Rewilding landscapes with apex predators: Cheetah movements reveal the importance of environmental and individual contexts

Dimbleby, J., Cristescu, B.*, Bandyopadhyay, K., Rooney, N.J., Marker, L.

* bogdan@cheetah.org

Supplementary Figures and Tables

Table S1. Vehicle-driven transect characteristics for estimating density of cheetah prey.

Farm	Area (km^2)	Monitoring started	Vehicle transect length (km)
Bellebenno (363)	73	2002	17.4
Boskop (324)	50.8	2001	13.9
Byanadaar (361)	73	2004/05	19.6
Cheetah View (317)	50.5	1998/99	17.3
Elandsvreugde (367)	73	1994	27.5 (A), 21.0 (B)
Janhelpman (358)	73	2002	15
Osonanga (368/00REM + 368/00001)	70.3	2001	22.4
Padberg (323/00REM)	40	2019	22
Otjenga (362)	73.1	2020	22.1
576.7	576.7	576.7	576.7

Table S2. Correlation matrix of factors tested for association with cheetah step length. Covariate pairs that were highly correlated ($|r| > 0.6$) are displayed in the table.

Variable 1	**Variable 2**	**Correlation ($\|r\|$)**
Small Prey	Male (sex)	0.88
Large Prey	Male (sex)	0.88
Distance to edge	Distance to marking tree	0.67
Distance to edge^2	Distance to marking tree	0.65
Distance to marking tree	Distance to edge	0.67
Distance to edge^2	Distance to edge	0.97
Distance to marking tree	Distance to edge^2	0.65
Distance to edge	Distance to edge^2	0.97
Male (sex)	Small Prey	0.88
Large Prey	Small Prey	0.91
Male (sex)	Large Prey	0.88
Small Prey	Large Prey	0.91

Table S3. Results of one-way ANOVA with post-hoc Tukey tests to assess whether average step lengths were statistically different among the four cheetah classes.

Class	**difference**	**lower**	**upper**	***p* adjusted**
Rehab Local	103.96	-2392.61	2600.52	1
Rehab Translocated	-180.93	-2671.27	2309.42	1
Wild Local	357.04	-2133.59	2847.67	1
Wild Rehab Translocated	-277.91	-2770.67	2214.86	1
Rehab Translocated x Rehab Local	-284.88	-473.64	-96.13	<0.001***
Wild Local x Rehab Local	253.08	60.49	445.67	0.003**
Wild Rehab Translocated x Rehab Local	-381.86	-600.30	-163.43	<0.001***
Wild Local x Rehab Translocated	537.97	460.14	615.79	0***
Wild Rehab Translocated x Rehab Translocated	-96.98	-226.13	32.17	0.24
Wild Rehab Translocated x Wild Local	-634.95	-769.64	-500.25	0***

Table S4. Results from one-way ANOVA with post-hoc Tukey tests assessing differences in average step lengths among three seasons.

Season	**difference**	**lower**	**upper**	***p* adjusted**
Cold-Dry	-151.42	-2570.26	2267.43	1
Hot-Dry	118.37	-2300.85	2537.60	1
Hot-Wet	76.00	-2342.84	2494.85	1
Hot-Dry x Cold-Dry	269.79	180.22	359.36	0***
Hot-Wet x Cold-Dry	227.42	148.70	306.14	0***
Hot-Wet x Hot-Dry	-42.37	-131.82	47.08	0.62

Table S5. Results of Welch two sample t-test comparing step lengths of male and female cheetahs.

Statistic	**value**
t-value	16.916
df	2321.3
p-value	<2.2e-16
Confidence Interval (95%)	(476.65, 601.65)
Mean of Male	903.253
Mean of Female	364.104

Table S6. The proportion of steps in relation to Big Field and the average step length for the four classes of cheetah. 'Intersections' represent steps that cross the open savanna-woodland savanna habitat edge, 'Inside' are steps within the Big Field and 'Outside' are steps outside the Big Field.

Class	**Proportion of steps**			**Average step length**		
	Intersections	**Inside**	**Outside**	**Intersection**	**Inside**	**Outside**
Wild Local	0.295	0.289	0.710	1932.409	1517.869	982.339
Rehab Translocated	0.0424	0.137	0.907	1100.694	486.328	365.307
Rehab Local	0.0523	0.158	0.841	1479.155	872.196	1479.155
Wild Rehab Translocated	0.0185	0.0510	0.948	1461.192	575.494	262.307

Table S7. Ranking of hypotheses on ecological factors associated with step lengths of Wild Local cheetahs. K represents the numbers of covariates per model, where model 2 only contains the intercept. Supported models are those with ΔAICc <2. AICc weight, Cumulative weight, and Log likelihood (LL) are also reported.

Model	K	AICc	Delta_AICc	AICcWt	Cum_Wt	LL
1	8	4224.63	0	0.93	0.93	-2103.32
6	5	4230.14	5.51	0.06	0.99	-2109.07
8	7	4234.11	9.48	0	1	-2109.05
4	4	4416.69	192.06	0	0.93	-2203.35
7	5	4417.90	193.27	0	0.99	-2202.95
3	4	4421.05	196.42	0	0.93	-2205.53
9	6	4422.23	197.60	0	1	-2204.12
5	5	4423.32	198.68	0	0.93	-2205.66
2	1	4682.66	458.03	0	0.93	-2339.33

Table S8. Ranking of hypotheses on ecological factors associated with step lengths of Rehabilitated Local cheetahs. K represents the numbers of covariates per model, where model 2 only contains the intercept. Supported models are those with ΔAICc <2. AICc weight, Cumulative weight, and Log likelihood (LL) are also reported.

Model	K	AICc	Delta_AICc	AICcWt	Cum_Wt	LL
8	7	503.49	0	0.27	0.94	-243.74
6	5	503.88	0.39	0.22	0.57	-245.94
3	4	505.03	1.54	0.13	0.24	-247.52
1	8	505.25	1.76	0.11	0.11	-243.63
7	5	505.53	2.04	0.10	0.67	-246.76
4	4	505.77	2.28	0.09	0.33	-247.88
9	6	506.52	3.04	0.06	1	-246.26
5	5	508.97	5.48	0.02	0.34	-248.49
2	1	530.84	27.35	0	0.11	-263.42

Table S9. Ranking of hypotheses on ecological factors associated with step lengths of Rehabilitated Translocated cheetahs. K represents the numbers of covariates per model, where model 2 only contains the intercept. Supported models are those with ΔAICc <2. AICc weight, Cumulative weight, and Log likelihood (LL) are also reported.

Model	K	AICc	Delta_AICc	AICcWt	Cum_Wt	LL
1	8	7362.42	0	0.92	0.92	-3672.21
6	5	7368.49	6.07	0.04	0.96	-3678.25
8	7	7368.84	6.41	0.04	1	-3676.42
5	5	7590.05	227.63	0	0.92	-3789.03
9	6	7591.57	229.14	0	1	-3788.78
3	4	7601.51	239.08	0	0.92	-3795.75
7	5	7601.69	239.27	0	0.96	-3794.85
4	4	7602.43	240.01	0	0.92	-3796.22
2	1	7662.43	300.01	0	0.92	-3829.22

Table S10. Ranking of hypotheses on ecological factors associated with step lengths of Wild Rehabilitated Translocated cheetahs. K represents the numbers of covariates per model, where model 2 only contains the intercept. Supported models are those with ΔAICc <2. AICc weight, Cumulative weight, and Log likelihood (LL) are also reported.

Model	K	AICc	Delta_AICc	AICcWt	Cum_Wt	LL
8	7	1121.64	0	0.86	1	-552.82
1	8	1126.35	4.71	0.08	0.082	-554.18
6	5	1127.17	5.53	0.05	0.14	-557.59
7	5	1150.12	28.47	0	0.14	-569.06
4	4	1153.39	31.75	0	0.08	-571.69
5	5	1158.09	36.44	0	0.08	-573.04
9	6	1158.81	37.17	0	1	-572.41
3	4	1165.08	43.43	0	0.08	-577.54
2	1	1226.12	104.48	0	0.08	-611.06

Table S11. Covariates associated with cheetah movements based on supported models ranked in an AIC framework (ΔAIC <2). Estimates for which confidence intervals did not overlap zero are highlighted with an asterisk. Mixed effects model for cheetah class as random intercept.

Hypothesis	Covariate	Estimate	p-value
6	Intercept	-2.54e-11 (+/- 0.91)	1
	Inside	-0.07 (+/- 0.92)	0.94
	Intersection	0.89 (+/- 0.92)	0.34
	Outside	-0.19 (+/- 0.92)	0.83
	Crepuscular	0.28 (+/- 0.03)	<0.001***
	Day	-0.01 (+/- 0.03)	0.66

Table S12. Ranking of hypotheses on ecological factors associated with step lengths all cheetahs with cheetah class as the random intercept. K represents the numbers of covariates per model, where model 2 only contains the intercept. Supported models are those with ΔAIC <2. AIC weight, Cumulative weight, and Log likelihood (LL) are also reported.

Model	K	AIC	Delta_AIC	AICWt	Cum_Wt	LL
6	8	12932.73	0	1	1	-6458.37
1	10	12941.70	8.97	0	0	-6460.85
8	9	12945.03	12.3	0	1	-6463.52
4	6	13521.53	588.8	0	0	-6754.77
7	7	13523.83	591.1	0	1	-6754.91
3	6	13529.12	596.39	0	0	-6758.56
9	8	13540.38	607.65	0	1	-6762.19
5	7	13540.43	607.7	0	0	-6763.22
2	3	13734.34	801.61	0	0	-6864.17

Table S13. R2 values from the mixed effects model for cheetah class as random intercept.

aic	bic	r2.conditional	r2.marginal	icc	rmse	nobs
12932.73	12984.81	0.20	0.15	0.057	0.88	4966

Table S14. Covariates associated with cheetah movements based on supported models ranked in an AIC framework (ΔAIC <2). Estimates for which confidence intervals did not overlap zero are highlighted with an asterisk. Mixed effects model for Individual ID as random intercept.

Hypothesis	Covariate	Estimate	p-value
6	Intercept	-2.52e-11 (+/- 0.92)	1
	Inside	-0.05 (+/- 0.92)	0.96
	Intersection	0.88 (+/- 0.92)	0.34
	Outside	-0.19 (+/- 0.92)	0.83
	Crepuscular	0.29 (+/- 0.03)	<0.001***
	Day	-4.11e-3 (+/- 0.03)	0.90

Table S15. Ranking of hypotheses on ecological factors associated with step lengths all cheetahs with Individual ID as the random intercept. K represents the numbers of covariates per model, where model 2 only contains the intercept. Supported models are those with ΔAIC <2. AIC weight, Cumulative weight, and Log likelihood (LL) are also reported.

Model	K	AIC	Delta_AIC	AICWt	Cum_Wt	LL
6	8	12922.55	0	1	1	-6453.28
1	10	12933.52	10.97	0	0	-6456.76
8	9	12936.86	14.31	0	1	-6459.43
4	6	13494.38	571.82	0	0	-6741.20
7	7	13507.94	575.97	0	1	-6742.27
3	6	13507.94	585.39	0	0	-6747.97
5	7	13518.81	596.26	0	0	-6752.41
9	8	13519.26	596.70	0	1	-6751.63
2	3	13712.95	790.40	0	0	-6853.47

Table S16. R2 values from the mixed effects model for Individual ID as random intercept.

aic	bic	r2.conditional	r2.marginal	icc	rmse	nobs
12922.55	12974.63	0.22	0.15	0.077	0.88	4966

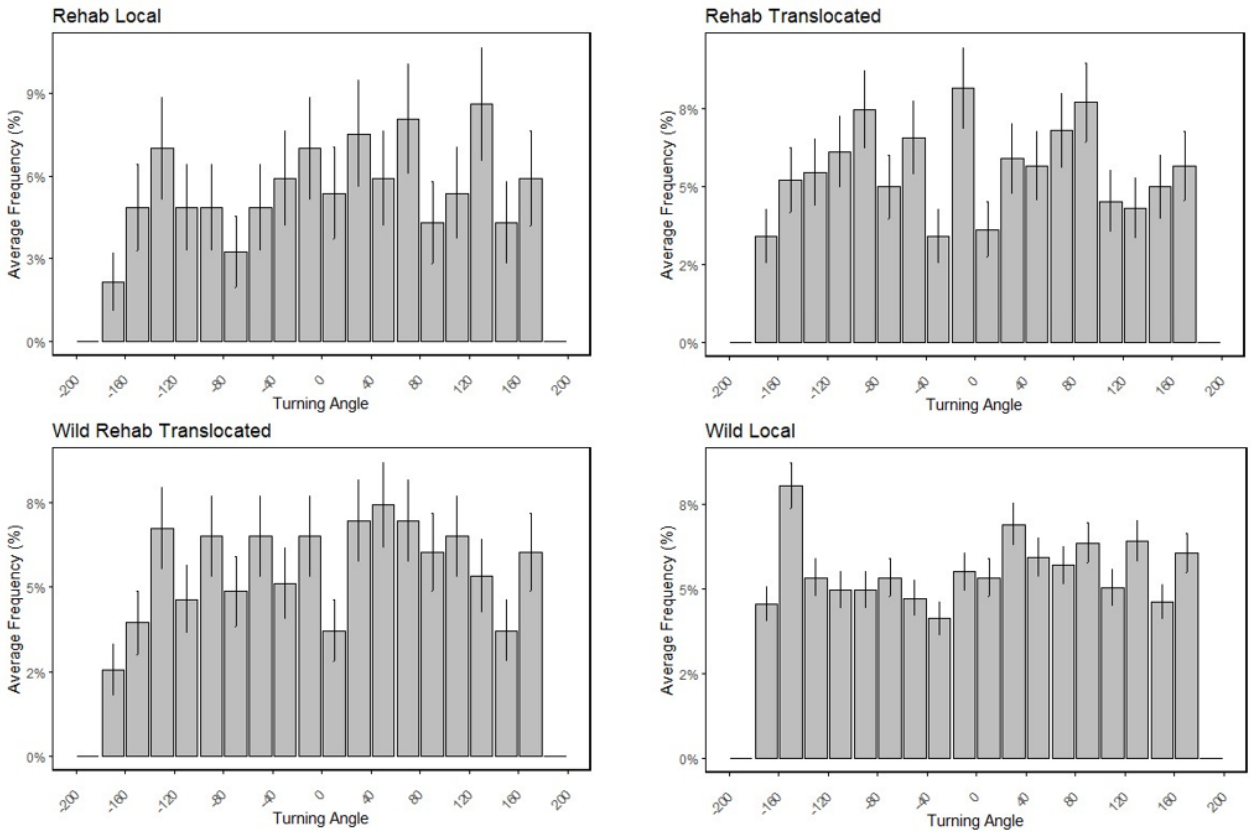

Figure S1. Histograms for turning angles of the four classes of cheetah. Average frequencies of turning angles represented as percentages.