Supporting Information

Appendix S1. Validating the accuracy of aerial survey location data.

To validate the accuracy of our aerial survey data, we compared habitat-use estimated using this data to habitat-use estimated using telemetry data (van Beest *et al*., 2014). During the dry season (June to September inclusive) of 2012, 26 collared female elephants, each representing separate herds spread across Kruger, provided us with hourly location data. A dry season aerial survey was also performed in 2012. We included all daytime telemetry locations during the dry season to assess whether the female habitat-use "snapshot" estimated using aerial survey data was indicative of habitat-use across the season (van Beest *et al*., 2014). As our habitat covariates were continuous, we divided each into equally sized bins (distance to rivers = 2000m bin width; percentage woody cover = 5% bin width) and estimated habitat-use as the percentage of occupied 5km2 grid-cells in each bin for aerial survey and telemetry data separately (see Fig. S1). We then tested if habitat-use was significantly different between the two data sources using a Wilcoxon matched-pairs signed rank test.

We did not find a significant difference between habitat-use estimated using aerial survey and telemetry data (woody cover: Wilcoxon p = 0.97, rs = 0.98; distance to rivers: Wilcoxon p = 0.23, rs = 0.98) (Fig. S1). Therefore, we considered habitat-use estimates using aerial survey data to be indicative of habitat-use throughout the dry season, with little bias introduced due to habitat-specific sightability issues.

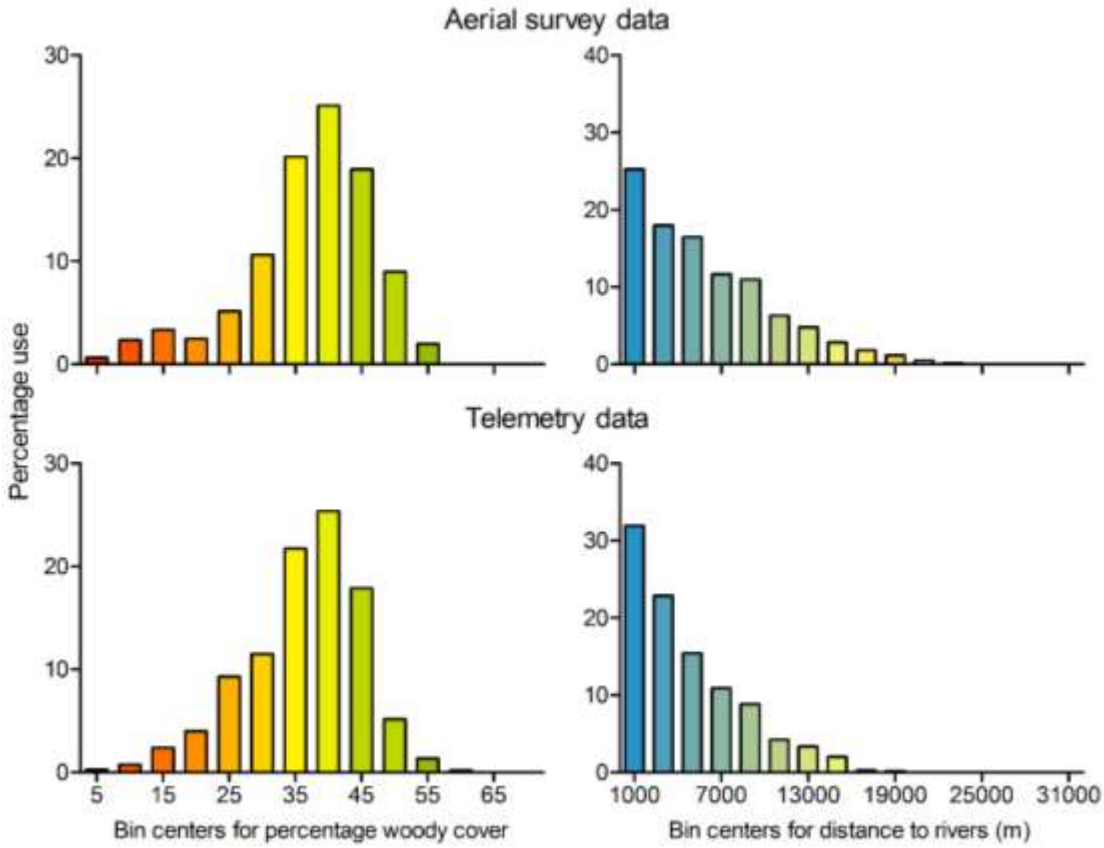

Figure S1. Comparison between female elephant habitat-use estimated using aerial survey and telemetry data during the dry season of 2012.

Appendix S2. Justification for the use of a static woody cover layer for assessing temporal variation in habitat selection.

We consider our use of a static woody cover layer as appropriate within the scope of our study for five reasons: (1) the layer was generated using multiple years of data collected during the middle of our study period (*Bucini et al.,* 2010) thereby avoiding an estimation of woody cover biased towards either low or high elephant densities; (2) our study period was relatively short (15 years), therefore decreasing the possibility of significant changes in woody cover over the period; (3) over the last 50 years, increases in woody cover have not been uniform across Kruger (Buitenwerf *et al.,* 2012); (4) even where increases did occur, there has been no change during the period overlapping our study (Buitenwerf *et al.*, 2012) and; (5) our 5km2 grid-cell sampling and the Kruger-wide extent of our study likely reduced the effects of fine-scale and spatially isolated changes in woody cover on our results.

Appendix S3.

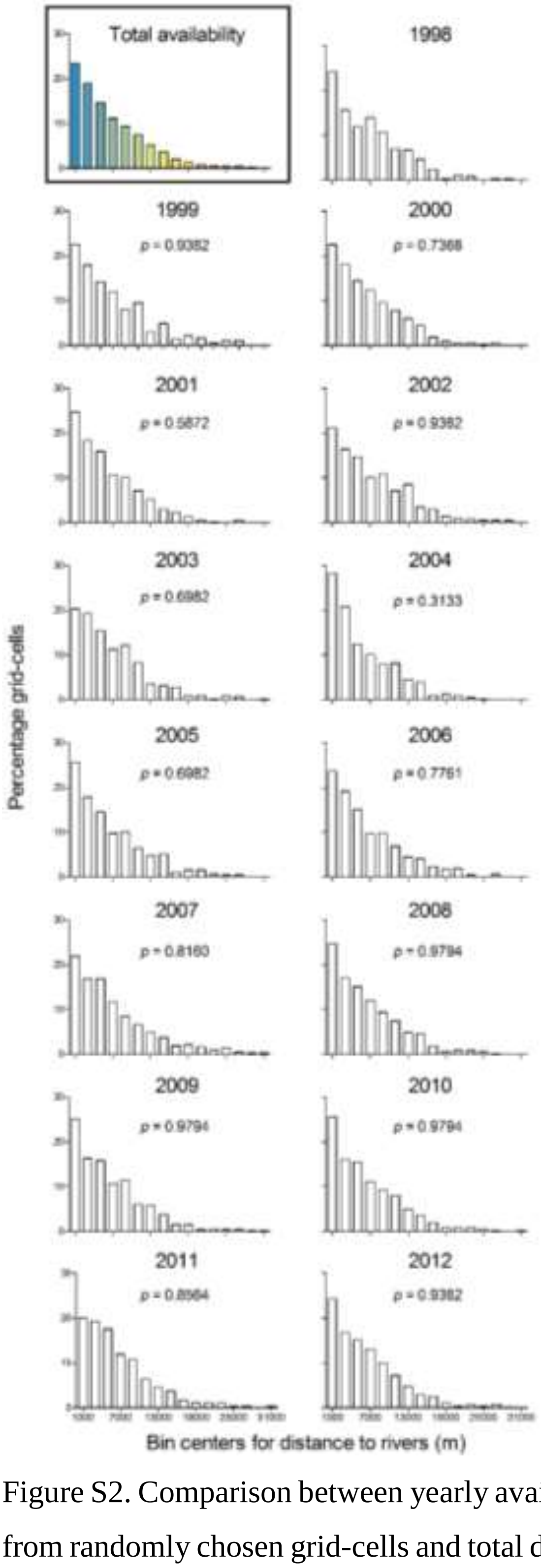

Figure S2. Comparison between yearly available distributions of distance to rivers (1998-2012) from randomly chosen grid-cells and total distance to rivers availability for the Kruger National Park. *P*-values are Wilcoxon *p*-values, where $p < 0.05$ suggests a significant difference in distribution.

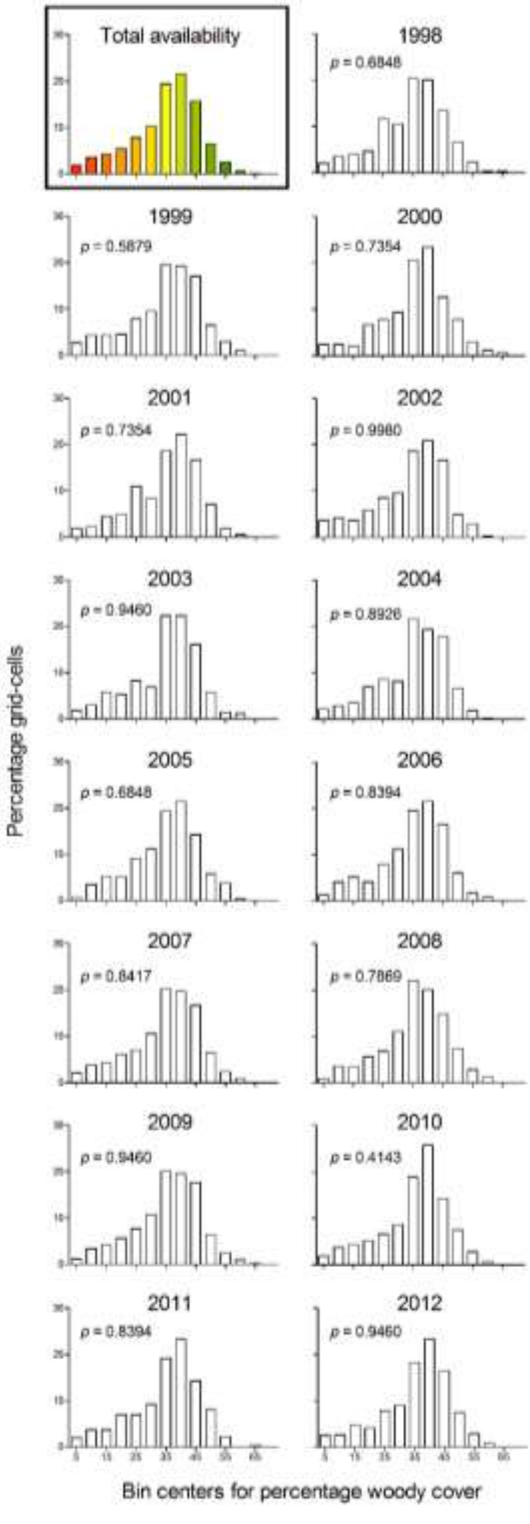

Figure S3. Comparison between yearly available distributions of percentage woody cover (1998-2012) from randomly chosen grid-cells and total percentage woody cover availability for the Kruger National Park. *P*-values are Wilcoxon *p*-values, where $p < 0.05$ suggests a significant difference in distribution.

Appendix S4. Assessment of the effect of including distance to waterholes as a covariate in resource selection functions.

To determine whether our habitat selection estimates independent of waterholes were appropriate, we included distance to waterholes in year-specific RSFs when the data were available (1998, 2011 and 2012). We then compared these models to separate models excluding distance to waterholes for the same years by calculating the change in Akaike Information Criterion (ΔAIC) (Burnham & Anderson, 2002), percentage difference in β coefficients for percentage woody cover and distance to rivers, and the β coefficient and significance of the distance to waterholes effect. We did this separately for female and male elephants for the whole of Kruger and each district, and used the same routine for calculating RSFs as detailed in "Estimating the influence of density and rainfall on habitat selection".

Comparisons between models excluding distance to waterholes and those models including the covariate showed that female habitat selection was mostly uninfluenced by the inclusion (see Table S1). Conversely, distance to waterholes had a strong effect on male selection (see Table S1). It was for that reason that we excluded estimates of male elephant habitat selection from our paper and viewed female habitat selection estimates independent of waterholes as appropriate. Our findings support the work of Smit, Grant & Whyte (2007) and others who found that sexual segregation in elephants, both in space and resource selection, occurs in Kruger. This segregation likely occurs because of differences in shade and nutritional requirements observed between relatively small-bodied females and calves and larger males (Smit, Grant & Whyte, 2007).

Table S1. The effects of including distance to waterholes in resource selection functions for a) female and b) male elephants for the whole of Kruger, and the northern, central and southern districts. Bold values indicate where models improved, according to changes in AIC (where ΔAIC < -2), by including distance to waterholes. Significant distance to waterhole effects are also in bold.

a)

				% Change in β		Distance to waterholes	
	Year	District	Δ AIC	Woody cover	Distance to rivers	β	p
Females	1998	Kruger	1.51	2%	4%	-0.20	0.48
		Northern	2.14	4%	6%	-0.25	0.53
		Central	1.93	-1%	1%	-0.15	0.79
		Southern	0.29	63%	-35%	0.94	0.20
	2011	Kruger	0.60	6%	-1%	-0.17	0.24
		Northern	1.94	-5%	1%	0.05	0.81
		Central	-1.65	1%	-1%	-0.53	0.06
		Southern	1.68	2%	-11%	0.19	0.57
	2012	Kruger	-0.20	8%	0%	-0.22	0.14
		Northern	1.47	56%	-2%	-0.15	0.47
		Central	1.15	2%	4%	-0.23	0.36
		Southern	-0.37	-2%	-13%	-0.59	0.13

b)

				% Change in β		Distance to waterholes	
	Year	District	Δ AIC	Woody cover	Distance to rivers	β	p
Males	1998	Kruger	**-11.10**	**-8%**	**189%**	**-1.01**	**< 0.001**
		Northern	**-12.33**	**-36%**	**1636%**	**-1.37**	**< 0.001**
		Central	-0.01	5%	11%	-0.75	0.16
		Southern	**-2.53**	**-43%**	**-14%**	**1.79**	**0.04**
	2011	Kruger	**-24.30**	**-17%**	**22%**	**-0.70**	**< 0.001**
		Northern	**-4.11**	**-17%**	**-23%**	**-0.46**	**0.01**
		Central	**-3.19**	**12%**	**30%**	**-0.66**	**0.02**
		Southern	1.98	3%	-2%	0.05	0.90
	2012	Kruger	**-12.20**	**-42%**	**25%**	**-0.51**	**< 0.001**
		Northern	**-10.08**	**-36%**	**-330%**	**-0.62**	**< 0.001**
		Central	0.89	-34%	15%	-0.27	0.29
		Southern	0.86	-6%	-28%	-0.41	0.29

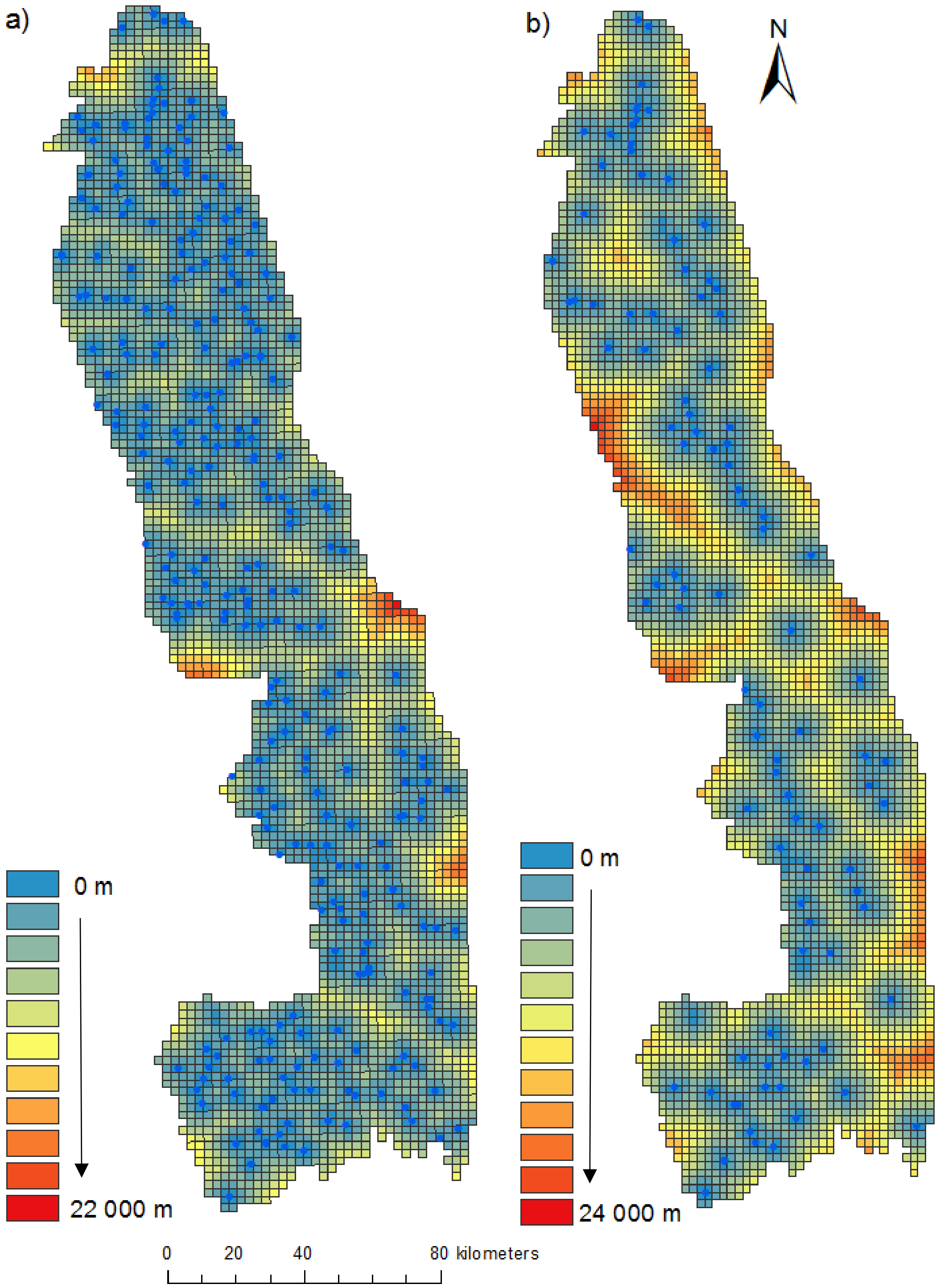

Figure S4. Estimates of distance to borehole-fed waterholes in a) 1998 and b) 2012 following a 65% reduction of waterholes by Kruger National Park management.

Appendix 5.

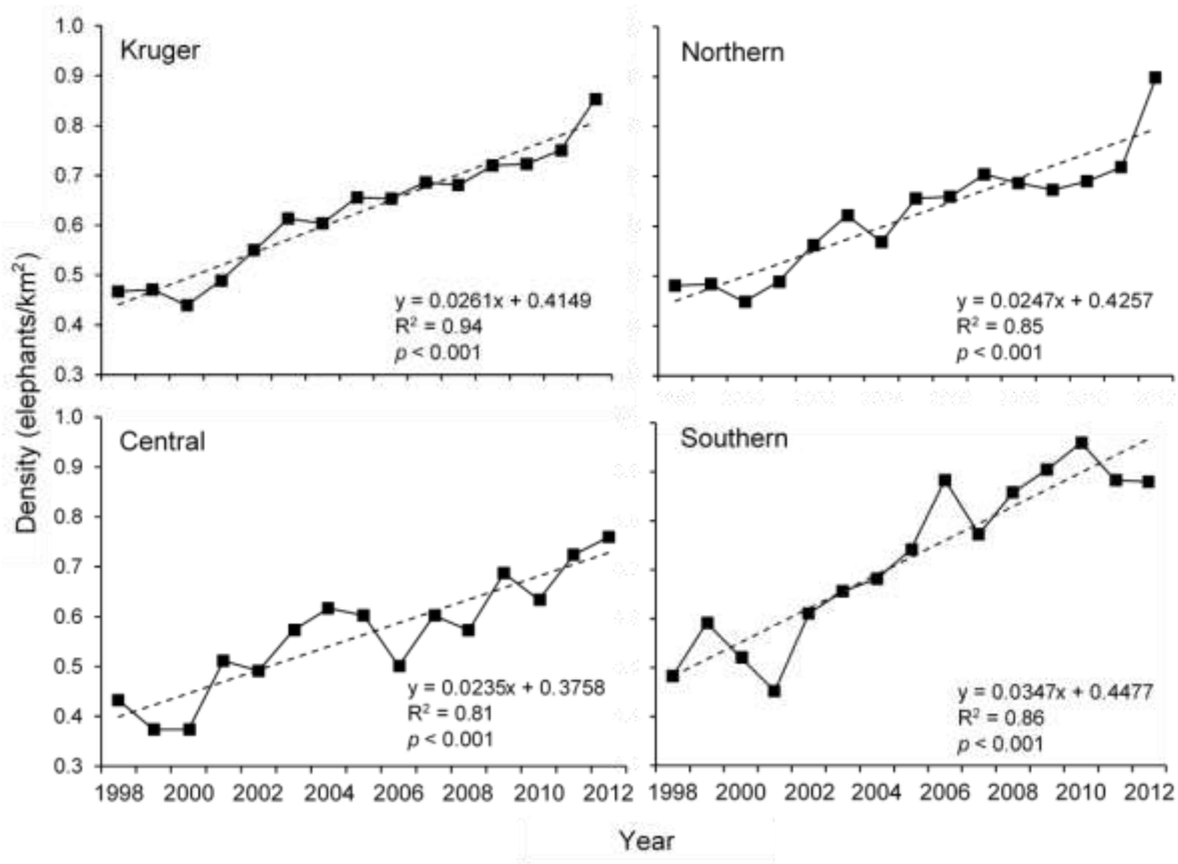

Figure S5. Time series of elephant density from 1998 to 2012 for the Kruger National Park and its three districts. Dashed lines are linear regressions between density and year, with the slopes indicating the average rate of increase in density over the 15-year period.

Appendix S6.

Table S2. Summary of park-wide and district-specific RSF models predicting female elephant habitat selection during the dry season as a function of distance to rivers, woody cover, density and dry season rainfall in the Kruger National Park, 1998-2012. The variables distance to rivers, woody cover, density and dry season rainfall were standardised prior to analyses by centring and dividing by two standard deviations.

District	RSF variable	*β*	SE	z-value	*p*
Kruger	(Intercept)	-0.01	0.02	-0.45	0.65
	Distance to rivers	**-0.63**	**0.04**	**-16.74**	**< 0.001**
	Woody cover	**0.38**	**0.04**	**10.38**	**< 0.001**
	Density	0.01	0.04	0.28	0.78
	Dry rain	0.01	0.04	0.22	0.83
	Distance to rivers × Density	0.08	0.08	1.08	0.28
	Woody cover × Density	**-0.27**	**0.08**	**-3.62**	**< 0.001**
	Distance to rivers × Dry rain	**0.14**	**0.08**	**1.87**	**0.05**
	Woody cover × Dry rain	0.05	0.07	0.68	0.49
	Random effect	Variance	SD		
	Year | District	< 0.001	< 0.001		
Northern	(Intercept)	-0.01	0.02	-0.32	0.75
	Distance to rivers	**-0.67**	**0.05**	**-12.67**	**< 0.001**
	Woody cover	**0.41**	**0.05**	**7.82**	**< 0.001**
	Density	0.01	0.05	0.19	0.85
	Dry rain	-0.01	0.05	-0.20	0.85
	Distance to rivers × Density	0.00	0.11	-0.02	0.99
	Woody cover × Density	**-0.31**	**0.11**	**-2.97**	**0.003**
	Distance to rivers × Dry rain	-0.05	0.11	-0.43	0.67
	Woody cover × Dry rain	-0.10	0.10	-0.91	0.36
	Random effect	Variance	SD		
	Year	< 0.001	< 0.001		
Central	(Intercept)	0.00	0.03	-0.13	0.90
	Distance to rivers	**-0.52**	**0.07**	**-6.96**	**< 0.001**
	Woody cover	**0.43**	**0.07**	**5.83**	**< 0.001**
	Density	0.01	0.07	0.20	0.85
	Dry rain	0.00	0.08	0.05	0.96
	Distance to rivers × Density	0.15	0.14	1.02	0.31
	Woody cover × Density	-0.18	0.14	-1.22	0.22
	Distance to rivers × Dry rain	**0.43**	**0.18**	**2.41**	**0.02**
	Woody cover × Dry rain	0.02	0.17	0.10	0.92
	Random effect	Variance	SD		
	Year	< 0.001	< 0.001		
Southern	(Intercept)	-0.02	0.04	-0.58	0.56

Distance to rivers	**-0.43**	**0.08**	**-5.68**	**< 0.001**
Woody cover	**0.35**	**0.07**	**4.68**	**< 0.001**
Density	-0.02	0.07	-0.30	0.77
Dry rain	-0.03	0.08	-0.37	0.71
Distance to rivers × Density	0.06	0.15	0.38	0.70
Woody cover × Density	-0.20	0.15	-1.34	0.18
Distance to rivers × Dry rain	**0.70**	**0.14**	**4.84**	**< 0.001**
Woody cover × Dry rain	0.01	0.15	0.08	0.93
Random effect	Variance	SD		
Year	< 0.001	< 0.001		

Note: Significant effects ($p \leq 0.05$) are indicated in bold. RSF, resource selection function. Dry rain is mean dry season rainfall (June-September inclusive).

Appendix S7. Justification for not including the influence of wet season rainfall on habitat selection in our main findings.

Unlike dry season rainfall, which we expected to mediate elephant distribution through access to water, wet season rainfall might be expected to influence the quantity/quality of forage. If wet season rainfall is high, green biomass of a high quality should be retained into the dry season (Mduma *et al*., 1999). Specifically, high-quality grass biomass should be available to herbivores for an extended period of the dry months. For elephants, this means that high wet season rainfall results in a less pronounced dietary shift from grass in the wet season to browse in the dry season (see Codron *et al*., 2011).

For the influence of wet season rainfall on elephant habitat selection to be assessed in our study, our RSFs would have had to detect changes in elephant distribution relative to our habitat covariates (woody cover and distance to rivers) which resulted from dietary shifts related to wet season rainfall variability. Because elephants do not browse or graze in proportion to the absolute, or relative, abundances of trees or grass and, therefore, dietary composition is only weakly associated with tree (and grass) cover (selective intake of forage is an important feeding strategy for elephants) (Codron *et al*., 2011), we reasoned that our RSFs using percentage woody cover (especially using 5 km2 grid cells) would be inappropriate for detecting extremely fine-scale changes in distribution associated with rainfall-induced dietary shifts. Furthermore, we reasoned that dietary preference is only one of the drivers of elephant selection for woody cover, and other drivers (e.g. shade seeking for thermal comfort; Mole *et al*., 2016)) could be unrelated to changes in primary production associated with wet season rainfall variability. To test our reasoning, we did calculate RSFs with wet season rainfall (December to March inclusive; see Material and Methods) and its interactions included for Kruger and each district (Table S3). As expected, the inclusion of wet season rainfall in our models did not significantly improve the models according to changes in AIC (Table S3).

Additionally, the effect of wet season rainfall on woody cover selection was weak and not significant for three of the four models. For the one model with a significant woody cover-wet season rainfall interaction, the strength of selection for woody cover increased with wet season rainfall, the opposite of expectations (Table S3). For the above reasons, we consider our exclusion of the influence of wet season rainfall on elephant habitat selection appropriate. It would be unsuitable to include the variable in our models and conclude that wet season rainfall does not influence elephant habitat selection. This conclusion would be based on a data mismatch rather than ecological reasoning because, given fine-scale and frequent location, habitat and rainfall data, it is likely that wet season rainfall would affect elephant habitat selection.

Table S3. The effect of including wet season rainfall and its interactions in the original RSFs.

	AIC			Woody cover × wet rainfall	
District	Original model	Original model + wet rainfall	Δ AIC	*β*	*p*
Kruger	18321.90	18325.00	3.10	-0.05	0.55
Northern	9066.10	9072.10	6.00	0.00	0.98
Central	4819.60	4818.10	-1.50	0.42	0.01
Southern	4115.40	4121.10	5.70	-0.08	0.60

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