 - 67.5)	3.5 (1.8 - 1.8)
	Whinnyfold	WIN	-1.869	57.385	796	2012	20	16	44.7 (34.4 - 34.4)	7.8 (4.6 - 4.6)
	Fowlsheugh	FOW	-2.197	56.925	800	2012	15	10	35.0 (22.2 - 22.2)	10.9 (5.4 - 5.4)
	Isle of May	IOM	-2.553	56.181	3,639	2012	17	9	35.3 (23.6 - 23.6)	2.0 (1.1 - 1.1)
						2013	22	15	25.9 (23.3 - 23.3)	7.0 (3.1 - 3.1)
						2014	11	9	24.7 (24.6 - 24.6)	2.8 (1.3 - 1.3)

	Colonsay	CSY	-6.238	56.089	59	2010	9	5	28.5 (23.4 - 23.4)	7.9 (3.9 - 3.9)
						2011	26	21	45.3 (24.5 - 24.5)	11.9 (4.3 - 4.3)
						2012	24	23	45.5 (43.9 - 43.9)	8.9 (6.0 - 6.0)
						2013	13	12	47.7 (43.3 - 43.3)	10.5 (6.9 - 6.9)
						2014	12	12	45.6 (39.8 - 39.8)	5.9 (2.9 - 2.9)
	St Abbs	SAB	-2.137	55.917	2,215	2012	15	15	62.7 (41.7 - 41.7)	15.7 (2.6 - 2.6)
	Coquet	COQ	-1.537	55.335	51	2011	13	7	24.8 (21.5 - 21.5)	4.4 (2.3 - 2.3)
						2012	23	18	27.4 (24.1 - 24.1)	1.9 (1.1 - 1.1)
	Rathlin	RAT	-6.265	55.307	325	2012	1	0		11.6 (11.6 - 11.6)
						2013	8	7	49.3 (48.4 - 48.4)	4.0 (1.6 - 1.6)
	Filey	FIL	-0.272	54.219	120	2013	18	14	48.4 (37.0 - 37.0)	6.6 (3.1 - 3.1)
						2014	16	16	48.2 (47.3 - 47.3)	9.8 (6.1 - 6.1)
	Bempton	BEM	-0.077	54.114	1,050	2010	23	14	25.6 (23.4 - 23.4)	7.7 (3.0 - 3.0)
						2011	17	8	22.9 (20.9 - 20.9)	6.1 (0.9 - 0.9)
						2012	9	8	64.2 (45.8 - 45.8)	17.4 (8.1 - 8.1)
						2013	20	16	41.0 (36.0 - 36.0)	5.6 (4.0 - 4.0)
						2014	17	17	47.0 (37.4 - 37.4)	8.6 (4.0 - 4.0)
	Lambay	LAM	-5.997	53.495	1,093	2010	10	5	24.0 (22.6 - 22.6)	3.3 (2.4 - 2.4)
						2011	4	4	47.3 (47.0 - 47.0)	4.0 (1.8 - 1.8)
	Puffin Island	PUF	-4.026	53.321	571	2010	15	15	56.5 (50.2 - 50.2)	1.9 (1.2 - 1.2)
						2011	30	28	47.1 (41.6 - 41.6)	4.2 (2.1 - 2.1)
						2012	24	23	49.6 (48.4 - 48.4)	4.8 (1.6 - 1.6)
						2013	4	4	68.8 (63.7 - 63.7)	1.8 (1.3 - 1.3)
	Bardsey	BAR	-4.78	52.758	288	2011	8	6	25.9 (24.1 - 24.1)	4.0 (2.5 - 2.5)
	St Martins	STM	-6.262	49.966	27	2010	18	8	23.8 (22.2 - 22.2)	3.6 (2.0 - 2.0)
						2011	14	7	24.1 (23.2 - 23.2)	4.9 (2.5 - 2.5)
						2012	3	3	35.2 (34.1 - 34.1)	6.4 (4.2 - 4.2)
	St Agnes	STA	-6.338	49.895	155	2011	2	1	24.0 (23.5 - 23.5)	1.8 (1.7 - 1.7)
						2012	2	1	35.5 (28.7 - 28.7)	8.2 (3.2 - 3.2)
Murre	Fair Isle	FAI	-1.619	59.551	78,514	2011	3	3	74.7 (74.1 - 74.1)	39.7 (0.9 - 0.9)
						2012	6	3	65.1 (64.3 - 64.3)	45.6 (41.2 - 41.2)

						2013	1	1	110.0 (110.0 - 110.0)	13.1 (6.9 - 6.9)
						2014	4	2	87.9 (83.5 - 83.5)	19.2 (14.1 - 14.1)
	Copinsay	COP	-2.674	58.903	160	2012	4	4	56.7 (49.6 - 49.6)	2.7 (1.3 - 1.3)
						2014	5	5	26.8 (25.9 - 25.9)	2.7 (1.6 - 1.6)
	Shiants	SHI	-6.358	57.901	46	2014	1	1	48.7 (48.7 - 48.7)	10.1 (10.1 - 10.1)
	Bullers of Buchan	BOB	-1.81	57.421	3,482	2012	2	2	53.2 (47.2 - 47.2)	13.0 (12.0 - 12.0)
	Whinnyfold	WIN	-1.865	57.375	1,630	2012	5	5	45.5 (45.2 - 45.2)	3.3 (1.3 - 1.3)
	Fowlsheugh	FOW	-2.187	56.914	9,853	2012	10	9	44.0 (34.2 - 34.2)	9.9 (3.7 - 3.7)
	Lunga	LUN	-6.427	56.491	17,852	2014	3	3	72.3 (72.3 - 72.3)	14.2 (1.9 - 1.9)
	Isle of May	IOM	-2.56	56.183	56,206	2012	20	15	42.9 (28.3 - 28.3)	8.5 (2.5 - 2.5)
						2013	20	20	51.2 (44.3 - 44.3)	10.1 (2.4 - 2.4)
						2014	11	11	47.5 (45.6 - 45.6)	5.0 (1.4 - 1.4)
	Colonsay	CSY	-6.241	56.092	620	2010	3	2	32.0 (27.3 - 27.3)	5.7 (1.2 - 1.2)
						2011	24	22	70.6 (50.4 - 50.4)	8.7 (1.6 - 1.6)
						2012	15	14	51.2 (43.9 - 43.9)	10.0 (3.1 - 3.1)
						2013	13	13	84.4 (69.5 - 69.5)	12.7 (5.6 - 5.6)
						2014	22	22	52.6 (45.8 - 45.8)	7.5 (2.0 - 2.0)
	St Abbs	SAB	-2.12	55.916	16,288	2012	1	1	98.7 (98.7 - 98.7)	0.8 (0.8 - 0.8)
	Lambay	LAM	-5.996	53.499	21,124	2010	3	2	49.5 (36.6 - 36.6)	8.0 (5.0 - 5.0)
						2011	1	1	66.7 (66.7 - 66.7)	19.1 (18.5 - 18.5)
	Puffin Island	PUF	-4.025	53.321	5,598	2012	5	4	52.3 (48.1 - 48.1)	3.6 (1.7 - 1.7)
						2013	10	9	74.4 (70.8 - 70.8)	4.4 (2.2 - 2.2)
Razorbill	Fair Isle	FAI	-1.619	59.55	7,198	2010	2	1	48.3 (48.3 - 48.3)	39.0 (39.0 - 39.0)
						2011	20	15	66.7 (51.8 - 51.8)	41.3 (23.2 - 23.2)
						2012	22	19	69.0 (55.5 - 55.5)	38.9 (18.8 - 18.8)
						2013	8	8	80.0 (66.6 - 66.6)	64.8 (50.9 - 50.9)
						2014	17	17	88.3 (65.9 - 65.9)	17.0 (8.3 - 8.3)
	Copinsay	COP	-2.668	58.901	332	2010	1	1	40.0 (40.0 - 40.0)	14.2 (13.1 - 13.1)
						2011	1	1	37.9 (37.9 - 37.9)	25.4 (25.4 - 25.4)
						2012	6	6	68.3 (61.2 - 61.2)	4.0 (1.3 - 1.3)
						2013	3	2	27.3 (26.2 - 26.2)	3.8 (2.8 - 2.8)

					2014	3	3	41.6 (40.6 - 40.6)	8.3 (7.9 - 7.9)
Swona	SWO	-3.056	58.738	446	2010	3	3	83.5 (82.0 - 82.0)	2.9 (1.3 - 1.3)
					2011	8	8	76.7 (70.0 - 70.0)	2.8 (1.6 - 1.6)
					2012	9	9	62.7 (46.9 - 46.9)	2.3 (1.1 - 1.1)
					2013	7	6	39.1 (31.4 - 31.4)	2.2 (1.5 - 1.5)
					2014	2	1	25.5 (25.5 - 25.5)	1.0 (0.9 - 0.9)
Muckle Skerry	MKS	-2.929	58.69	356	2010	8	7	54.6 (44.5 - 44.5)	7.3 (2.0 - 2.0)
					2011	4	3	48.5 (46.8 - 46.8)	4.4 (2.2 - 2.2)
					2012	9	8	50.0 (48.9 - 48.9)	2.8 (1.3 - 1.3)
					2013	7	5	59.8 (40.4 - 40.4)	9.9 (1.1 - 1.1)
					2014	5	4	42.2 (41.7 - 41.7)	6.3 (2.4 - 2.4)
Flannans	FAN	-7.593	58.287	1,448	2014	4	4	87.1 (83.2 - 83.2)	6.7 (3.0 - 3.0)
Shiants	SHI	-6.357	57.899	7,470	2014	4	4	70.8 (62.2 - 62.2)	7.3 (6.2 - 6.2)
Lunga	LUN	-6.427	56.491	716	2014	7	7	86.0 (76.7 - 76.7)	10.0 (1.8 - 1.8)
Isle of May	IOM	-2.558	56.184	8,228	2012	15	6	23.6 (22.5 - 22.5)	1.8 (0.9 - 0.9)
					2013	7	7	66.4 (62.6 - 62.6)	3.5 (1.3 - 1.3)
					2014	5	5	61.5 (58.3 - 58.3)	2.6 (1.5 - 1.5)
Colonsay	CSY	-6.238	56.093	289	2010	5	4	48.6 (42.8 - 42.8)	9.6 (1.7 - 1.7)
					2011	10	10	78.1 (68.1 - 68.1)	10.6 (3.1 - 3.1)
					2012	10	10	71.3 (70.3 - 70.3)	4.5 (1.4 - 1.4)
					2013	11	10	69.8 (51.2 - 51.2)	7.4 (2.0 - 2.0)
					2014	6	5	105.9 (78.0 - 78.0)	3.4 (2.0 - 2.0)
Rathlin	RAT	-6.247	55.311	693	2012	1	1	86.8 (86.8 - 86.8)	25.1 (23.7 - 23.7)
Lambay	LAM	-5.997	53.495	1,300	2011	5	5	65.9 (64.4 - 64.4)	5.2 (1.9 - 1.9)
Puffin Island	PUF	-4.029	53.321	302	2011	12	12	74.7 (66.9 - 66.9)	4.3 (1.1 - 1.1)
					2012	10	10	72.8 (69.8 - 69.8)	3.9 (1.3 - 1.3)
					2013	12	11	100.0 (95.1 - 95.1)	12.4 (5.1 - 5.1)
Bardsey	BAR	-4.78	52.762	1,572	2011	19	16	61.0 (51.7 - 51.7)	10.0 (2.5 - 2.5)
Skomer	SKO	-5.303	51.733	3,898	2011	7	7	98.8 (74.4 - 74.4)	10.9 (3.7 - 3.7)
					2012	4	4	118.9 (72.6 - 72.6)	14.4 (12.4 - 12.4)

† Number of apparently occupied nests (AON) recorded during the Seabird 2000 census, 1998 – 2002 (Mitchell et al. 2004)

Table S2. Change in the performance of models of log(intensity of tracking locations) with the addition of explanatory covariates.

Species	Step	Additional covariate(s)	$\overline{BA}$ (± sd)	$\Delta \overline{BA}$ †
Shag	1. Colony distance	d	0.415 ± 0.130	0.277
	2. Cumulative area at distance	$\log(A)$	0.446 ± 0.117	0.308
	3. Sympatric competition	$\log(A)*N$	0.443 ± 0.124	0.305
		$\log(A)*\sqrt{N}$	0.443 ± 0.122	0.305
		$\log(A)*\theta$	0.445 ± 0.123	0.307
		$\log(A)*\sqrt{\theta}$	0.444 ± 0.124	0.306
		$\log(A)*\theta'$	0.449 ± 0.133	0.311
	3. Parapatric competition	ρ	0.425 ± 0.121	0.287
	4. Habitat	gravel	0.483 ± 0.086	0.345
		$\text{gravel} * \overline{\text{gravel}}$	0.503 ± 0.112	0.365
		$\sqrt{\text{PEA}}$	0.519 ± 0.117	0.381
		$\sqrt{\text{PEA}} * \overline{\sqrt{\text{PEA}}}$	0.517 ± 0.115	0.379
		NPP	0.521 ± 0.124	0.383
		$\text{NPP} * \overline{\text{NPP}}$	0.517 ± 0.119	0.379
		coast distance	0.522 ± 0.122	0.384
		$\text{coast distance} * \overline{\text{coast distance}}$	0.520 ± 0.124	0.382
		TFGD	0.515 ± 0.122	0.377
		$\text{front gradient} * \overline{\text{front gradient}}$	0.509 ± 0.116	0.371

		SST	**0.524 ± 0.130**	0.386
		$\mathrm{SST} * \overline{\mathrm{SST}}$	0.521 ± 0.135	0.383
	5. Habitat polynomials	gravel^2	0.523 ± 0.130	0.385
		$\mathrm{gravel}^2 * \overline{\mathrm{gravel}}^2$	0.522 ± 0.123	0.384
		$\sqrt{\mathrm{PEA}}^2$	0.495 ± 0.143	0.357
		NPP^2	0.509 ± 0.107	0.371
		coast $\mathrm{distance}^2$	0.522 ± 0.125	0.384
		SST^2	0.524 ± 0.132	0.386
Kittiwake	1. Colony distance	d	0.440 ± 0.099	0.294
	2. Cumulative area at distance	$\log(A)$	0.472 ± 0.088	0.326
	3. Sympatric competition	$\log(A)*N$	0.474 ± 0.092	0.328
		$\log(A)*\sqrt{N}$	0.476 ± 0.088	0.33
		$\log(A)*\theta$	0.490 ± 0.113	0.344
		$\log(A)*\sqrt{\theta}$	0.489 ± 0.113	0.343
		$\log(A)*\theta'$	0.488 ± 0.108	0.342
	3. Parapatric competition	ρ	0.501 ± 0.119	0.355
	4. Habitat	log(seabed slope)	0.499 ± 0.117	0.353
		$\log(\text{seabed slope}) * \overline{\log(\text{seabed slope})}$	0.514 ± 0.112	0.368
		sSST	0.524 ± 0.111	0.378
		$\mathrm{sSST} * \overline{\mathrm{sSST}}$	0.524 ± 0.111	0.378
		gravel	0.521 ± 0.112	0.375

		$\text{gravel} * \overline{\text{gravel}}$	0.518 ± 0.112	0.372
		stratification	0.520 ± 0.110	0.374
		$\text{stratification} * \overline{\text{stratification}}$	0.526 ± 0.128	0.38
		sand:mud	0.524 ± 0.129	0.378
		$\text{sand : mud} * \overline{\text{sand : mud}}$	0.521 ± 0.124	0.375
	5. Habitat polynomials	$\log(\text{seabed slope})^2$	**0.527 ± 0.127**	0.381
		$\log(\text{seabed slope})^2 * \overline{\log(\text{seabed slope})^2}$	0.527 ± 0.127	0.381
		sSST^2	0.521 ± 0.125	0.375
		$\text{sSST}^2 * \overline{\text{sSST}^2}$	0.521 ± 0.123	0.375
		stratification^2	0.522 ± 0.129	0.376
		$\text{stratification}^2 * \overline{\text{stratification}^2}$	0.518 ± 0.123	0.372
Murre	1. Colony distance	d	0.455 ± 0.181	0.367
	2. Cumulative area at distance	$\log(A)$	0.477 ± 0.175	0.389
	3. Sympatric competition	$\log(A)*N$	0.434 ± 0.206	0.346
		$\log(A)*\sqrt{N}$	0.448 ± 0.185	0.360
		$\log(A)*\theta$	0.486 ± 0.190	0.398
		$\log(A)*\sqrt{\theta}$	0.487 ± 0.184	0.399
		$\log(A)*\theta'$	0.474 ± 0.177	0.386
	3. Parapatric competition	ρ	0.492 ± 0.189	0.404
	4. Habitat	gravel	0.510 ± 0.199	0.422
		$\text{gravel} * \overline{\text{gravel}}$	0.506 ± 0.196	0.418

		sand:mud	0.508 ± 0.200	0.420
		$\text{sand : mud} * \overline{\text{sand : mud}}$	0.512 ± 0.204	0.424
		TFGD	0.520 ± 0.212	0.432
		$\text{TFGD} * \overline{\text{TFGD}}$	0.519 ± 0.210	0.431
		coast distance	0.524 ± 0.213	0.436
		$\text{coast distance} * \overline{\text{coast distance}}$	0.527 ± 0.218	0.439
	5. Habitat polynomials	gravel^2	0.526 ± 0.220	0.438
		$\text{gravel}^2 * \overline{\text{gravel}}^2$	0.525 ± 0.221	0.437
		$(\text{sand:mud})^2$	**0.529 ± 0.219**	0.441
		$(\text{sand : mud})^2 * \overline{(\text{sand : mud})^2}$	0.529 ± 0.218	0.441
		TFGD^2	0.524 ± 0.217	0.436
		$\text{TFGD}^2 * \overline{\text{TFGD}^2}$	0.527 ± 0.218	0.439
		coast distance^2	0.524 ± 0.217	0.436
		$\text{coast distance}^2 * \overline{\text{coast distance}^2}$	0.519 ± 0.215	0.431
Razorbill	1. Colony distance	d	0.248 ± 0.055	0.159
	2. Cumulative area at distance	$\log(A)$	0.304 ± 0.072	0.215
	3. Sympatric competition	$\log(A)*N$	0.323 ± 0.111	0.234
		$\log(A)*\sqrt{N}$	0.326 ± 0.114	0.237
		$\log(A)*\theta$	0.321 ± 0.107	0.232
		$\log(A)*\sqrt{\theta}$	0.322 ± 0.110	0.233
		$\log(A)*\theta'$	0.298 ± 0.063	0.209

3. Parapatric competition	ρ	0.314 ± 0.103	0.225
4. Habitat	SST	0.331 ± 0.124	0.242
	$\mathrm{SST} * \overline{\mathrm{SST}}$	0.332 ± 0.113	0.243
	sand:mud	0.335 ± 0.115	0.246
	$\mathrm{sand:mud} * \overline{\mathrm{sand:mud}}$	0.335 ± 0.123	0.246
	log(seabed slope)	0.336 ± 0.117	0.247
	$\log(\text{seabed slope}) * \overline{\log(\text{seabed slope})}$	0.337 ± 0.115	0.248
5. Habitat polynomials	SST^2	0.336 ± 0.113	0.247
	$\mathrm{SST}^2 * \overline{\mathrm{SST}^2}$	0.332 ± 0.113	0.243
	$(\mathrm{sand:mud})^2$	**0.339 ± 0.110**	0.25
	$\log(\text{seabed slope})^2$	0.336 ± 0.114	0.247
	$\log(\text{seabed slope})^2 * \overline{\log(\text{seabed slope})^2}$	0.337 ± 0.115	0.248

The $\overline{BA}$ scores of the final models are highlighted in **bold**.

† Relative to the intercept-only model. Covariates highlighted in blue were retained in models I-IV and those highlighted in yellow were also retained in the models V-VIII. N = pairs of birds breeding at the home site, k; θ = inverse-distance weighted breeding density; θ' = inverse-distance weighted square-root breeding density; ρ = density of birds from the home site relative to those from all other sites; NPP = net primary production; PEA = mean potential energy anomaly; SST = mean sea surface temperature; sSST = mean standardised SST. Overbars indicate the mean of the covariate in water accessible from each colony.

Table S3. Summary of fixed effects in inhomogeneous Poisson point process models of the density of seabird tracking locations as functions of colony distance, coastal geometry and sympatric intra-specific competition.

Model (sites, birds)	Covariate†	Estimate	SE‡	z
I. Shag (13, 230)	Intercept	-4.287	0.064	-67.13
	d	-1.527	0.016	-94.15
	$\log(A)$	-1.214	0.008	-147.34
	θ'	0.221	0.061	3.62
	$\log(A)^* \theta'$	0.145	0.005	31.80
	Intercept	-5.600	0.047	-118.42
II. Kittiwake (20, 464)	d	-1.991	0.009	-233.62
	$\log(A)$	-0.748	0.004	-187.98
	θ	0.555	0.046	12.14
	$\log(A)^* \theta$	0.383	0.003	137.08
III. Murre (12, 178)	Intercept	-6.726	0.087	-77.26
	d	-2.967	0.018	-165.84
	$\log(A)$	-0.771	0.006	-130.94
	$\sqrt{\theta}$	0.615	0.081	7.64
	$\log(A)^*\sqrt{\theta}$	0.338	0.004	82.94
IV. Razorbill (14, 281)	Intercept	-5.090	0.082	-61.86
	d	-1.126	0.008	-141.35
	$\log(A)$	-1.017	0.004	-245.17
	$\sqrt{N}$	0.499	0.087	5.73
	$\log(A)^* \sqrt{N}$	0.325	0.003	122.35

† Covariates standardised prior to model fitting; d = distance by-sea from the colony; A = cumulative area at distance d; θ = inverse-distance weighted number of conspecifics breeders; θ'= inverse-distance weighted square-root number of conspecific breeders; N = number of conspecific breeders at the home site.

‡ Relative standard errors.

Table S4. Change in model performance caused by adding environmental covariates singly or together with their first order expectations to the model containing colony distance *d*, cumulative area *A* at *d* and sympatric competition (see Table S3).

Species	Additional covariate(s)[†]	$\overline{BA}$ (± sd)	$\Delta \overline{BA}$	Rank
Shag	coast distance	0.465 ± 0.125	0.016	12
	$\text{coast distance} * \overline{\text{coast distance}}$	0.464 ± 0.125	0.015	13
	depth	0.444 ± 0.142	-0.005	25
	$\text{depth} * \overline{\text{depth}}$	0.441 ± 0.140	-0.008	26
	TFGD	0.463 ± 0.134	0.014	15
	$\text{TFGD} * \overline{\text{TFGD}}$	0.463 ± 0.134	0.014	14
	NPP	0.439 ± 0.139	-0.010	28
	$\text{NPP} * \overline{\text{NPP}}$	0.428 ± 0.146	-0.021	32
	log(NPP)	0.450 ± 0.140	0.001	20
	$\log(\text{NPP}) * \overline{\log(\text{NPP})}$	0.446 ± 0.133	-0.003	24
	stratification	0.467 ± 0.154	0.018	10
	$\text{stratification} * \overline{\text{stratification}}$	0.466 ± 0.154	0.017	11
	PEA	0.462 ± 0.116	0.013	16
	$\text{PEA} * \overline{\text{PEA}}$	0.481 ± 0.130	0.032	6
	$\sqrt{\text{PEA}}$	0.481 ± 0.140	0.032	5
	$\sqrt{\text{PEA}} * \overline{\sqrt{\text{PEA}}}$	0.479 ± 0.139	0.030	7
	gravel	0.483 ± 0.086	0.034	4
	$\text{gravel} * \overline{\text{gravel}}$	0.503 ± 0.112	0.054	1
	$\sqrt{\text{gravel}}$	0.446 ± 0.138	-0.003	22
	$\sqrt{\text{gravel}} * \overline{\sqrt{\text{gravel}}}$	0.432 ± 0.152	-0.017	30
	sand:mud	0.441 ± 0.138	-0.008	27
	$\text{sand : mud} * \overline{\text{sand : mud}}$	0.439 ± 0.138	-0.010	29
	$\sqrt{\text{sand : mud}}$	0.493 ± 0.134	0.044	2

	$\sqrt{\text{sand : mud}} * \overline{\sqrt{\text{sand : mud}}}$	0.484 ± 0.138	0.035	3
	seabed slope	0.472 ± 0.087	0.023	8
	$\text{seabed slope} * \overline{\text{seabed slope}}$	0.470 ± 0.092	0.021	9
	log(seabed slope)	0.446 ± 0.138	-0.003	23
	$\log(\text{seabed slope}) * \overline{\log(\text{seabed slope})}$	0.430 ± 0.157	-0.019	31
	SST	0.452 ± 0.101	0.003	19
	$\text{SST} * \overline{\text{SST}}$	0.459 ± 0.105	0.010	17
	sSST	0.446 ± 0.121	-0.003	21
	$\text{sSST} * \overline{\text{sSST}}$	0.456 ± 0.116	0.007	18
Kittiwake	coast distance	0.499 ± 0.123	-0.002	25
	$\text{coast distance} * \overline{\text{coast distance}}$	0.493 ± 0.131	-0.008	31
	depth	0.499 ± 0.120	-0.002	24
	$\text{depth} * \overline{\text{depth}}$	0.497 ± 0.119	-0.004	27
	TFGD	0.494 ± 0.111	-0.007	30
	$\text{TFGD} * \overline{\text{TFGD}}$	0.467 ± 0.092	-0.034	32
	NPP	0.499 ± 0.117	-0.002	23
	$\text{NPP} * \overline{\text{NPP}}$	0.514 ± 0.112	0.013	1
	log(NPP)	0.502 ± 0.119	0.001	15
	$\log(\text{NPP}) * \overline{\log(\text{NPP})}$	0.501 ± 0.122	0.000	16
	stratification	0.501 ± 0.119	0.000	18
	$\text{stratification} * \overline{\text{stratification}}$	0.496 ± 0.113	-0.005	29
	PEA	0.501 ± 0.119	0.000	17
	$\text{PEA} * \overline{\text{PEA}}$	0.504 ± 0.132	0.003	9
	$\sqrt{\text{PEA}}$	0.500 ± 0.116	-0.001	21
	$\sqrt{\text{PEA}} * \overline{\sqrt{\text{PEA}}}$	0.503 ± 0.126	0.002	12
	gravel	0.505 ± 0.119	0.004	6
	$\text{gravel} * \overline{\text{gravel}}$	0.502 ± 0.121	0.001	13
	$\sqrt{\text{gravel}}$	0.503 ± 0.121	0.002	10

	$\sqrt{\text{gravel}} * \overline{\sqrt{\text{gravel}}}$	0.500 ± 0.115	-0.001	19
	sand:mud	0.500 ± 0.119	-0.001	22
	$\text{sand : mud} * \overline{\text{sand : mud}}$	0.496 ± 0.110	-0.005	28
	$\sqrt{\text{sand : mud}}$	0.500 ± 0.119	-0.001	20
	$\sqrt{\text{sand : mud}} * \overline{\sqrt{\text{sand : mud}}}$	0.504 ± 0.130	0.003	8
	seabed slope	0.504 ± 0.120	0.003	7
	$\text{seabed slope} * \overline{\text{seabed slope}}$	0.502 ± 0.121	0.001	14
	log(seabed slope)	0.503 ± 0.121	0.002	11
	$\log(\text{seabed slope}) * \overline{\log(\text{seabed slope})}$	0.498 ± 0.115	-0.003	26
	SST	0.509 ± 0.113	0.008	3
	$\text{SST} * \overline{\text{SST}}$	0.508 ± 0.112	0.007	5
	sSST	0.510 ± 0.113	0.009	2
	$\text{sSST} * \overline{\text{sSST}}$	0.508 ± 0.112	0.007	4
Murre	coast distance	0.493 ± 0.188	0.001	12
	$\text{coast distance} * \overline{\text{coast distance}}$	0.493 ± 0.189	0.001	13
	depth	0.486 ± 0.186	-0.006	28
	$\text{depth} * \overline{\text{depth}}$	0.487 ± 0.187	-0.005	24
	TFGD	0.498 ± 0.194	0.006	9
	$\text{TFGD} * \overline{\text{TFGD}}$	0.498 ± 0.193	0.006	10
	MLD	0.495 ± 0.190	0.003	21
	$\text{MLD} * \overline{\text{MLD}}$	0.488 ± 0.186	-0.004	31
	log(MLD)	0.487 ± 0.186	-0.005	14
	$\log(\text{MLD}) * \overline{\log(\text{MLD})}$	0.484 ± 0.182	-0.008	17
	NPP	0.489 ± 0.188	-0.003	20
	$\text{NPP} * \overline{\text{NPP}}$	0.444 ± 0.168	-0.048	25
	log(NPP)	0.491 ± 0.188	-0.001	11
	$\log(\text{NPP}) * \overline{\log(\text{NPP})}$	0.490 ± 0.188	-0.002	18
	stratification	0.489 ± 0.187	-0.003	22

	$\text{stratification} * \overline{\text{stratification}}$	0.487 ± 0.185	-0.005	19
	PEA	0.496 ± 0.193	0.004	1
	$\text{PEA} * \overline{\text{PEA}}$	0.490 ± 0.189	-0.002	3
	$\sqrt{\text{PEA}}$	0.488 ± 0.185	-0.004	8
	$\sqrt{\text{PEA}} * \overline{\sqrt{\text{PEA}}}$	0.489 ± 0.185	-0.003	5
	gravel	0.510 ± 0.199	0.018	26
	$\text{gravel} * \overline{\text{gravel}}$	0.506 ± 0.196	0.014	32
	$\sqrt{\text{gravel}}$	0.502 ± 0.194	0.010	16
	$\sqrt{\text{gravel}} * \overline{\sqrt{\text{gravel}}}$	0.506 ± 0.197	0.014	15
	sand:mud	0.487 ± 0.185	-0.005	2
	$\text{sand : mud} * \overline{\text{sand : mud}}$	0.422 ± 0.166	-0.070	4
	$\sqrt{\text{sand : mud}}$	0.490 ± 0.187	-0.002	7
	$\sqrt{\text{sand : mud}} * \overline{\sqrt{\text{sand : mud}}}$	0.490 ± 0.185	-0.002	6
	seabed slope	0.509 ± 0.197	0.017	30
	$\text{seabed slope} * \overline{\text{seabed slope}}$	0.506 ± 0.195	0.014	27
	log(seabed slope)	0.502 ± 0.194	0.010	29
	$\log(\text{seabed slope}) * \overline{\log(\text{seabed slope})}$	0.505 ± 0.197	0.013	23
	SST	0.482 ± 0.183	-0.010	12
	$\text{SST} * \overline{\text{SST}}$	0.486 ± 0.191	-0.006	13
	sSST	0.483 ± 0.184	-0.009	28
	$\text{sSST} * \overline{\text{sSST}}$	0.487 ± 0.191	-0.005	24
Razorbill	coast distance	0.332 ± 0.114	0.006	1
	$\text{coast distance} * \overline{\text{coast distance}}$	0.331 ± 0.124	0.005	3
	depth	0.332 ± 0.113	0.006	2
	$\text{depth} * \overline{\text{depth}}$	0.331 ± 0.124	0.005	4
	TFGD	0.327 ± 0.120	0.001	8
	$\text{TFGD} * \overline{\text{TFGD}}$	0.329 ± 0.116	0.003	6
	NPP	0.324 ± 0.110	-0.002	17

$NPP * \overline{NPP}$	0.324 ± 0.110	-0.002	16
log(NPP)	0.328 ± 0.122	0.002	7
$\log(NPP) * \overline{\log(NPP)}$	0.330 ± 0.116	0.004	5
stratification	0.320 ± 0.118	-0.006	22
$\text{stratification} * \overline{\text{stratification}}$	0.325 ± 0.118	-0.001	11
PEA	0.317 ± 0.125	-0.009	25
$PEA * \overline{PEA}$	0.318 ± 0.124	-0.008	23
$\sqrt{PEA}$	0.306 ± 0.110	-0.02	30
$\sqrt{PEA} * \overline{\sqrt{PEA}}$	0.322 ± 0.124	-0.004	18
gravel	0.313 ± 0.097	-0.013	28
$\text{gravel} * \overline{\text{gravel}}$	0.324 ± 0.115	-0.002	15
$\sqrt{\text{gravel}}$	0.311 ± 0.112	-0.015	29
$\sqrt{\text{gravel}} * \overline{\sqrt{\text{gravel}}}$	0.314 ± 0.117	-0.012	27
sand:mud	0.327 ± 0.114	0.001	9
$\text{sand : mud} * \overline{\text{sand : mud}}$	0.326 ± 0.116	0.000	10
$\sqrt{\text{sand : mud}}$	0.264 ± 0.134	-0.062	32
$\sqrt{\text{sand : mud}} * \overline{\sqrt{\text{sand : mud}}}$	0.321 ± 0.110	-0.005	21
seabed slope	0.290 ± 0.102	-0.036	31
$\text{seabed slope} * \overline{\text{seabed slope}}$	0.324 ± 0.118	-0.002	12
log(seabed slope)	0.318 ± 0.109	-0.008	24
$\log(\text{seabed slope}) * \overline{\log(\text{seabed slope})}$	0.322 ± 0.109	-0.004	20
SST	0.316 ± 0.109	-0.01	26
$SST * \overline{SST}$	0.322 ± 0.113	-0.004	19
sSST	0.324 ± 0.115	-0.002	14
$sSST * \overline{sSST}$	0.324 ± 0.116	-0.002	13

Covariates highlighted in **bold** were considered for inclusion in the final model.

† An over-bar indicates the mean of the covariate within waters accessible from each breeding site.

An asterisk indicates inclusion of the covariates and their interactions.

NPP = net primary production; PEA = mean potential energy anomaly; SST = mean sea surface temperature; sSST = mean standardised SST; TFGD = thermal front gradient density.

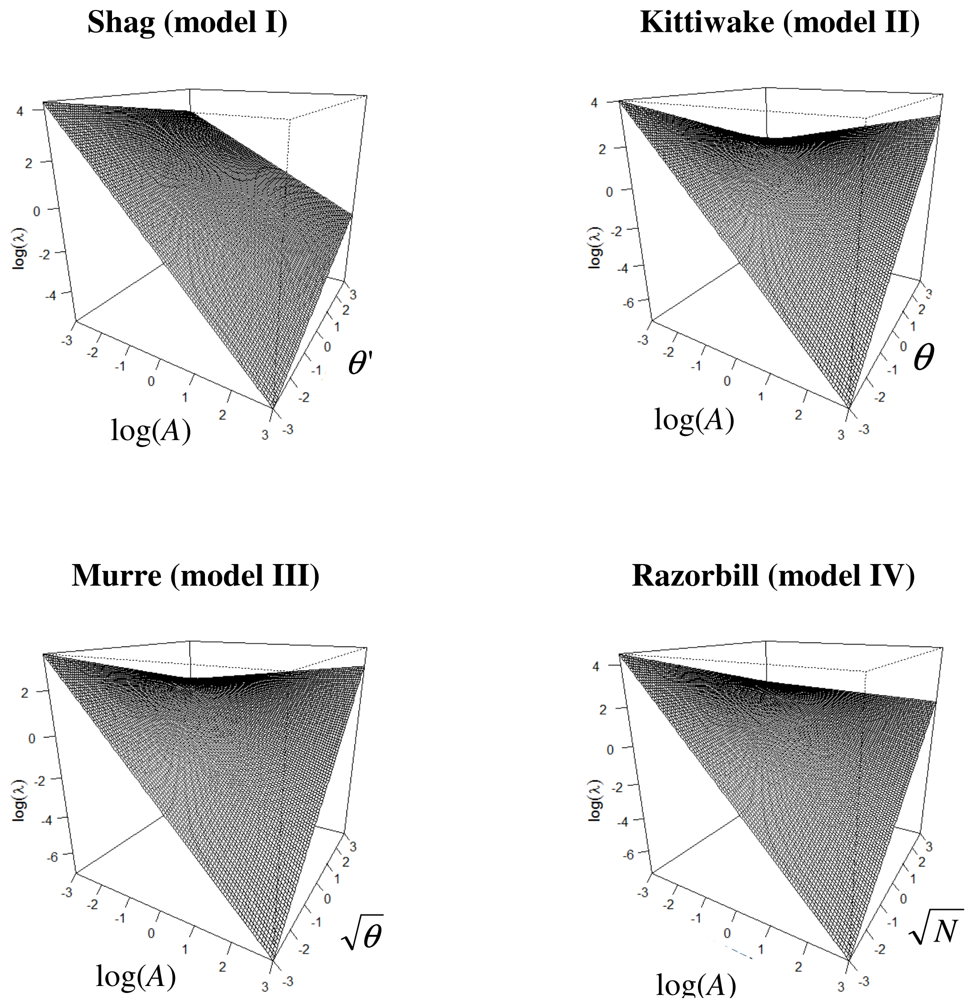
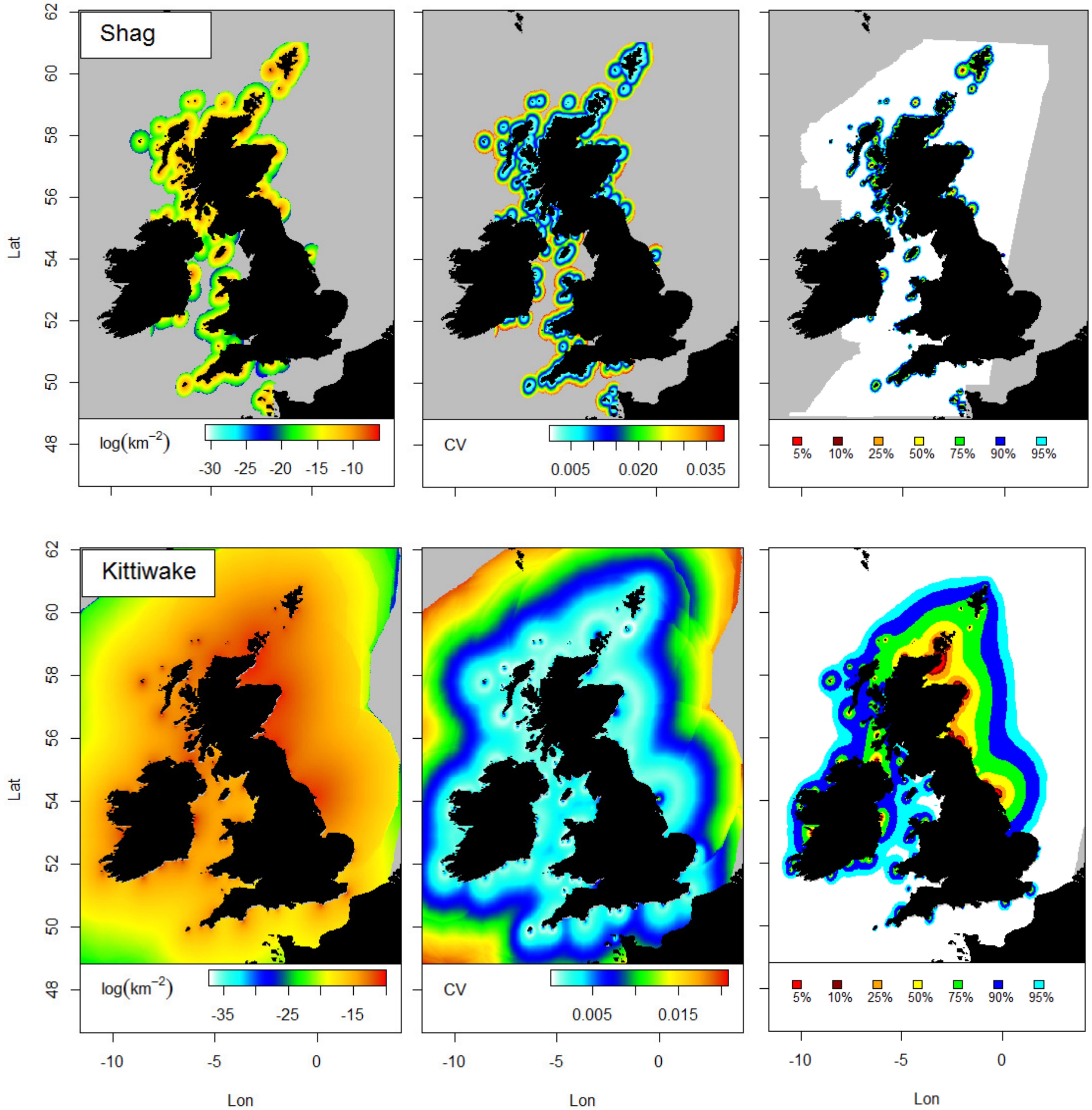
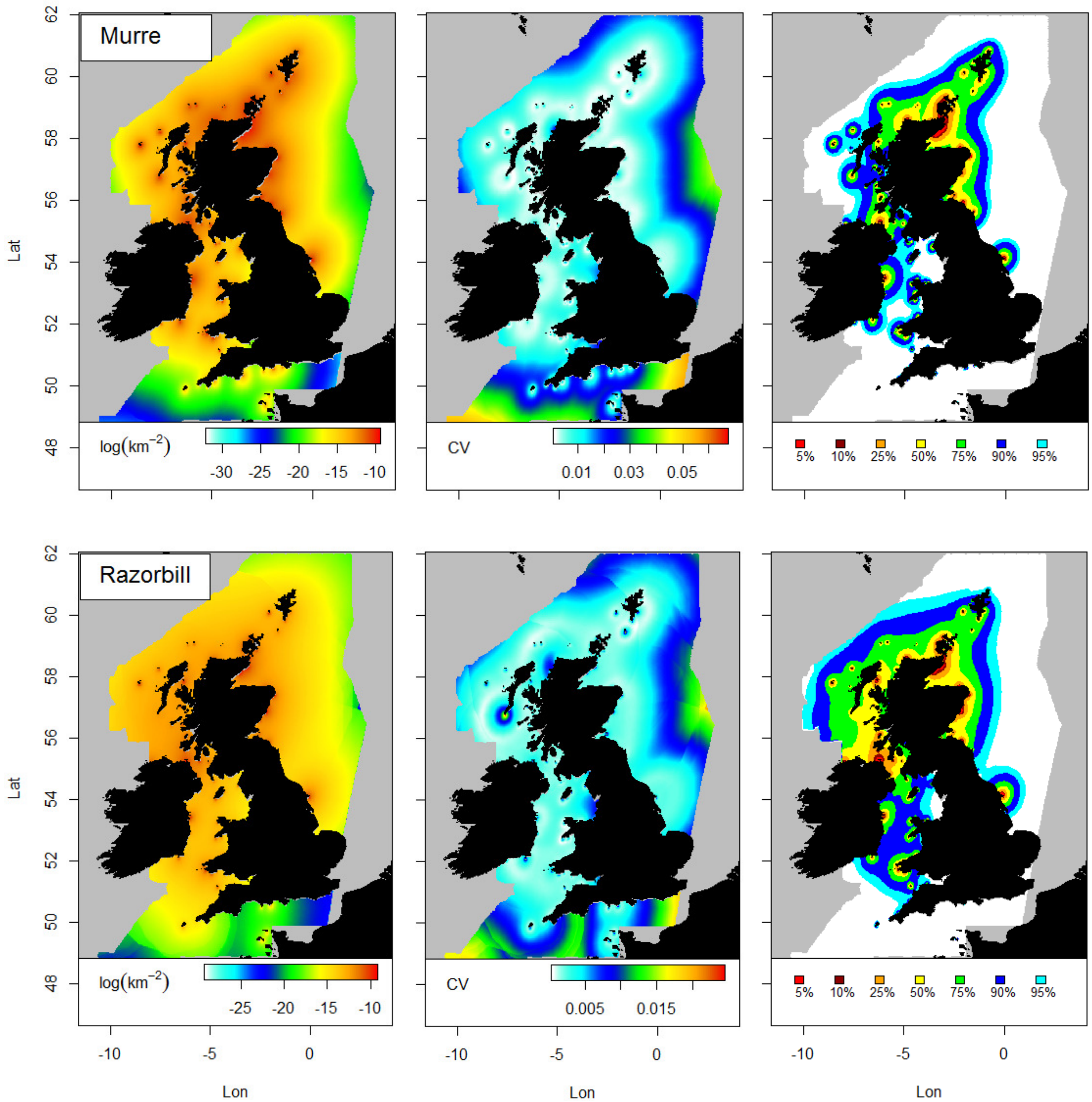


Fig. S1. Non-linear partial responses in models I-IV of log(λ) (≈ log density of seabird tracking locations) to interactions between A (cumulative area at distance) and indices of parapatric competition (θ= inverse-distance weighted number of conspecifics breeders; θ'= inverse-distance weighted square-root number of conspecific breeders; N = number of conspecifics breeding at the home site).


Shag
Kittiwake
Lat
Lon
log(km^{-2})
CV
-30 -25 -20 -15 -10
0.005 0.020 0.035
-35 -25 -15
0.005 0.015
5% 10% 25% 50% 75% 90% 95%
62 60 58 56 54 52 50 48
-10 -5 0

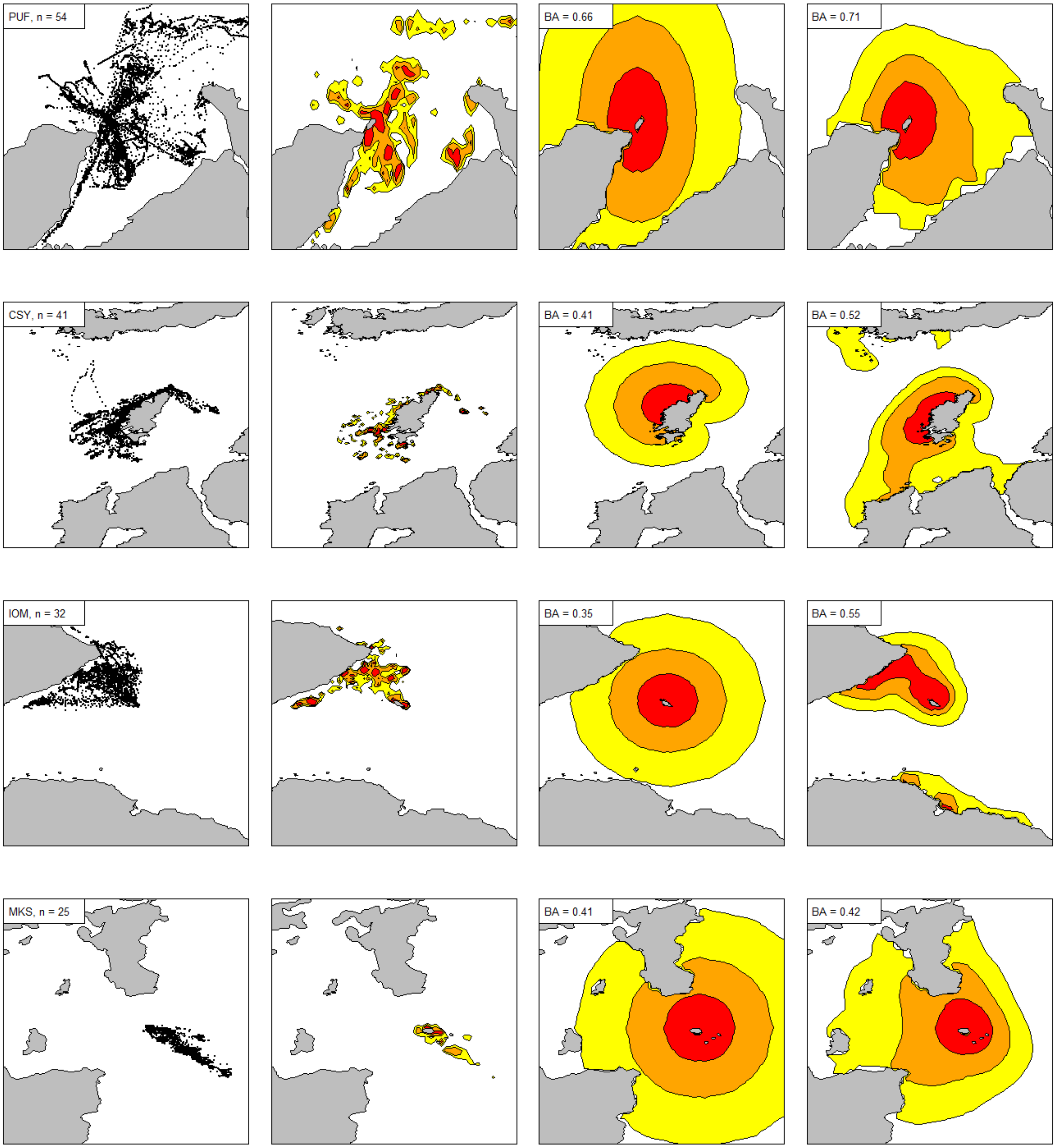


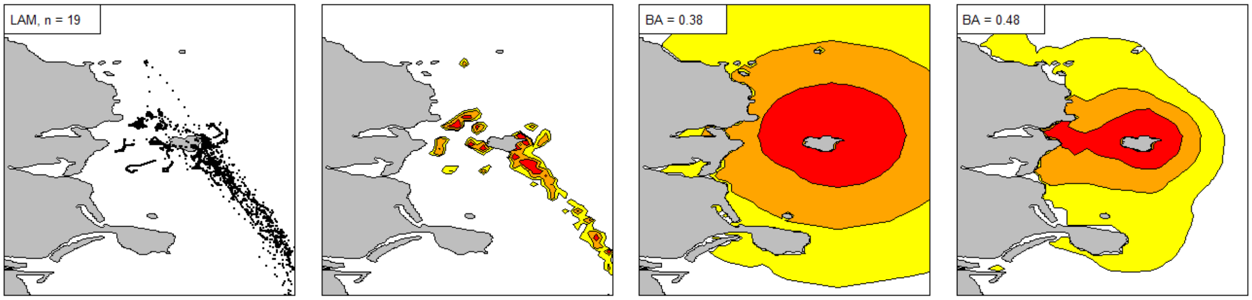
Murre
Razorbill
Lat
Lon
log(km^-2)
CV
-30 -25 -20 -15 -10
0.01 0.03 0.05
-25 -20 -15 -10
0.005 0.015
5% 10% 25% 50% 75% 90% 95%
62 60 58 56 54 52 50 48
-10 -5 0

46

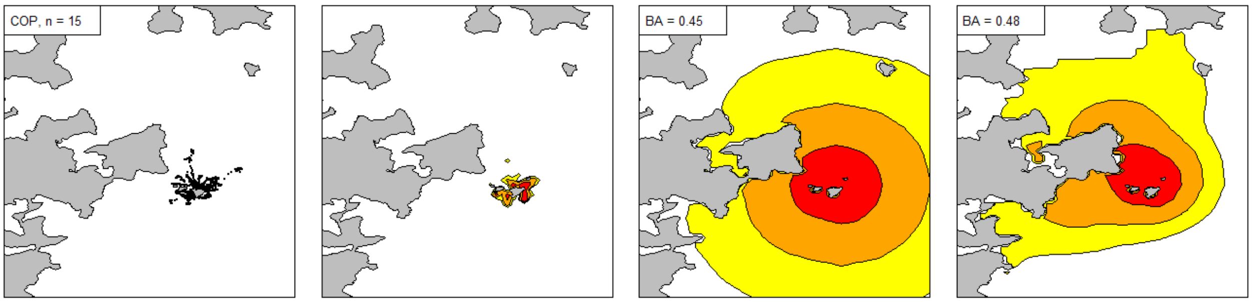
Fig. S2. The at-sea distribution of populations seabirds breeding in Britain and Ireland during late incubation/early chick-rearing, estimated as functions of colony distance, coastal geometry and sympatric intra-specific competition (models I-IV). Left-hand panels show the log mean proportion of time spent per bird per km^2; central panels show the relative coefficient of variation (CV) of these estimates; and right-hand panels show the respective percentage utilisation distributions.

Shag

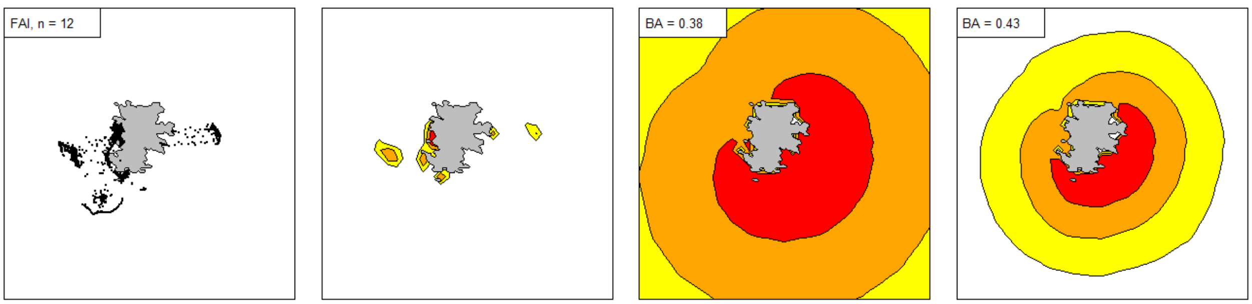

PUF, n = 54
BA = 0.66
BA = 0.71
CSY, n = 41
BA = 0.41
BA = 0.52
IOM, n = 32
BA = 0.35
BA = 0.55
MKS, n = 25
BA = 0.41
BA = 0.42


LAM, n = 19
BA = 0.38
BA = 0.48

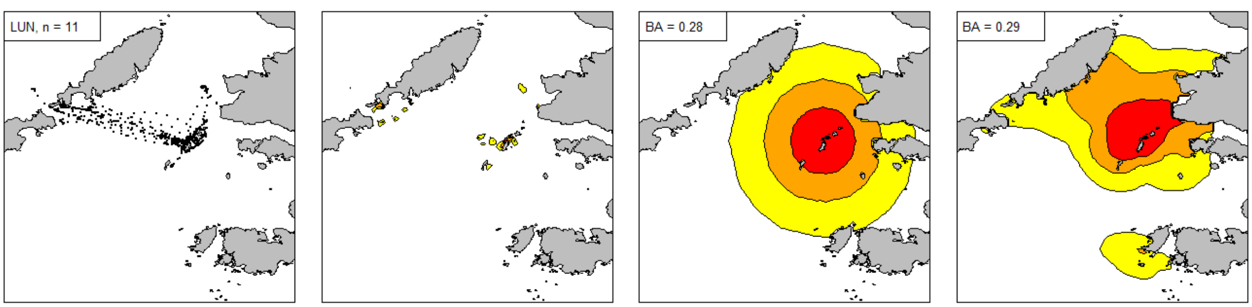
59


COP, n = 15
BA = 0.45
BA = 0.48

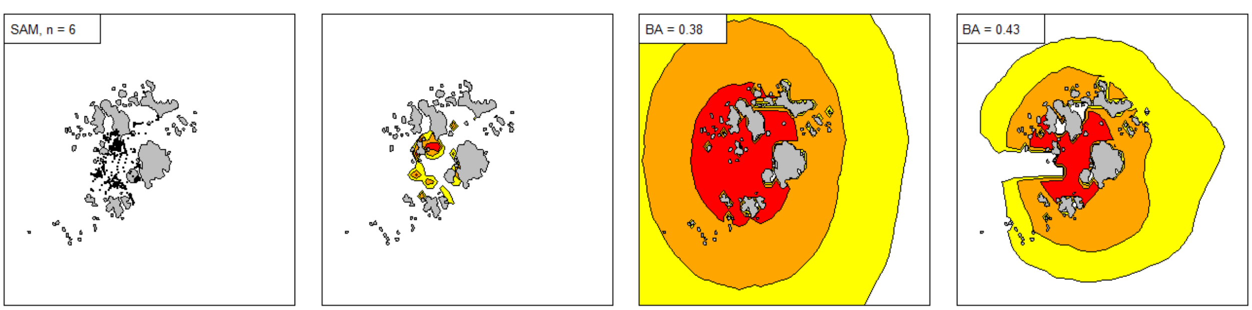
60


FAI, n = 12
BA = 0.38
BA = 0.43

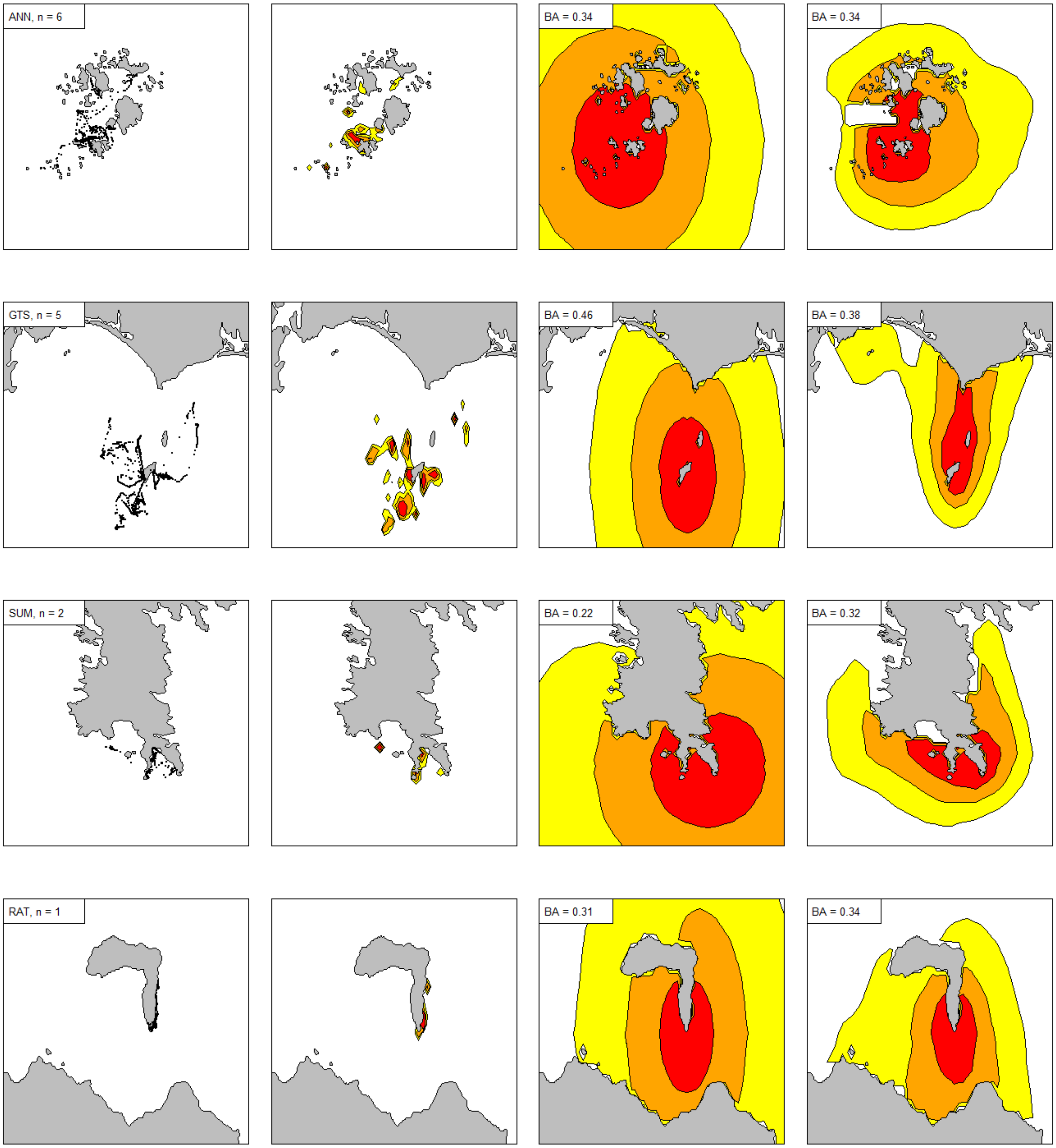
61


LUN, n = 11
BA = 0.28
BA = 0.29

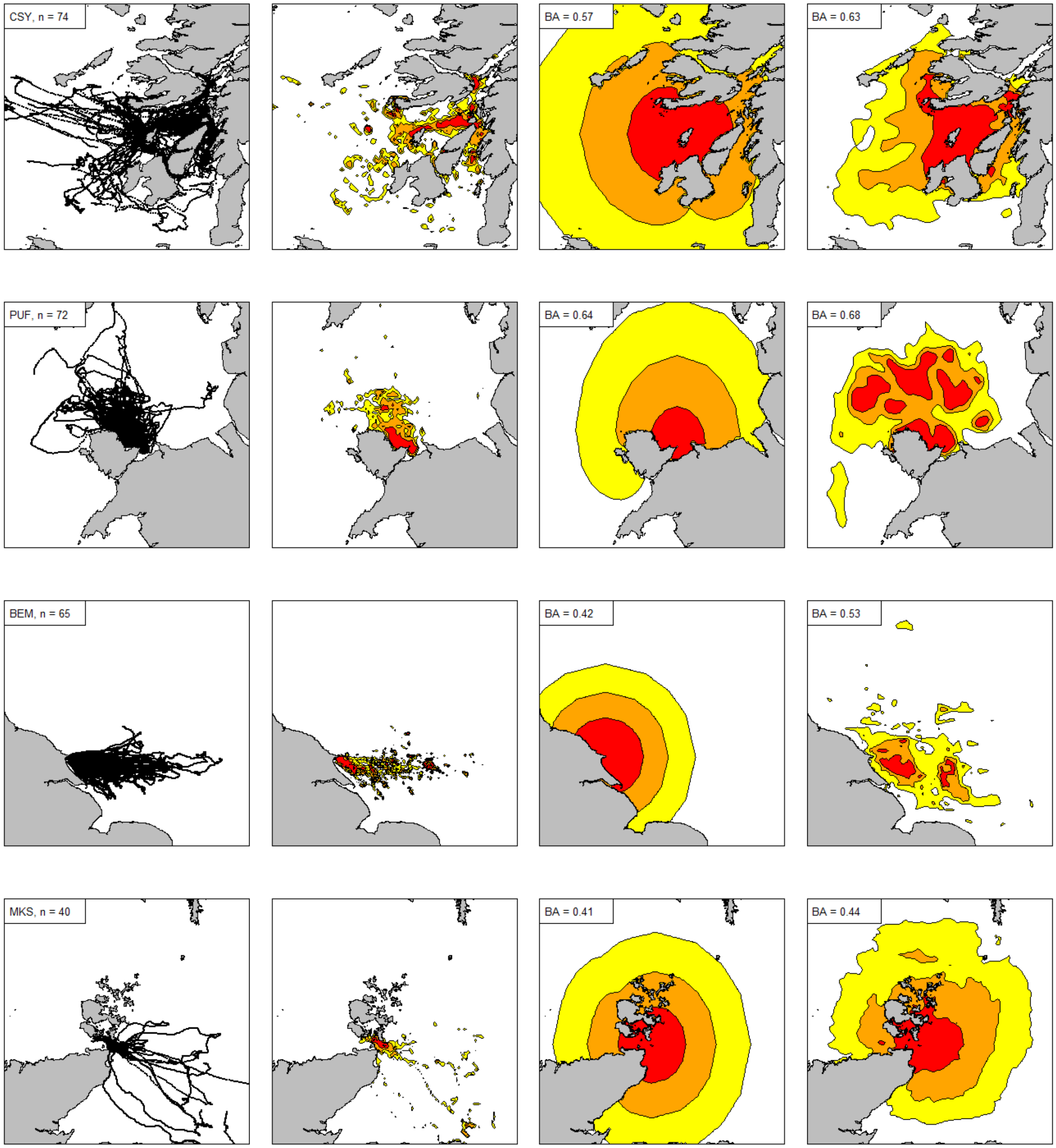
62


SAM, n = 6
BA = 0.38
BA = 0.43

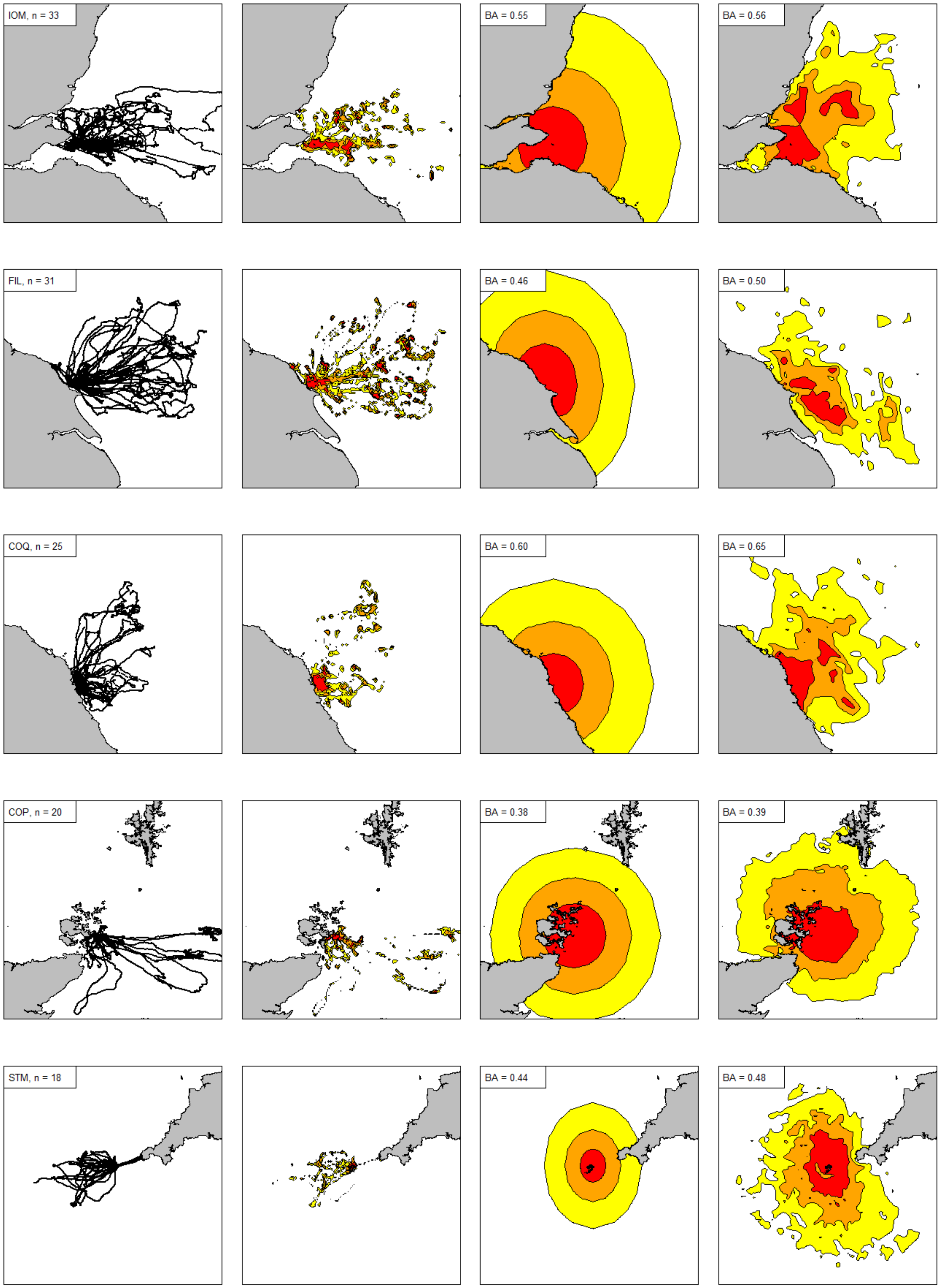
63

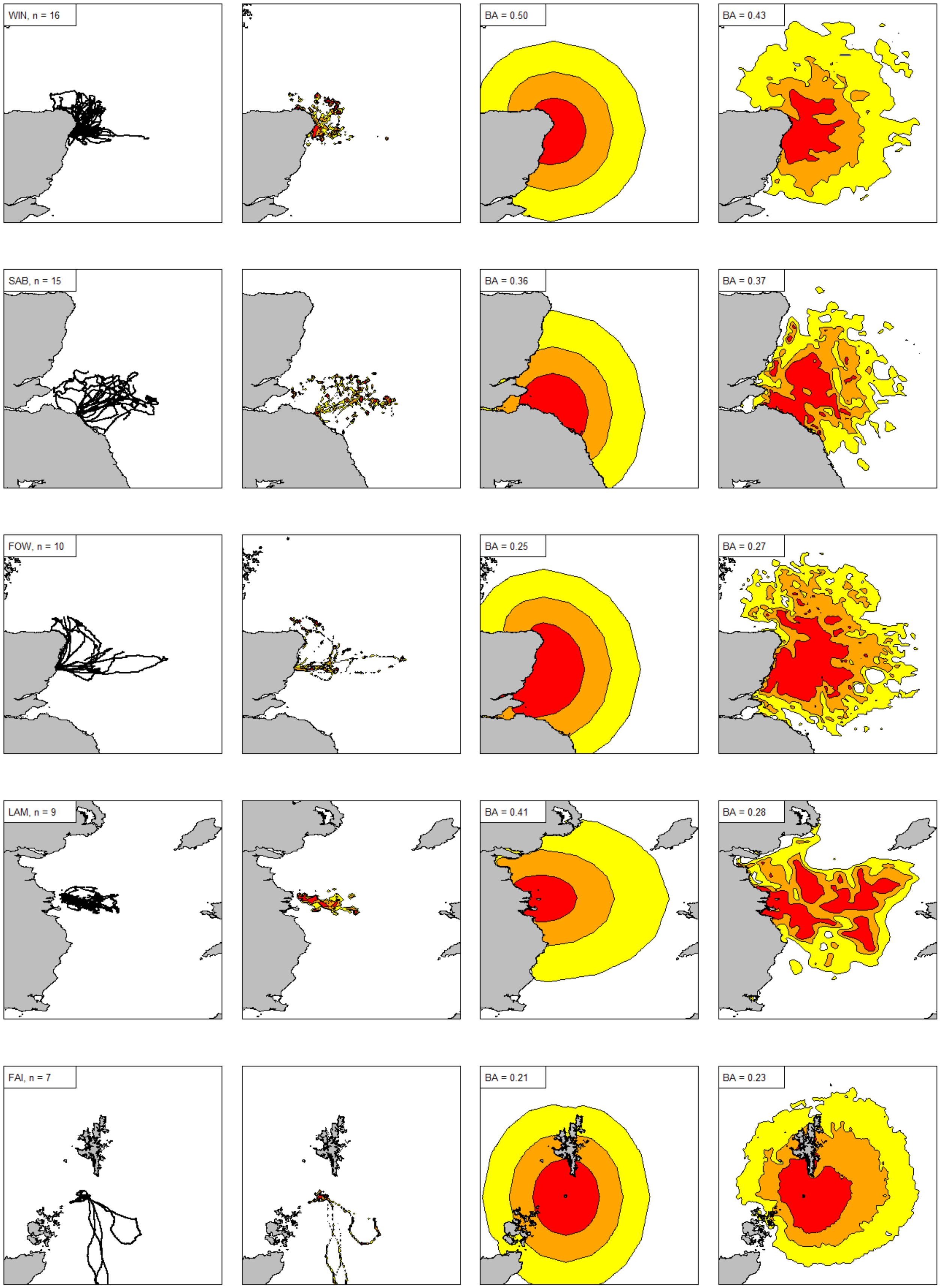

ANN, n = 6
BA = 0.34
BA = 0.34
GTS, n = 5
BA = 0.46
BA = 0.38
SUM, n = 2
BA = 0.22
BA = 0.32
RAT, n = 1
BA = 0.31
BA = 0.34

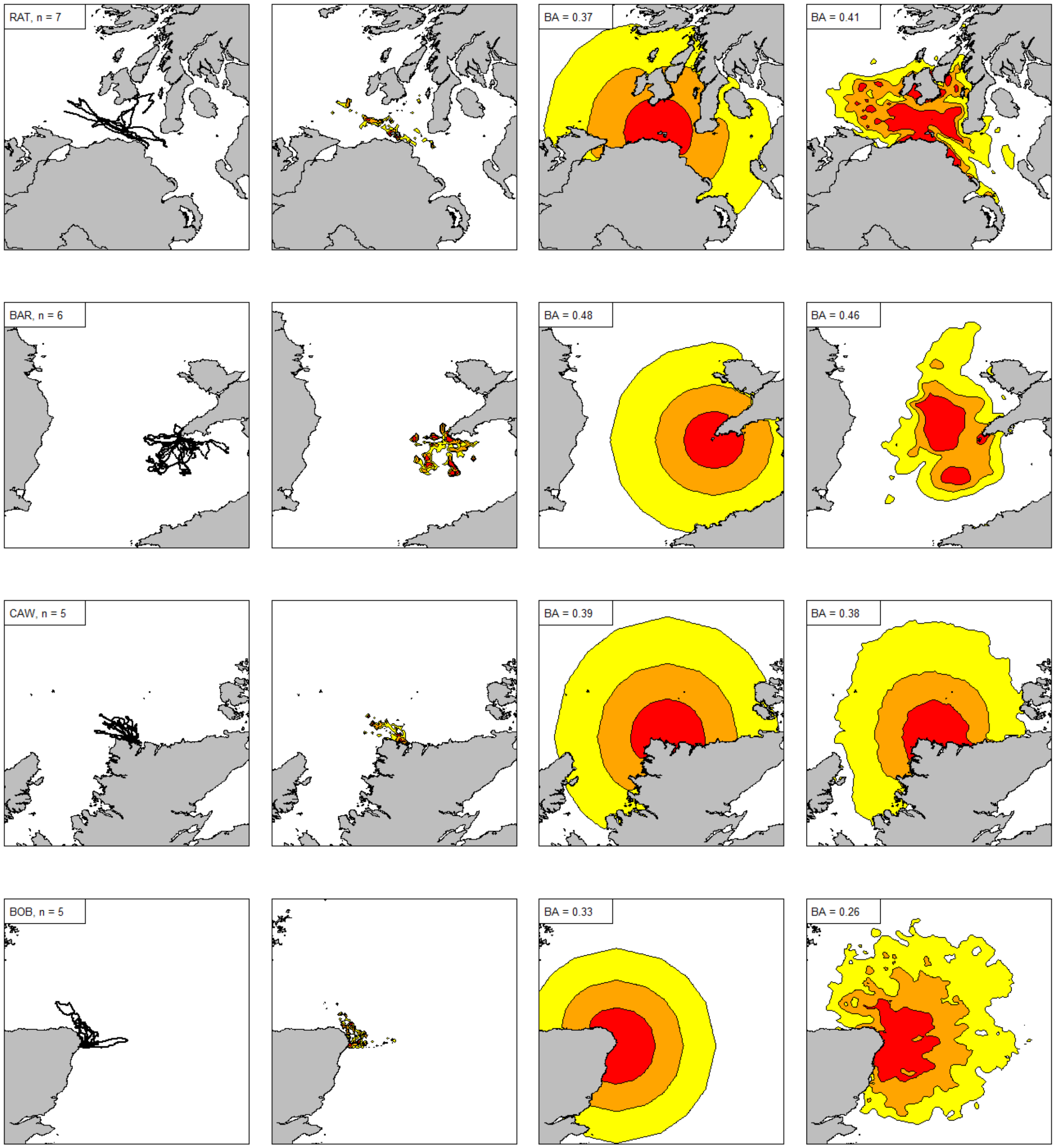
Kittiwake

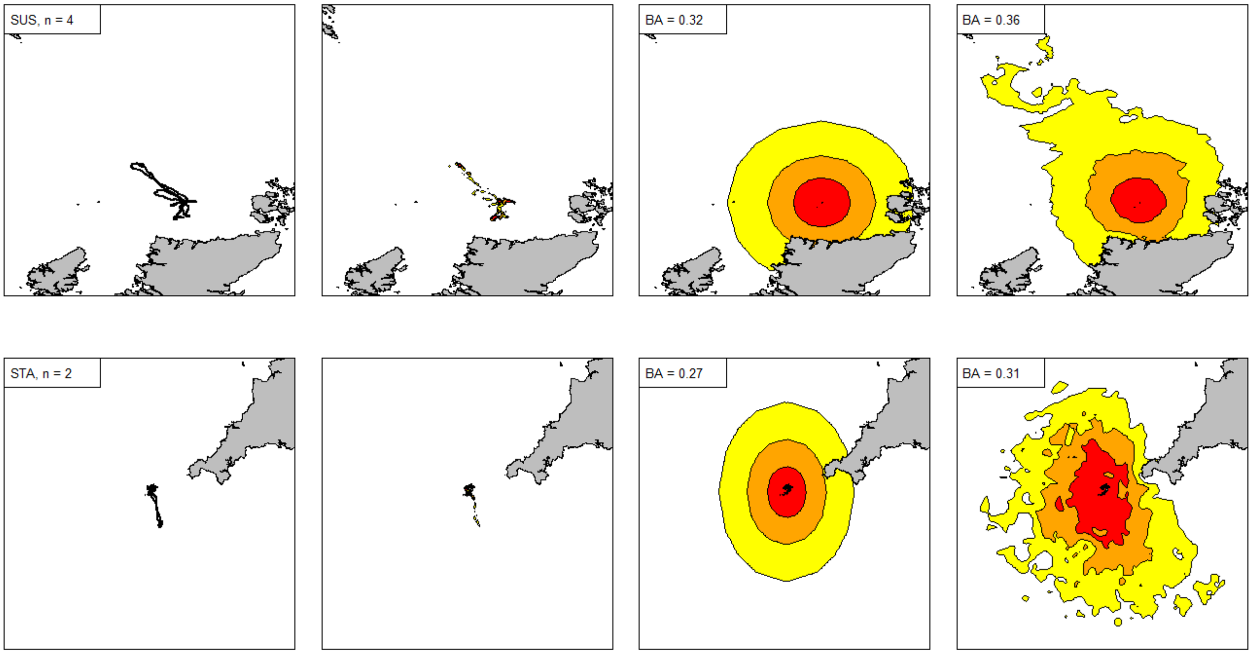


CSY, n = 74
BA = 0.57
BA = 0.63
PUF, n = 72
BA = 0.64
BA = 0.68
BEM, n = 65
BA = 0.42
BA = 0.53
MKS, n = 40
BA = 0.41
BA = 0.44

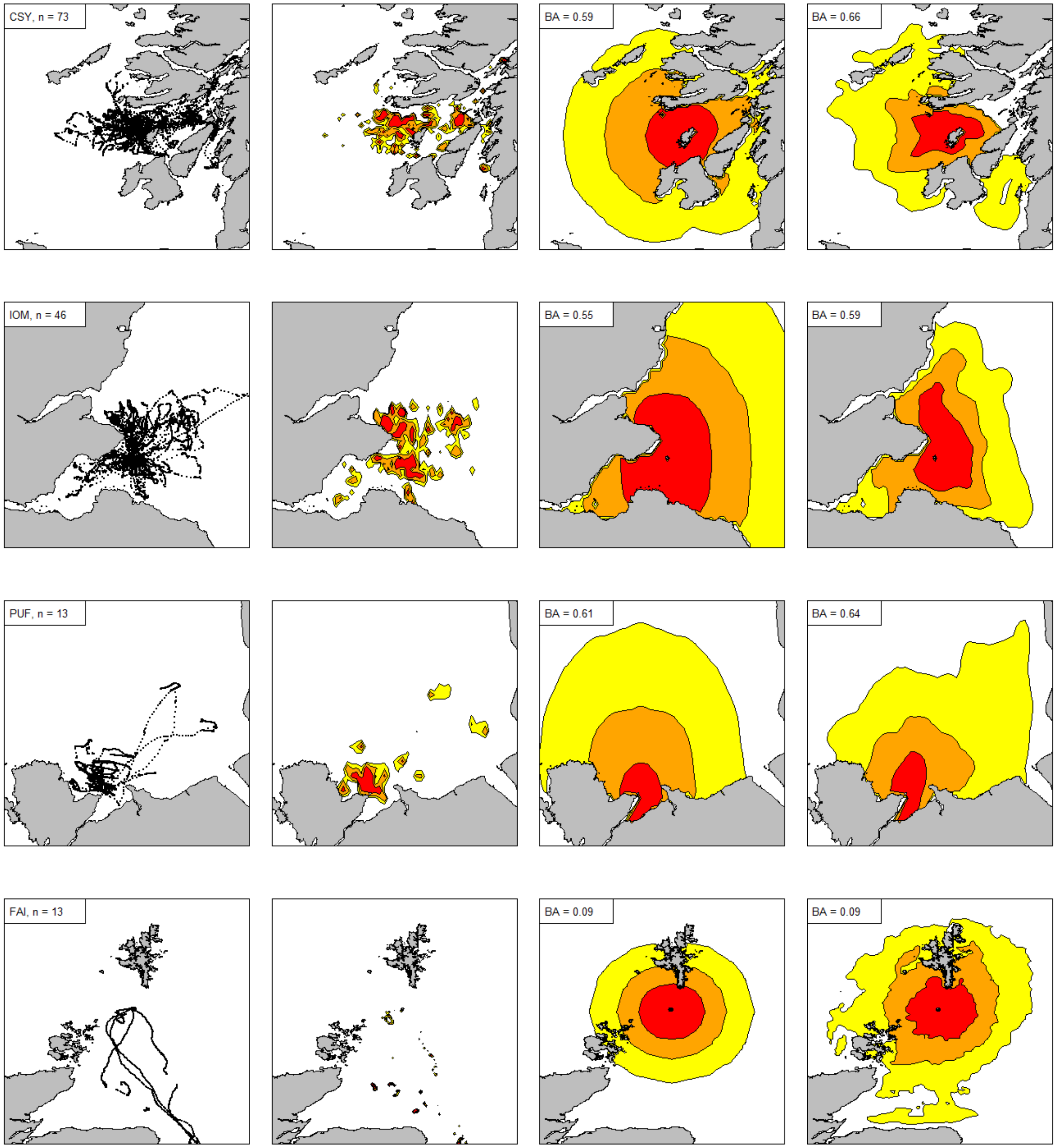

IOM, n = 33
BA = 0.55
BA = 0.56
FIL, n = 31
BA = 0.46
BA = 0.50
COQ, n = 25
BA = 0.60
BA = 0.65
COP, n = 20
BA = 0.38
BA = 0.39
STM, n = 18
BA = 0.44
BA = 0.48


WIN, n = 16
BA = 0.50
BA = 0.43
SAB, n = 15
BA = 0.36
BA = 0.37
FOW, n = 10
BA = 0.25
BA = 0.27
LAM, n = 9
BA = 0.41
BA = 0.28
FAI, n = 7
BA = 0.21
BA = 0.23

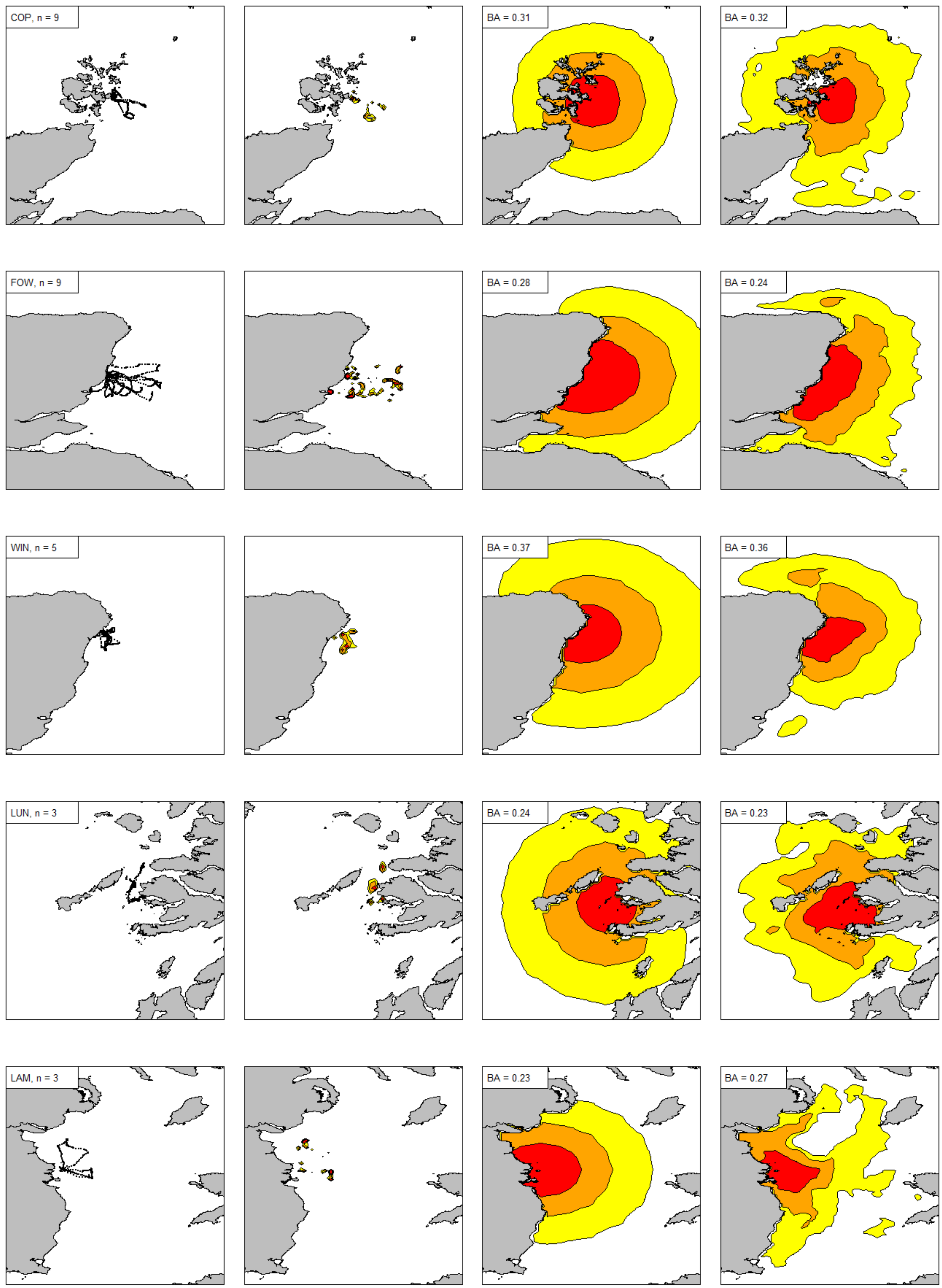

RAT, n = 7
BA = 0.37
BA = 0.41
BAR, n = 6
BA = 0.48
BA = 0.46
CAW, n = 5
BA = 0.39
BA = 0.38
BOB, n = 5
BA = 0.33
BA = 0.26

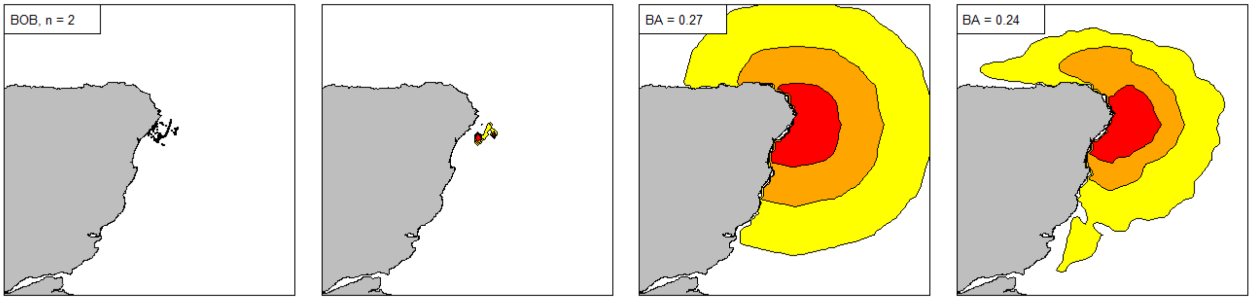

SUS, n = 4
BA = 0.32
BA = 0.36
STA, n = 2
BA = 0.27
BA = 0.31

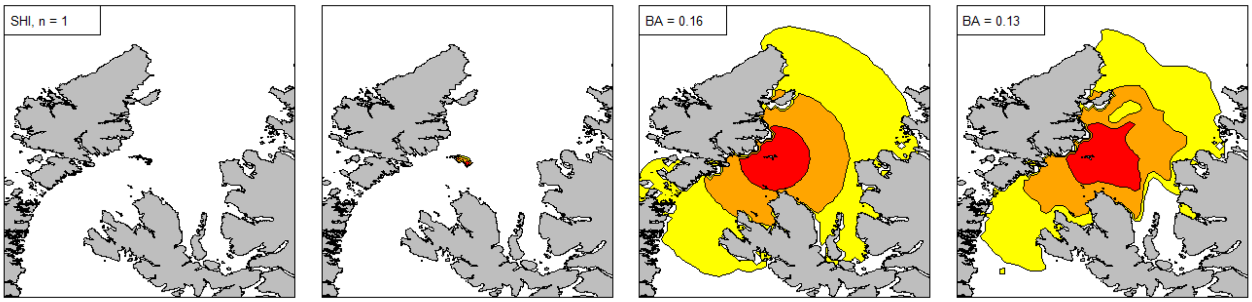
Murre

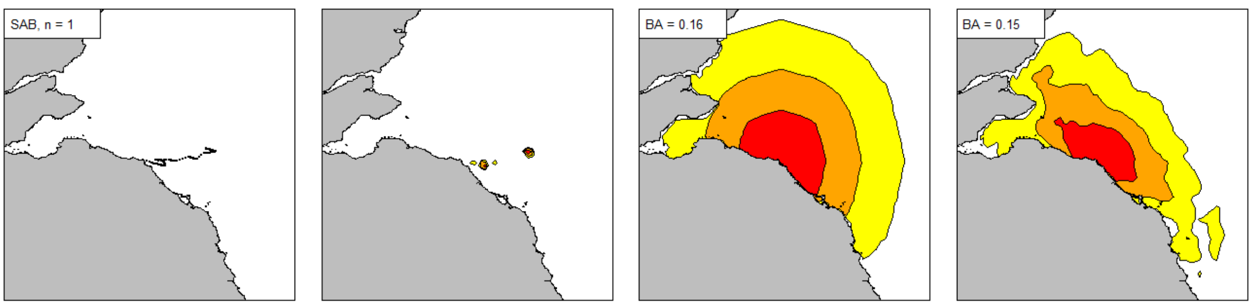


CSY, n = 73
BA = 0.59
BA = 0.66
IOM, n = 46
BA = 0.55
BA = 0.59
PUF, n = 13
BA = 0.61
BA = 0.64
FAI, n = 13
BA = 0.09
BA = 0.09

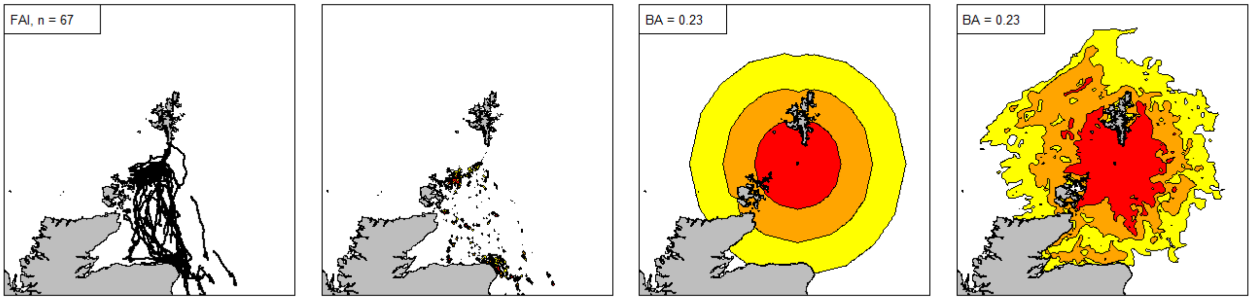

COP, n = 9
BA = 0.31
BA = 0.32
FOW, n = 9
BA = 0.28
BA = 0.24
WIN, n = 5
BA = 0.37
BA = 0.36
LUN, n = 3
BA = 0.24
BA = 0.23
LAM, n = 3
BA = 0.23
BA = 0.27

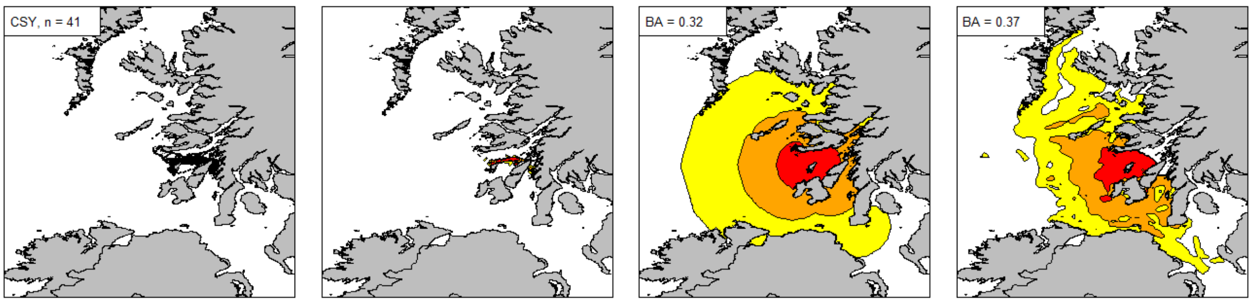

BOB, n = 2
BA = 0.27
BA = 0.24

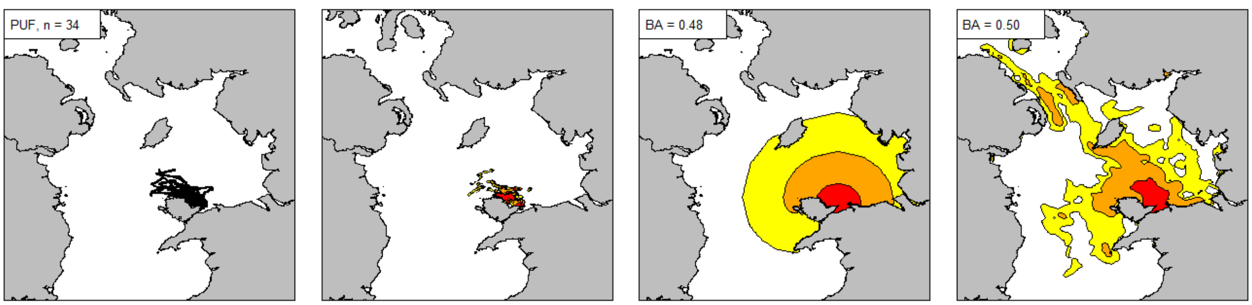

SHI, n = 1
BA = 0.16
BA = 0.13

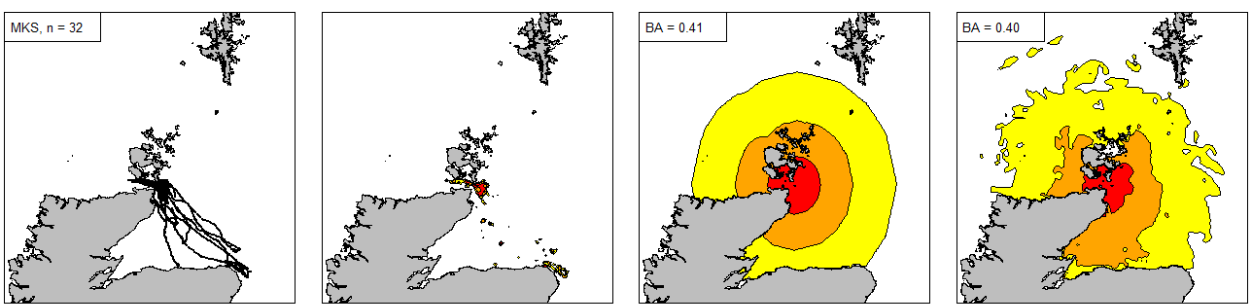

SAB, n = 1
BA = 0.16
BA = 0.15

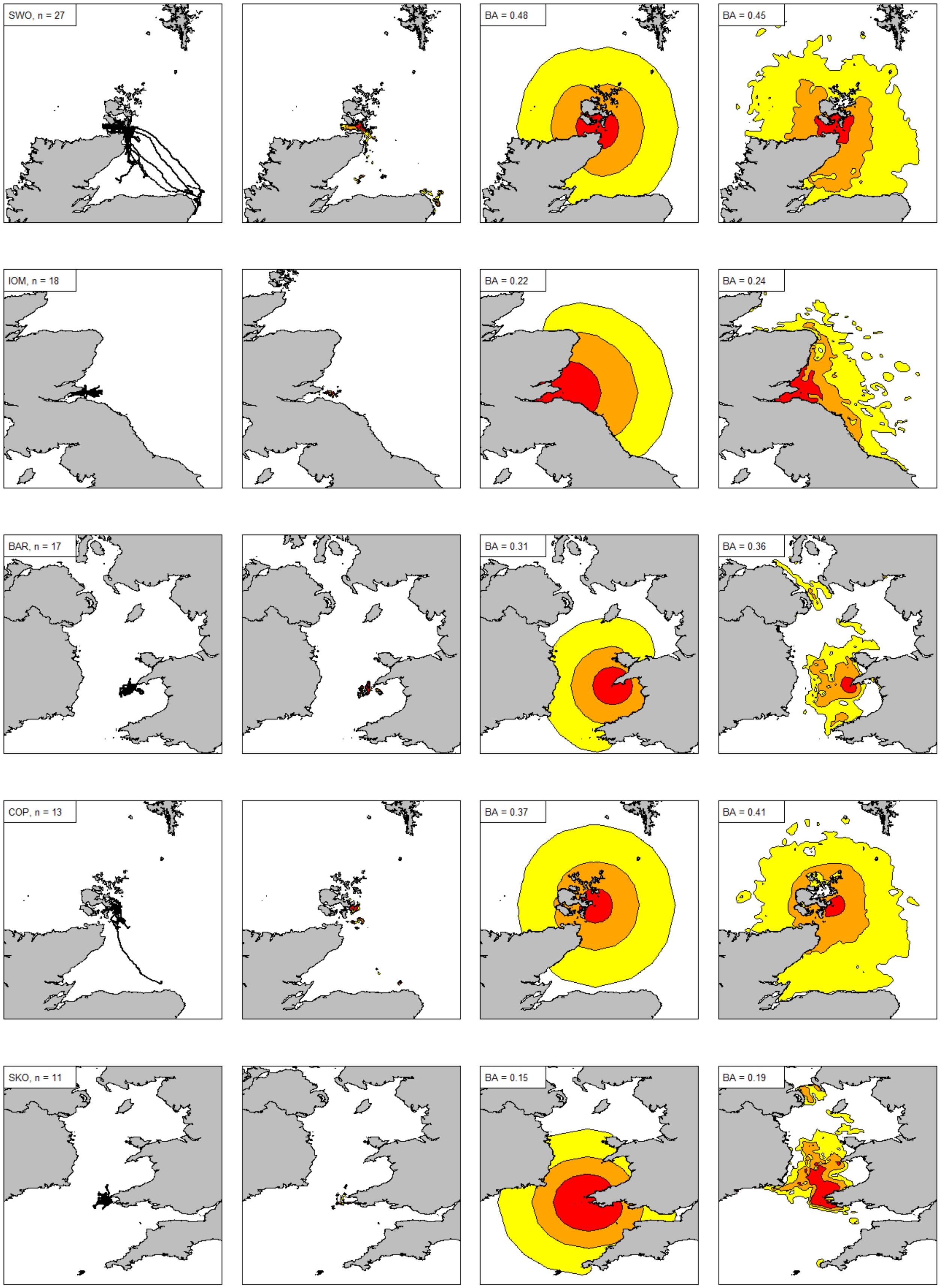
Razorbill


FAI, n = 67
BA = 0.23
BA = 0.23


CSY, n = 41
BA = 0.32
BA = 0.37


PUF, n = 34
BA = 0.48
BA = 0.50


MKS, n = 32
BA = 0.41
BA = 0.40


SWO, n = 27
BA = 0.48
BA = 0.45
IOM, n = 18
BA = 0.22
BA = 0.24
BAR, n = 17
BA = 0.31
BA = 0.36
COP, n = 13
BA = 0.37
BA = 0.41
SKO, n = 11
BA = 0.15
BA = 0.19

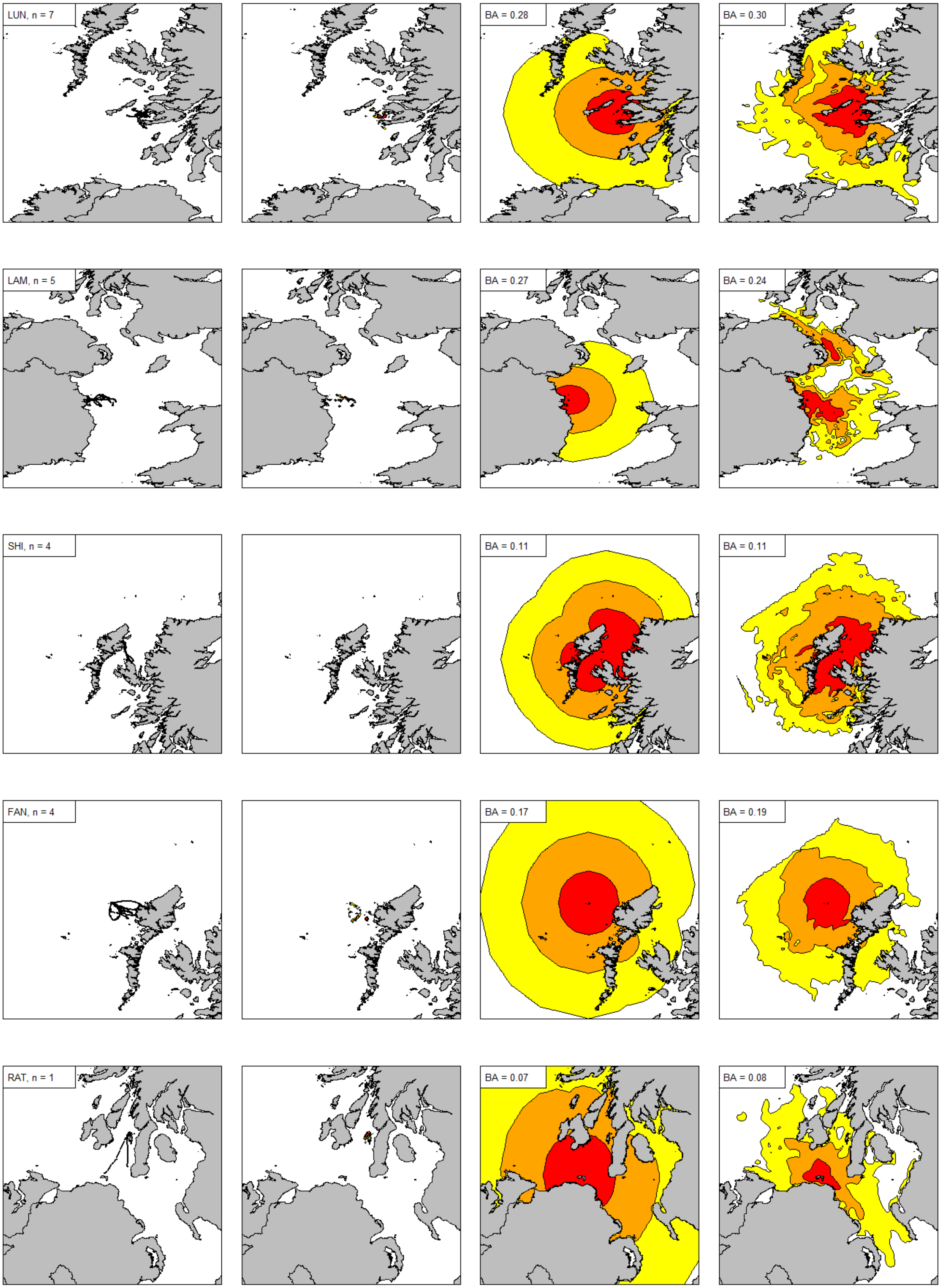

LUN, n = 7
BA = 0.28
BA = 0.30
LAM, n = 5
BA = 0.27
BA = 0.24
SHI, n = 4
BA = 0.11
BA = 0.11
FAN, n = 4
BA = 0.17
BA = 0.19
RAT, n = 1
BA = 0.07
BA = 0.08

Fig. S3. Cross-validation of inhomogeneous Poisson point process models of the density of seabird tracking locations as functions of colony distance, coastal geometry, intra-specific competition and habitat. Far-left panels show tracking locations; middle-left panels, observed utilisation distributions (UD); middle right panels, UDs estimated by models I-IV; far-right panels, UDs estimated by models V-VIII. BA = the Bhattacharyya affinity between the observed and model-estimated UDs. Three character colony codes correspond to those in Table S1 (sites arranged in order of descending numbers of birds tracked). Polygons encompassing 50, 75 and 90% of the UDs are shaded red, orange and yellow respectively.

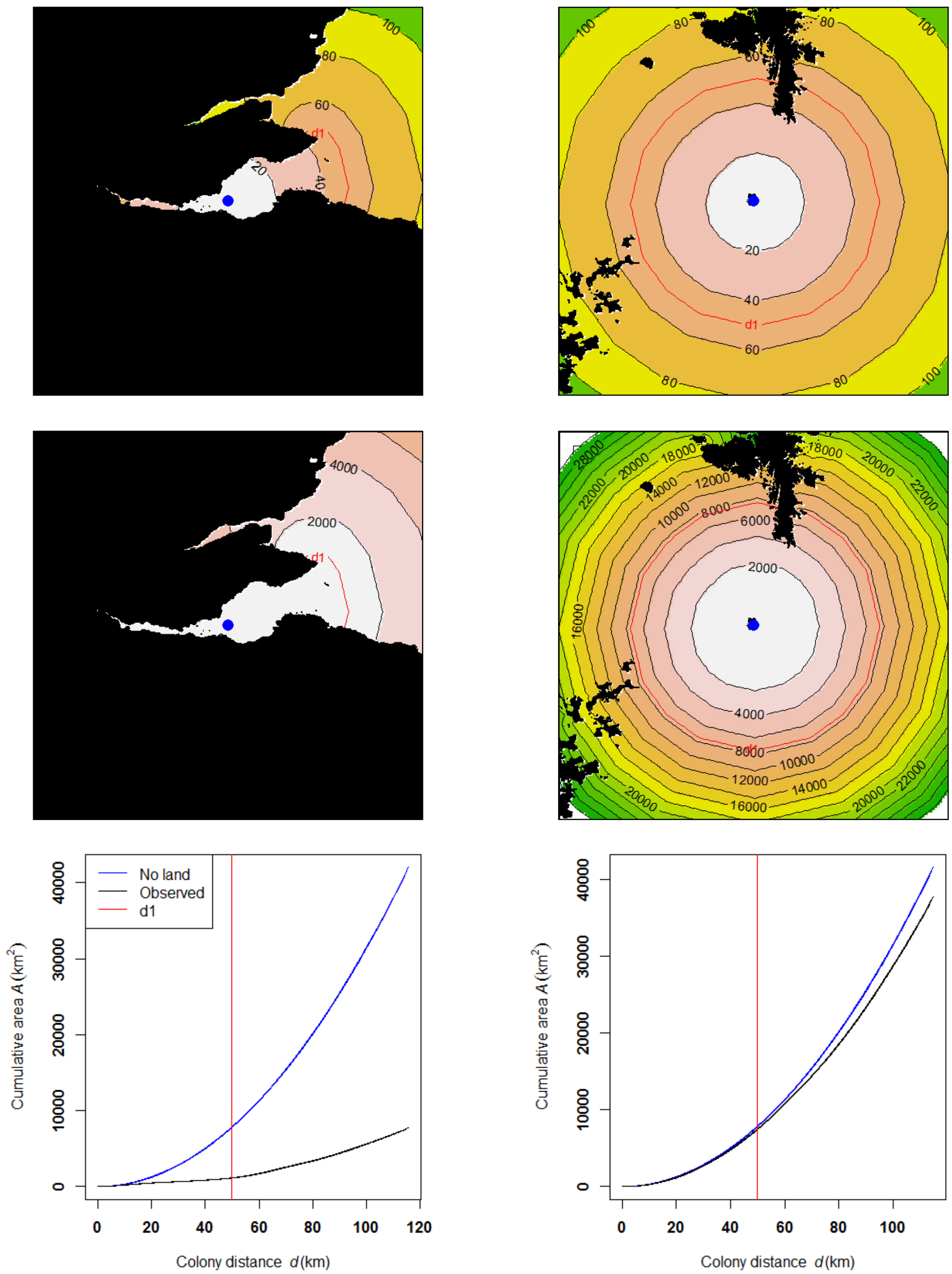
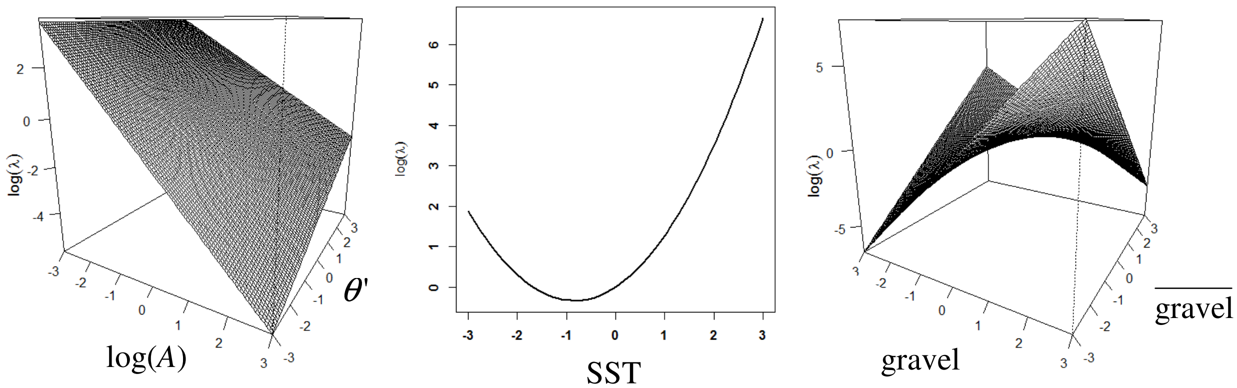
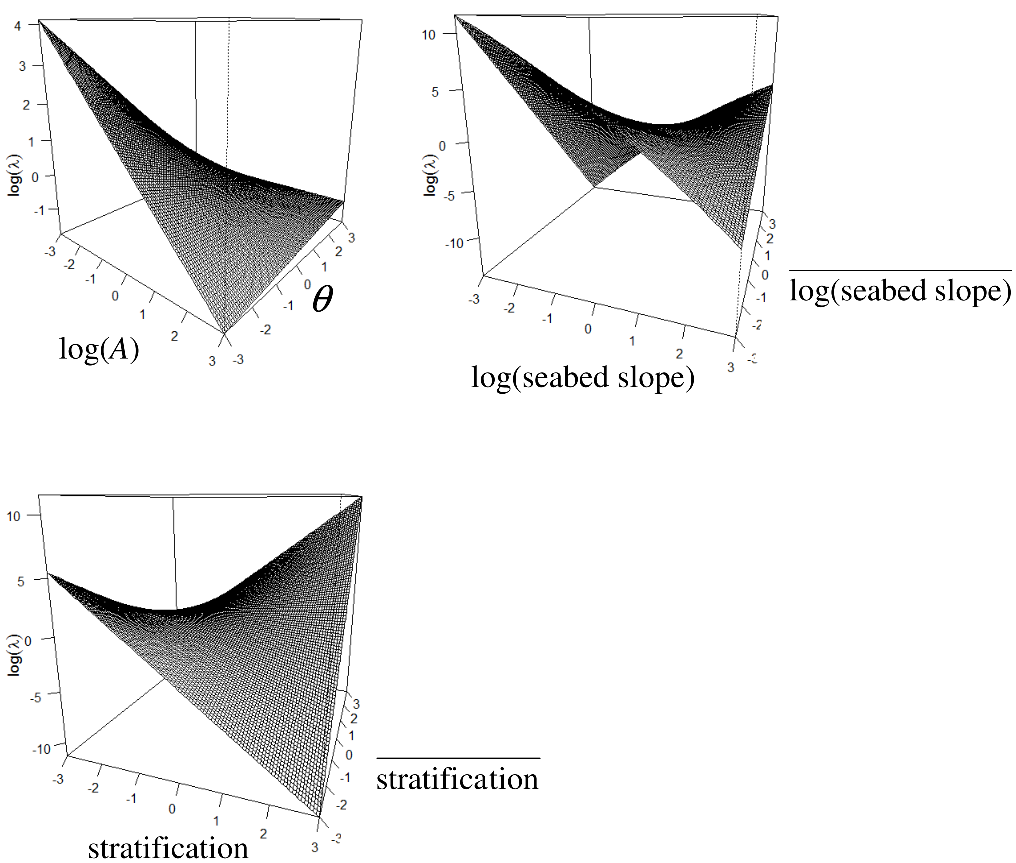

No land
Observed
d1
Cumulative area A (km2)
Colony distance d (km)
0
20
40
60
80
100
120
0
10000
20000
30000
40000
d1
20
40
60
80
100
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
22000
28000

Fig. S4. Distance by sea *d* (km, top panels) and cumulative area *A* (km^2, middle panels) relative to two colonies with contrasting coastal geometry. Colony *C* (Inchkeith, left) is located in a narrow inlet, while Colony *D* (Fair Isle, right) is an isolated island, surrounded by open water. The size of the area depicted is the same in each panel and blue dots indicate colony locations. In all plots the red line indicates d_1 an arbitrary distance by sea from the colony (50 km). The lower plots show that the observed rate of accumulation of area with distance from colony *C* (black line) is lower than that expected if no land were present (red line).

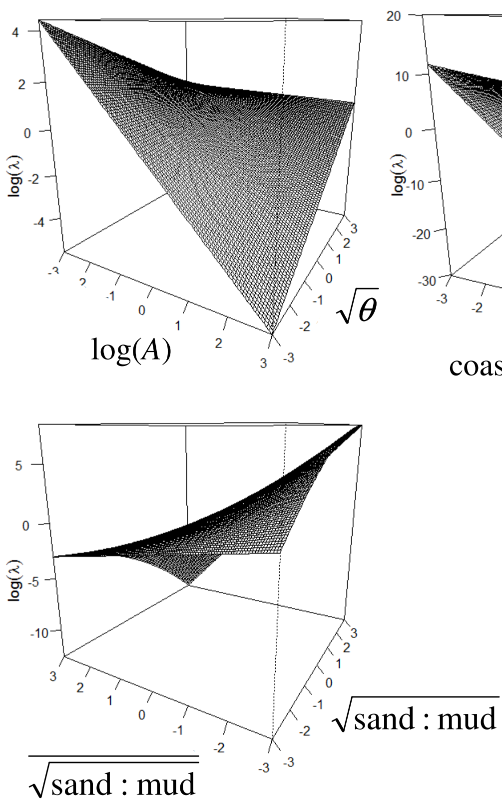
Shag (model V)



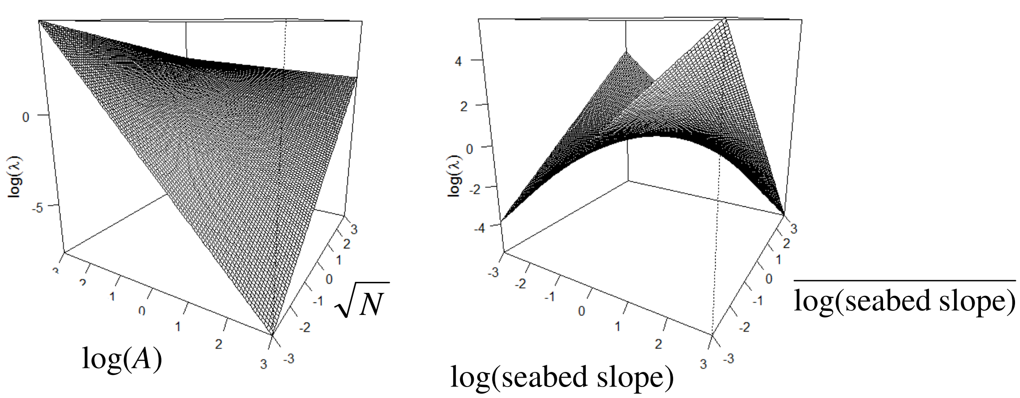
Kittiwake (model VI)



Murre (model VII)



Razorbill (model VIII)



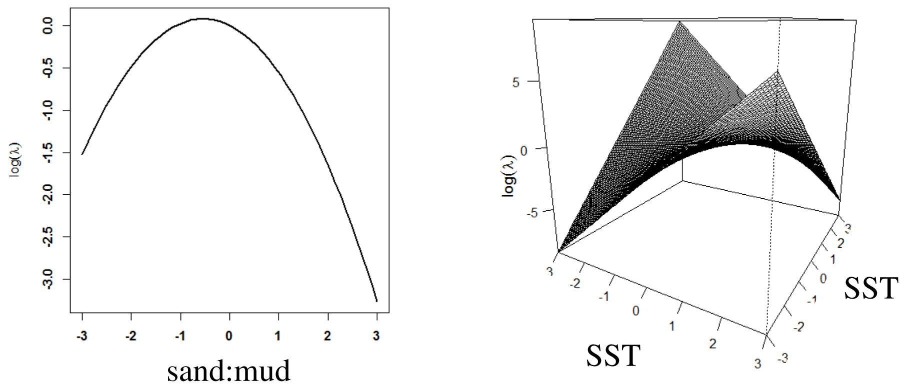
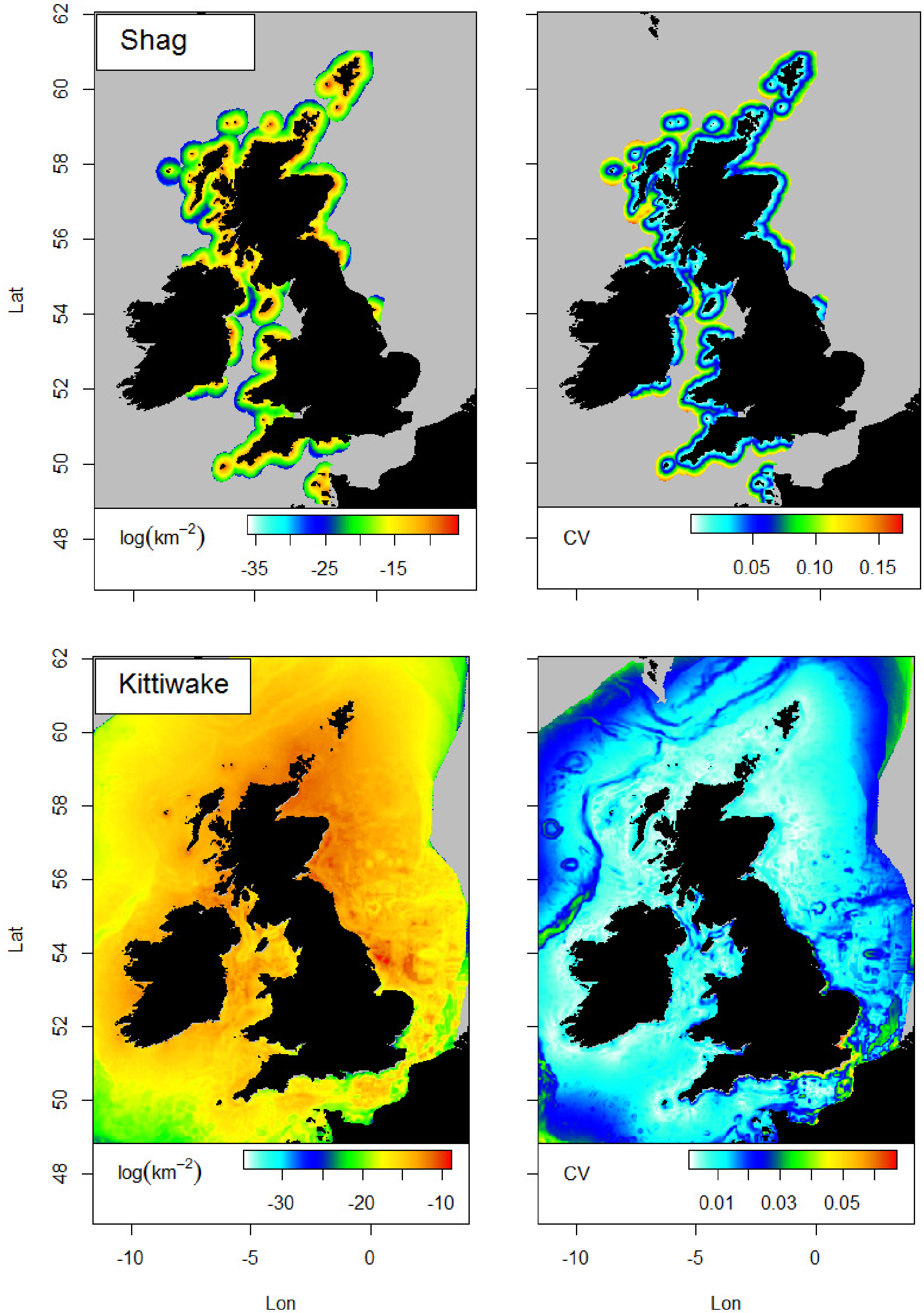


Fig. S5. Non-linear partial responses of log(λ) (≈ log density of seabird tracking locations) to interactions between covariates retained in models V-VIII: d = distance by-sea from the colony; A = cumulative area at distance d; θ = inverse-distance weighted number of conspecifics breeders; θ' = inverse-distance weighted square-root number of conspecific breeders; N = number of conspecifics breeding at the home site; SST = sea surface temperature. Overbars indicate the mean of the covariate in waters accessible from each colony.



Shag
Kittiwake
Lat
Lon
log(km^-2)
CV
62
60
58
56
54
52
50
48
-35
-25
-15
0.05
0.10
0.15
-30
-20
-10
0.01
0.03
0.05
-10
-5
0

182

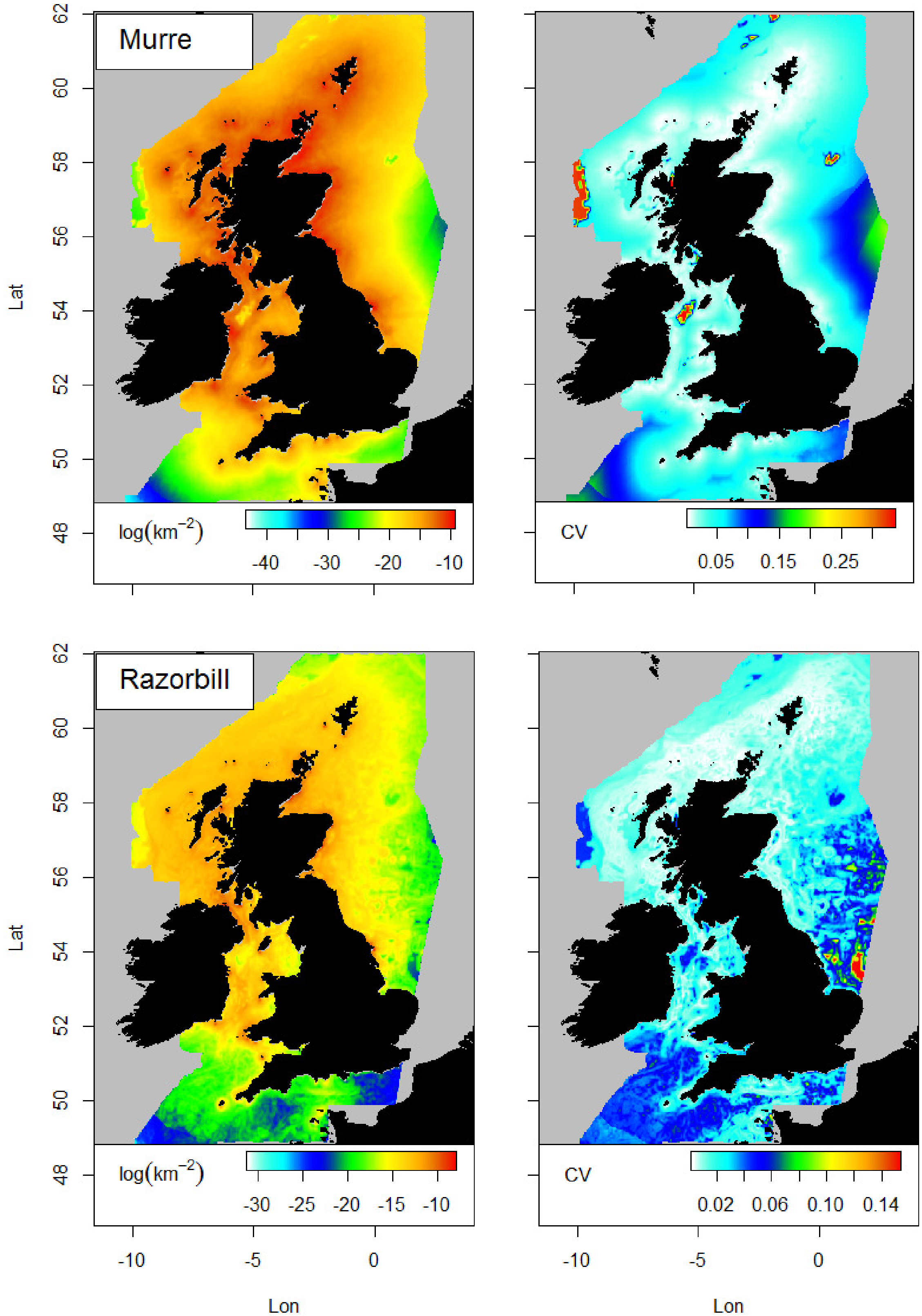

Murre
Razorbill
Lat
Lon
log(km^{-2})
CV
-40 -30 -20 -10
0.05 0.15 0.25
-30 -25 -20 -15 -10
0.02 0.06 0.10 0.14
62 60 58 56 54 52 50 48
-10 -5 0

Fig. S6. The at-sea distribution of populations seabirds breeding in Britain and Ireland during late incubation/early chick-rearing, estimated using models V-VIII as functions of colony distance, coastal geometry, sympatric and parapatric intra-specific competition and habitat. Left-hand panels show the log mean proportion of time spent per bird per km^2 and right-hand panels show the relative coefficient of variation (CV) of these estimates.

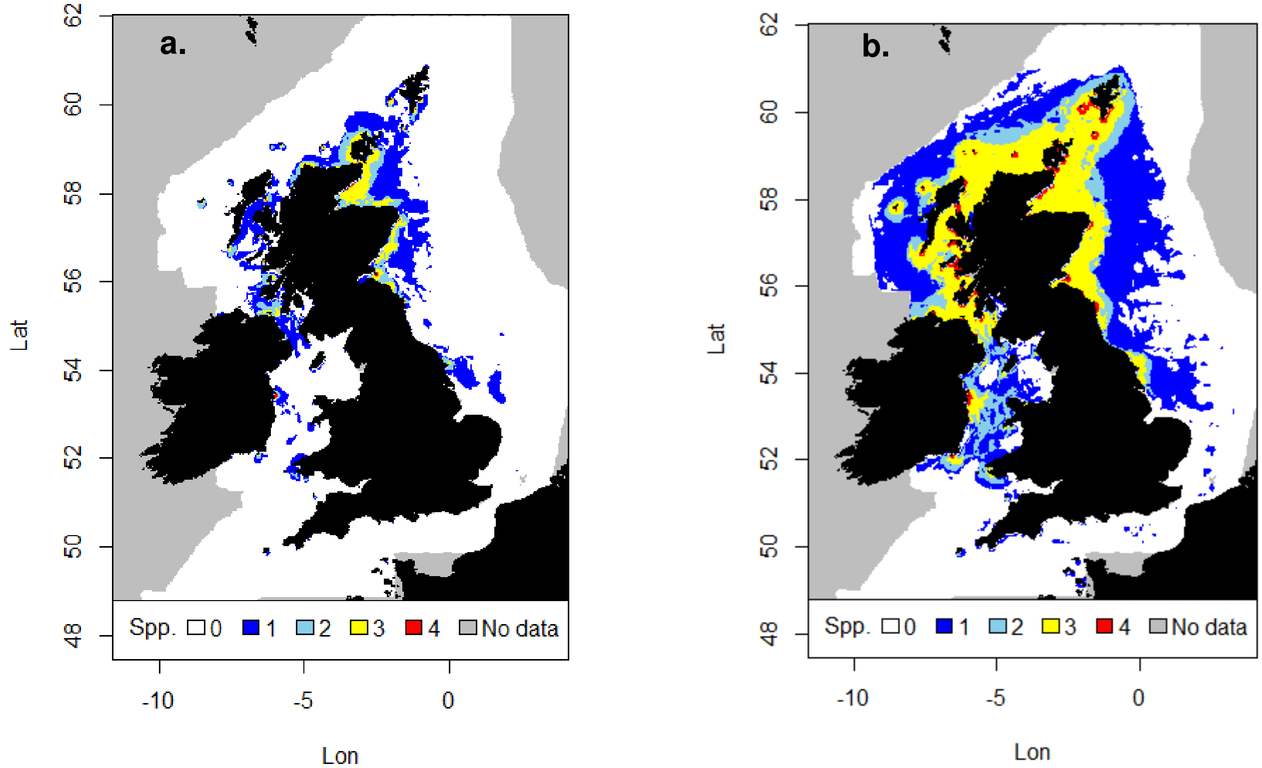


Fig. S7. Overlap between estimated core areas used by four species of seabirds breeding in Britain and Ireland during late incubation/early chick-rearing. Colours indicate number of overlapping species' core areas, where the latter are the areas encompass (a) 50 and (b) 90% of each species utilisation distribution (UD).

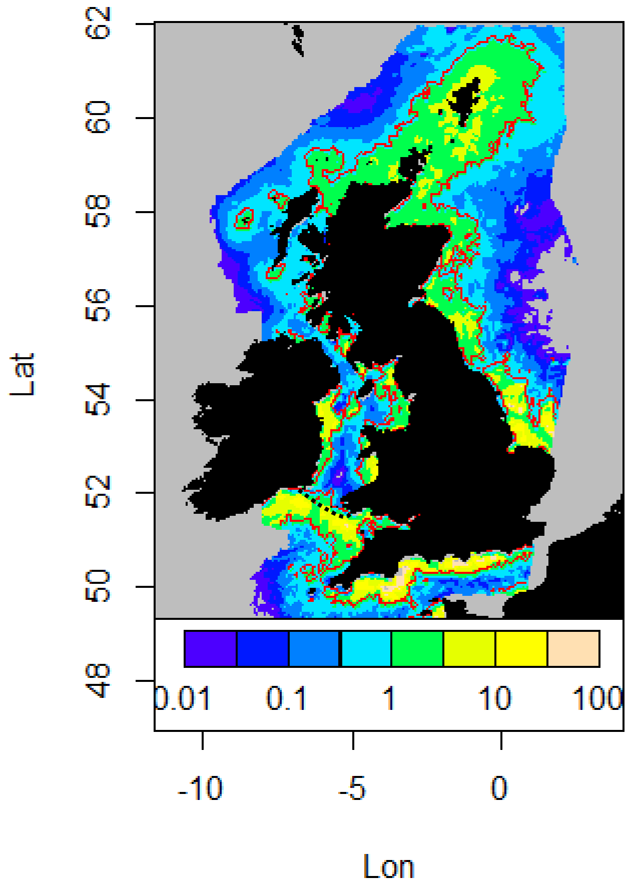


Fig. S8. The expected ratio of breeding adult murres to breeding adult razorbills based on probability densities estimated by models VII and VIII. The red isopleth indicates locations at which breeding murres and razorbills are expected to occur at equal densities. Black dotted line indicates the approximate location of the Celtic Sea Front.