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SUPPLEMENTARY MATERIAL

Precision, accuracy and bias of walked line-transect distance sampling to estimate eastern grey kangaroo population size

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Fig. S1. Study area at Yanakie Isthmus airstrip, Wilsons Promontory National Park, south-eastern Australia. Note the grass (left) and rush (right) habitats. Photo credit: R. Glass.

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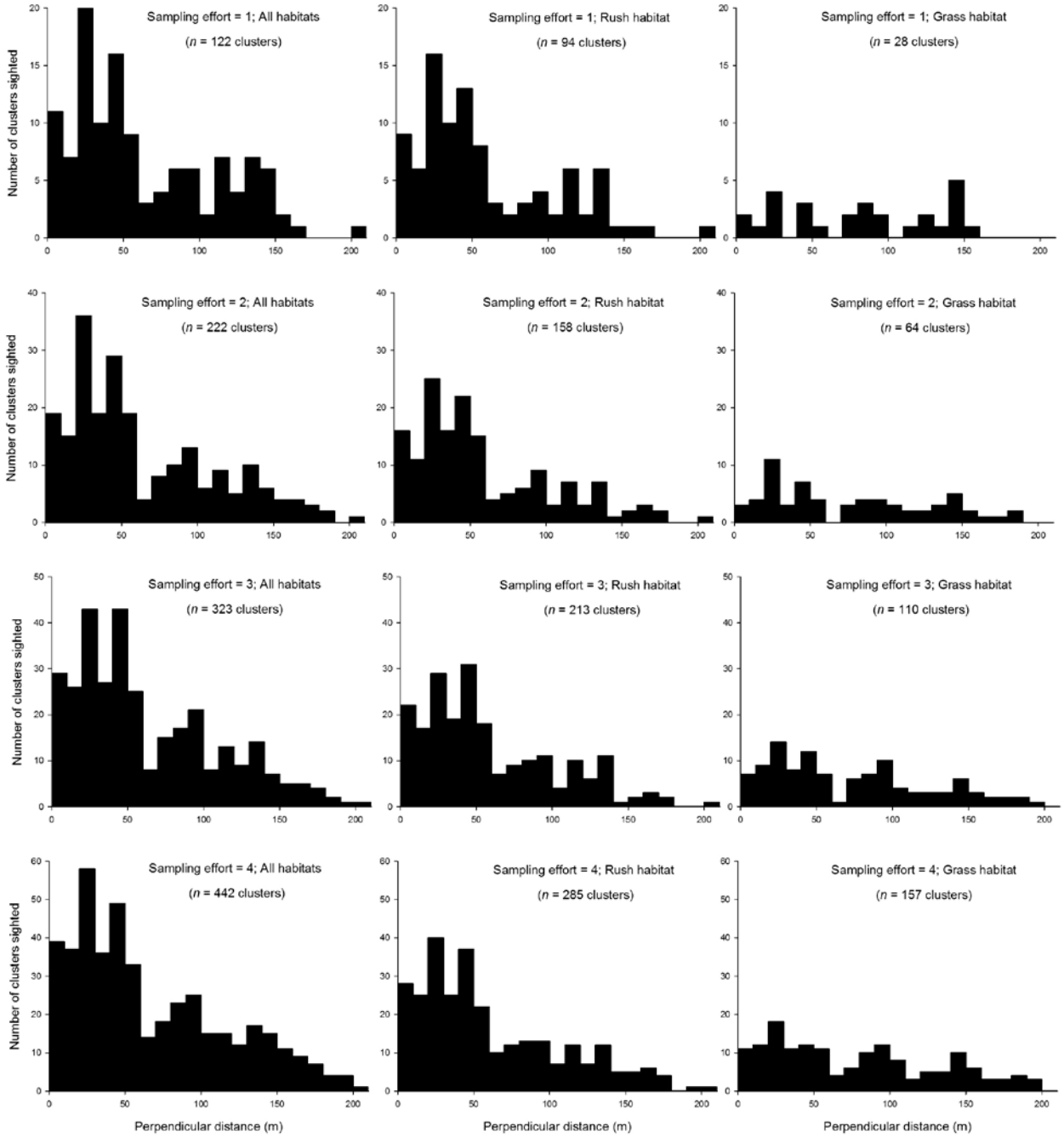

Fig. S2. Detection histograms for distance-sampling data collected during November 2012. Sampling effort is the number of times that each line transect was walked. Clusters (i.e. groups of ≥1 collared kangaroo) are grouped into 10-m intervals for all habitats (left column) and rush (centre column) and grass (right column) habitats.

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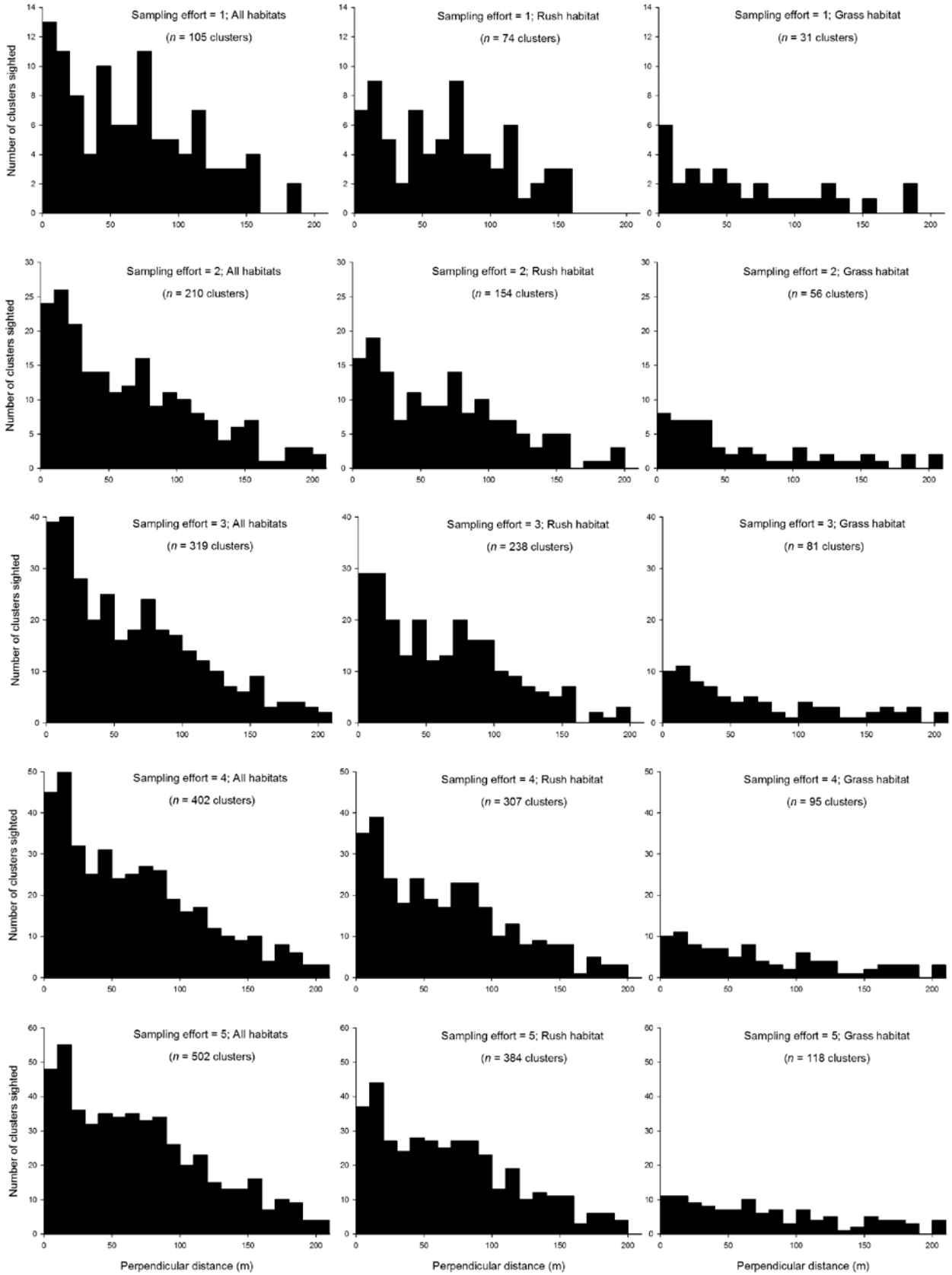

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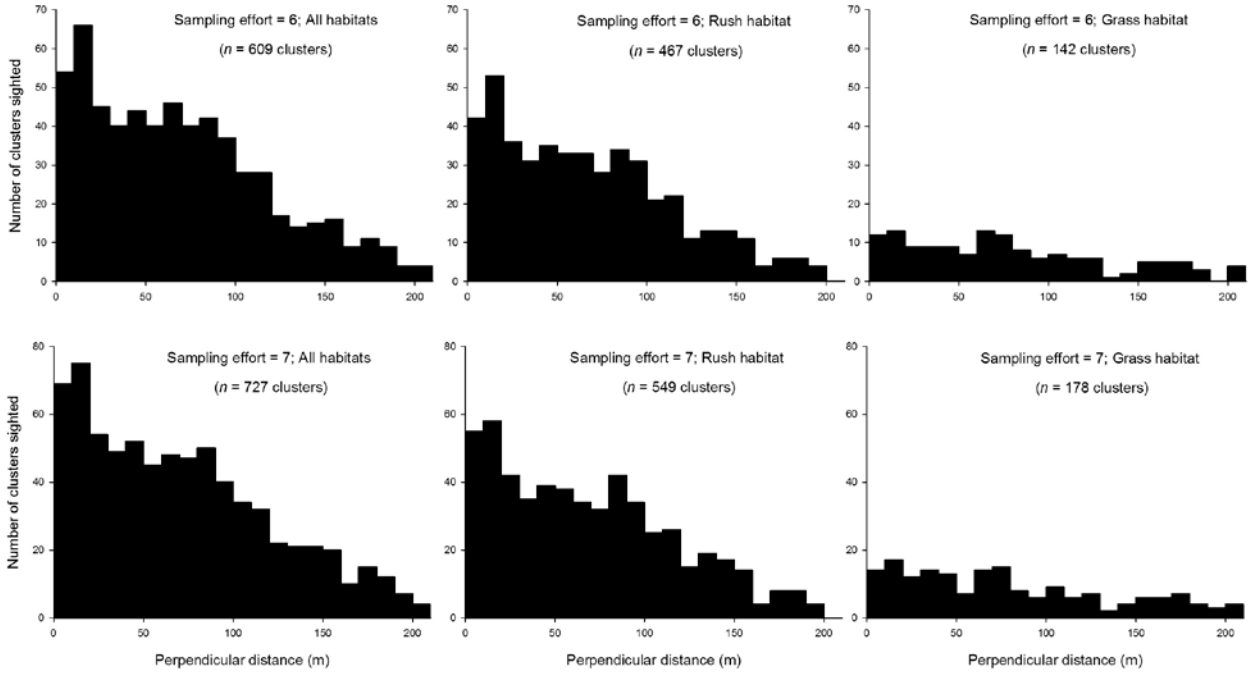

Fig. S3. Detection histograms for distance-sampling data collected during May 2013. Sampling effort is the number of times that each line transect was walked. Clusters (i.e. groups of ≥1 collared kangaroo) are grouped into 10-m intervals for all habitats (left column) and rush (centre column) and grass (right column) habitats.

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Table S1. Summary of distance-sampling analyses of data collected during the November 2012 line-transect surveys

AIC, Akaike's information criterion; ΔAIC, the difference between each model AIC and the AIC of the most parsimonious model; w_i, model weight; *N*, estimated abundance; sampling effort, the number of times that each line transect was walked. Analyses were conducted using the program DISTANCE 6.0 release 2 (Thomas *et al*. 2010, available at: http://www.ruwpa.st-and.ac.uk/distance/, verified 2 October 2015). Mean cluster size was estimated using the size-bias method. Models are listed from most supported (smallest AIC) to least supported (largest AIC)

Model specification			Model selection			Estimated abundance			
Key function	Series expansion	Habitat covariate?	AIC	ΔAIC	w_i	*N*	$N_{L95\%}$	$N_{U95\%}$	CV%
*Sampling effort = 1 (*n *= 122 clusters; mean cluster size = 1.24 (95%, CI: 1.14–1.35))*									
Uniform	Cosine	No	1143.58	0.00	0.24	160	99	258	22.2
Half-normal	Cosine	Yes	1143.93	0.35	0.20	141	89	224	19.1
Half-normal	Hermite polynomial	Yes	1143.93	0.35	0.20	141	89	224	19.1
Half-normal	Cosine	No	1144.55	0.97	0.15	169	103	276	23.1
Hazard rate	Simple polynomial	No	1145.22	1.64	0.11	154	90	263	26.2
Hazard rate	Simple polynomial	Yes	1146.37	2.79	0.06	155	98	246	19.2
Half-normal	Hermite polynomial	No	1147.35	3.78	0.04	134	84	212	19.9
*Sampling effort = 2 (*n *= 222 clusters; mean cluster size = 1.24 (95%, CI: 1.16–1.33))*									
Half-normal	Cosine	Yes	2085.52	0.00	0.28	132	88	197	16.6
Half-normal	Hermite polynomial	Yes	2085.52	0.00	0.28	132	88	197	16.6
Uniform	Cosine	No	2086.53	1.01	0.17	148	99	224	17.9
Half-normal	Cosine	No	2087.26	1.74	0.12	139	90	216	20.8
Hazard-rate	Simple polynomial	No	2087.47	1.96	0.11	146	94	228	21.1
Half-normal	Hermite polynomial	No	2090.46	4.94	0.02	128	86	192	17.0
Hazard rate	Simple polynomial	Yes	2091.42	5.90	0.01	155	103	232	16.8
*Sampling effort = 3 (*n *= 323 clusters; mean cluster size = 1.24 (95%, CI: 1.18–1.32))*									
Hazard-rate	Simple polynomial	Yes	3031.02	0.00	0.25	131	89	194	15.9
Uniform	Cosine	No	3031.85	0.83	0.16	129	88	191	16.0
Half-normal	Cosine	Yes	3032.02	1.00	0.15	129	87	191	15.8
Half-normal	Hermite polynomial	Yes	3032.02	1.00	0.15	129	87	191	15.8
Half-normal	Cosine	No	3032.64	1.62	0.11	143	96	213	17.7
Hazard rate	Simple polynomial	No	3032.65	1.63	0.11	140	93	212	19.1
Half-normal	Hermite polynomial	No	3033.59	2.57	0.07	127	86	188	16.2
*Sampling effort = 4 (*n *= 442 clusters; mean cluster size = 1.25 (95%, CI: 1.19–1.30))*									
Hazard rate	Simple polynomial	Yes	4189.00	0.00	0.63	133	97	182	12.9
Hazard rate	Simple polynomial	No	4192.74	3.74	0.10	137	98	192	15.7
Uniform	Cosine	No	4192.92	3.91	0.09	137	100	189	13.8
Half-normal	Cosine	No	4193.03	4.03	0.08	143	104	198	14.3
Half-normal	Cosine	Yes	4194.29	5.29	0.05	124	91	170	12.9
Half-normal	Hermite polynomial	Yes	4194.29	5.29	0.05	124	91	170	12.9
Half-normal	Hermite polynomial	No	4200.70	11.70	0.00	121	88	166	13.1

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Table S2. Summary of distance-sampling analysis of data collected during the May 2013 line-transect surveys

AIC, Akaike's information criterion; ΔAIC, the difference between each model AIC and the AIC of the most parsimonious model; w_i, model weight; *N*, estimated abundance; sampling effort, the number of times that each line transect was walked. Analyses were conducted using the program DISTANCE 6.0 release 2 (Thomas *et al*. 2010, available at: http://www.ruwpa.st-and.ac.uk/distance/, verified 2 October 2015). Mean cluster size was estimated using the size-bias method

Model specification			Model selection			Estimated abundance			
Key function	Series expansion	Habitat covariate?	AIC	ΔAIC	w_i	*N*	$N_{L95\%}$	$N_{U95\%}$	CV%
*Sampling effort = 1 (*n *= 105 clusters; mean cluster size = 1.27 (95%, CI: 1.14–1.42))*									
Uniform	Cosine	No	994.03	0.00	0.21	121	75	197	21.2
Half-normal	Cosine	No	994.32	0.28	0.18	117	72	191	21.3
Half-normal	Hermite polynomial	No	994.32	0.28	0.18	117	72	191	21.3
Half-normal	Cosine	Yes	994.60	0.56	0.16	121	75	196	20.1
Half-normal	Hermite polynomial	Yes	994.6	0.56	0.16	121	75	196	20.1
Hazard rate	Simple polynomial	No	995.80	1.77	0.09	132	75	233	27.9
Hazard rate	Simple polynomial	Yes	997.82	3.79	0.03	129	79	208	20.4
*Sampling effort = 2 (*n *= 210 clusters; mean cluster size = 1.23 (95%, CI: 1.14–1.31))*									
Hazard rate	Simple polynomial	No	1977.93	0.00	0.33	148	95	231	21.7
Hazard rate	Simple polynomial	Yes	1978.66	0.74	0.23	143	99	208	15.7
Uniform	Cosine	No	1979.31	1.39	0.17	122	84	177	15.8
Half-normal	Cosine	No	1979.76	1.84	0.13	139	94	204	17.6
Half-normal	Hermite polynomial	No	1981.66	3.73	0.05	119	82	173	15.9
Half-normal	Cosine	Yes	1982.05	4.12	0.04	120	83	175	15.4
Half-normal	Hermite polynomial	Yes	19.82.05	4.12	0.04	120	83	175	15.4
*Sampling effort = 3 (*n *= 319 clusters; mean cluster size = 1.27 (95%, CI: 1.20–1.34))*									
Half-normal	Cosine	No	3009.02	0.00	0.39	167	115	243	17.4
Hazard rate	Simple polynomial	No	3009.87	0.85	0.25	158	106	236	19.1
Uniform	Cosine	No	3011.05	2.02	0.14	129	91	185	14.7
Hazard rate	Simple polynomial	Yes	3012.28	3.25	0.08	144	101	206	14.7
Half-normal	Hermite polynomial	No	3012.86	3.84	0.06	127	89	182	14.9
Half-normal	Cosine	Yes	3013.47	4.45	0.04	128	90	183	14.5
Half-normal	Hermite polynomial	Yes	3013.47	4.45	0.04	128	90	183	14.5
*Sampling effort = 4 (*n *= 402 clusters; mean cluster size = 1.31 (95%, CI: 1.24–1.38))*									
Half-normal	Cosine	No	3825.56	0.00	0.23	120	90	159	12.2
Half-normal	Hermite polynomial	No	3825.56	0.00	0.23	120	90	159	12.2
Uniform	Cosine	No	3825.68	0.12	0.21	121	91	161	11.9
Hazard-rate	Simple polynomial	No	3826.54	0.98	0.14	135	97	187	15.7
Half-normal	Cosine	Yes	3827.41	1.85	0.09	120	90	159	11.8
Half-normal	Hermite polynomial	Yes	3827.41	1.85	0.09	120	90	159	11.8
Hazard rate	Simple polynomial	Yes	3830.99	5.43	0.02	133	100	178	11.9
*Sampling effort = 5 (*n *= 502 clusters; mean cluster size = 1.30 (95%, CI: 1.24–1.37))*									
Half-normal	Cosine	No	4821.38	0.00	0.27	112	81	155	13.3
Half-normal	Hermite polynomial	No	4821.38	0.00	0.27	112	81	155	13.3
Uniform	Cosine	No	4822.44	1.06	0.16	114	83	158	13.2
Half-normal	Cosine	Yes	4822.83	1.45	0.13	112	81	155	13.0
Half-normal	Hermite polynomial	Yes	4822.83	1.45	0.13	112	81	155	13.0
Hazard rate	Simple polynomial	No	4825.19	3.81	0.04	116	83	162	15.5
Hazard rate	Simple polynomial	Yes	4828.34	6.96	0.01	102	74	140	13.0
*Sampling effort = 6 (*n *= 609 clusters; mean cluster size = 1.32 (95%, CI: 1.20–1.38))*									
Half-normal	Cosine	No	5822.67	0.00	0.26	114	81	162	14.1
Half-normal	Hermite polynomial	No	5822.67	0.00	0.26	114	81	162	13.9
Half-normal	Cosine	Yes	5823.82	1.15	0.15	114	81	161	13.9
Half-normal	Hermite polynomial	Yes	5823.82	1.15	0.15	114	81	161	13.9

Uniform	Cosine	No	5824.01	1.34	0.13	111	79	157	14.9
Hazard rate	Simple polynomial	No	5826.18	3.51	0.04	105	75	149	14.2
Hazard rate	Simple polynomial	Yes	5827.99	5.32	0.02	105	74	148	13.8
*Sampling effort = 7 (*n *= 727 clusters; mean cluster size = 1.29 (95%, CI: 1.24–1.34))*									
Half-normal	Cosine	No	6982.39	0.00	0.24	112	80	159	14.0
Half-normal	Hermite polynomial	No	6982.39	0.00	0.24	112	80	159	14.0
Half-normal	Cosine	Yes	6982.71	0.32	0.20	113	80	159	13.8
Half-normal	Hermite polynomial	Yes	6982.71	0.32	0.20	113	80	159	13.8
Uniform	Cosine	No	6984.73	2.23	0.08	115	81	162	13.9
Hazard rate	Simple polynomial	No	6986.30	3.91	0.03	114	80	162	15.4
Hazard rate	Simple polynomial	Yes	6991.21	8.82	0.00	102	72	114	13.8

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Table S3. Summary of model-averaged component percentages of the variance of the estimated abundances of collared kangaroos during November 2012

Sampling effort, the number of times that each line transect was walked; *n*, the number of clusters

Component	Sampling effort			
	1 (*n* = 122)	2 (*n* = 222)	3 (*n* = 323)	4 (*n* = 442)
Detection probability	23.0	16.9	10.8	11.5
Encounter rate	74.7	81.3	87.7	87.0
Cluster size	2.3	1.8	1.5	1.5
Total	100.0	100.0	100.0	100.0

Table S4. Summary of model-averaged component percentages of the variance of the estimated abundances of collared kangaroos during May 2013

Sampling effort, the number of times that each line transect was walked; *n*, the number of clusters

Component	Sampling effort						
	1 (*n* = 105)	2 (*n* = 210)	3 (*n* = 319)	4 (*n* = 402)	5 (*n* = 502)	6 (*n* = 609)	7 (*n* = 727)
Detection probability	17.5	27.6	27.6	15.6	8.5	7.0	5.0
Encounter rate	79.5	70.5	70.8	81.8	89.8	91.6	94.0
Cluster size	3.0	1.9	1.6	2.6	1.7	1.4	1.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0