The influence of prey, pastoralism and poaching on the hierarchical use of habitat by an apex predator.

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SUPPLEMENTARY INFORMATION

METHODS

Warthog occupancy model

Twenty-three lion grid cells were surveyed for warthogs (mean = 3.6 camera sites / lion grid cell). Active camera stations were located ≥ 4 km apart. Sampling occasions (n = 797; mean = 9.7 / site; range = 2 - 22) were represented by seven day intervals. We made the assumptions of an occupancy model, but note that the closure assumption was relaxed because the estimator was *probability of site use* (MacKenzie *et al.*, 2006). Warthog spatial use is influenced by the nutritional quality of vegetation, water availability and predation risk (Estes, 1991). To describe heterogeneity in warthog site use, we used six landscape covariates accounting for variation in vegetation communities, underlying geology, surface water availability, topography and anthropogenic disturbance (Table S1).

Table S1. Covariates expected to influence occurrence of warthog.

Covariate	Fitness value to warthog	Description	Sampling effort
Mopane shrubveld	Nutritional variation	Shrublands and thickets of *Colophospermum mopane* on calcerous soil	12 sites
Combretum/ mopane rugged veld	Nutritional variation	Woodlands and shrublands of *Combretum spp*. and *Colophospermum mopane* on clay soils	17 sites
Lebombo hills	Nutritional variation	Short woodlands and shrublands of *Combretum apiculatum* on rhylolite soils	11sites
Sand plains	Nutritional variation	Short woodlands and thickets of *Baphia massaiensis* and *Combretum apiculatum* on sandy soils	42 sites
Water	Water availability Nutritional variation	Proximity to rivers measured in ArcGIS (km)	0.0 – 9.3 mean = 3.7
Village	Direct persecution	Proximity to settlements measured in ArcGIS (km)	0.5 – 22.7 mean = 11.7

A detection/non-detection matrix was constructed for each site (n = 82), recording a '1' or '0' where warthog were detected or not detected, respectively. Similarly, a season (wet *versus* dry) specific matrix was built to account for differing detection probabilities throughout the year (1 = November - April, 0 = May - October). First, covariates describing heterogeneity in warthog detection probability were evaluated. The detection covariate for season was included in all the following analysis; the model with this covariate was strongly supported (ΔAICc < 2) and ranked higher than the model that assumed detectability was constant. Following this, we compared all possible combinations of occupancy covariates (63 models). Final covariate values were extracted as mean warthog site use from a continuous (30 m x 30 m resolution) raster layer using the Spatial Analysis toolbox in ArcGIS 9.3.1. (esri).

RESULTS

Warthog site use

The model selection procedure for warthog site use is provided in Table S3. Model averaged estimates showed that the probability of detecting warthogs at a site where they occur was $\bar{\hat{p}}$ = 0.336 (SE = 0.035). Site level estimates ranged from 0.008 (SE = 0.011) to 0.771 (SE = 0.004) with a weighted average of 0.513 (SE = 0.049). Site use by warthogs increased strongly with distance from villages (Table S4). There was no evidence lack of fit (p = 1.10) or over-dispersion ($\hat{c}$ = 0.20).

Table S2. Summary of model selection procedure for factors influencing warthog site use (Ψ) across 82 sites in the Limpopo National Park, Mozambique. Covariates considered include; distance from villages (V), combretum/mopane rugged veld (C), distance from water (W), sand plains (SP) and mopane shrubveld (M). Detectability (p) varies with season (S).

Models	**ΔAICc**	***w***	**K**	**-2l**
Ψ(V)p(S)	0.00	0.267	4	538.42
Ψ(V+C)p(S)	0.20	0.241	5	536.35
Ψ(V+W+C)p(S)	1.12	0.152	6	534.94
Ψ(V+SP)p(S)	1.60	0.120	5	537.75
Ψ(V+W)p(S)	1.67	0.116	5	537.82
Ψ(V+M)p(S)	1.96	0.100	5	538.11
Ψ(.)p(S)	38.84	0.000	3	579.47

Ψ(.) assumes site use is constant, ΔAICc is the difference in AICc values between each model with the low AICc model, *w* is the AICc model weight, K is the number of parameters in the model, and −2l is twice the negative log-likelihood value.

Table S3. β- coefficient estimates for covariates influencing warthog site use (Ψ) in order of their summed model weights (∑w).

Occupancy Covariate	**∑ model w (%)**	**β**	**SE**
Village	99.6	-2.95*	0.77
Combretum/Mopane rugged veld	39.4	0.61	0.52
Water	26.8	1.39	1.05
Sand plains	12.0	-0.79	1.00
Mopane shrubveld	10.0	-0.57	1.02

* Indicates covariate has robust impact (β ± 1.96 x SE not overlapping 0).

Lion occupancy model

Table S4. Results of Pearson's *r* correlation test from lion occupancy models.

Home range		**Short term**	
Covariates	**r**	**Covariates**	**r**
B+P	0.000	B+P	0.000
B+AP	-0.386	B+AP	-0.363
B+W*	0.561	B+W	0.254
B+V	0.373	B+V	-0.431
P+AP*	0.702	P+AP*	0.544
P+W	0.235	P+W	0.137
P+V*	-0.695	P+V*	0.526
AP+W	-0.039	AP+W	0.051
AP+V*	-0.943	AP+V*	0.895
W+V	-0.069	W+V	-0.055

* indicates covariates that are correlated using a cut-off of |r| = 0.5 and were therefore not combined in models.

REFERENCES

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