

Supplementary Materials for

Guns, germs, and trees determine density and distribution of gorillas and chimpanzees in Western Equatorial Africa

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Supplementary Materials

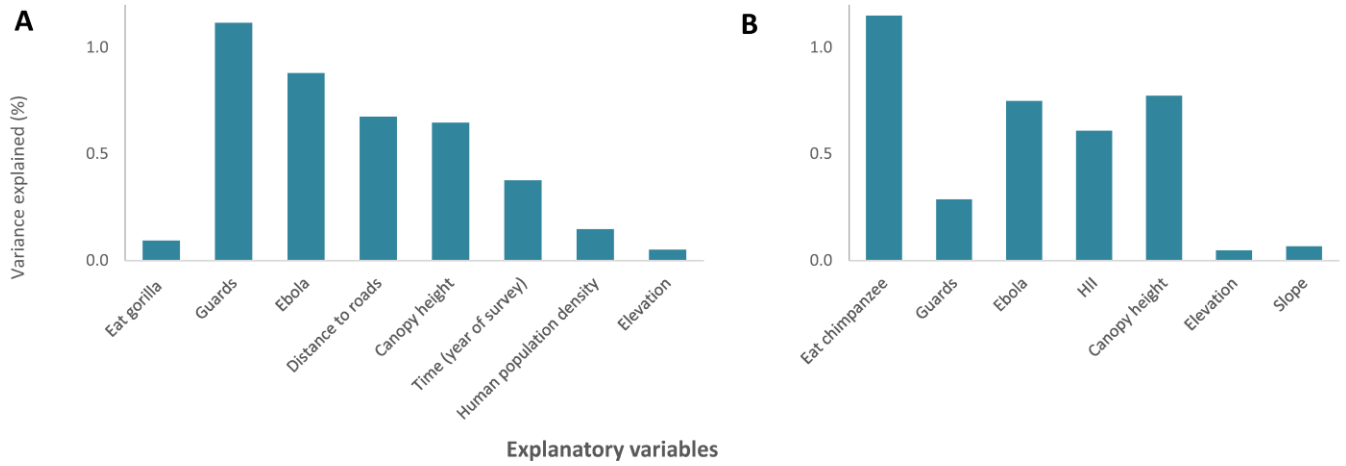


fig. S1. Percentage variance explained by different variables for (A) western lowland gorillas and (B) central chimpanzees.

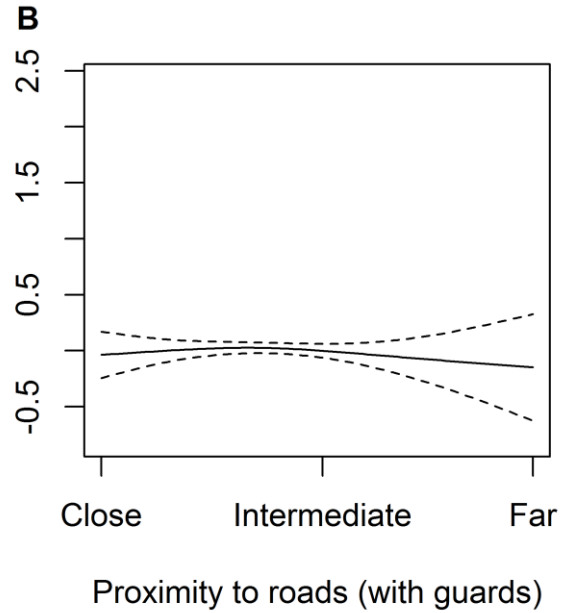
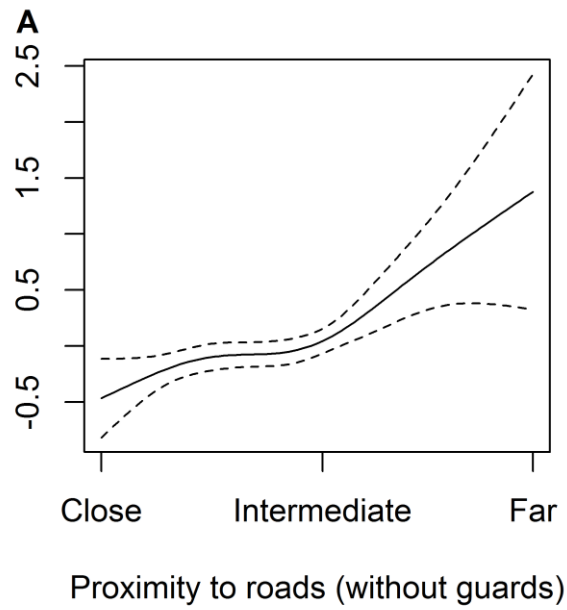


fig. S2. Estimated conditional dependence of chimpanzee nest density on proximity to roads. The y-axis (nest density) is on the scale of the linear predictor with estimates (solid line) and confidence intervals (dashed lines) shown for **(A)** proximity to roads when there are no guards and **(B)** proximity to roads when guards are present.

table S1. Parameter estimates of the top-ranked model used to predict (A) western lowland gorilla and (B) central chimpanzee densities across their range.

A.

Covariate	Category	Estimate	SE	P-value	Signif.
<i>Canopy height</i> (15–25 m)	None	–0.2959	0.2215	0.182	
	1–15 m	–1.3743	0.3447	<0.001	*
	25–35 m	0.3069	0.1373	0.026	‡
	>35 m	0.2812	0.1657	0.090	§
<i>Elevation (high)</i>	Low	0.3801	0.2755	0.067	§
	Medium	0.2632	0.2081	0.206	
<i>Guards (no)</i>	Present	0.6997	0.1074	<0.001	*
<i>Eat gorilla (no)</i>	Yes	–5.5209	3.4534	0.011	‡
<i>Ebola (no)</i>	Yes	–1.5330	0.2582	<0.001	*

Covariate	Interaction	Filter	EDF	P-value	Signif.
<i>Time (year of survey)</i>			2.947	0.003	†
<i>Distance to road</i>	Without guards		1.000	0.023	‡
<i>Distance to road</i>	With guards		2.344	0.004	†
<i>HPD</i>		Not E. Guinea	2.871	0.039	‡
<i>Latitude, Longitude</i>			28.285	<0.001	*

B.

Covariate	Category	Estimate	SE	P-value	Signif.
<i>Canopy height</i> (15–25 m)	None	–0.7451	0.2432	0.002	†
	1–15 m	–0.9491	0.3042	0.002	†
	25–35 m	0.2611	0.1570	0.014	‡
	>35 m	0.3594	0.1767	0.003	†
<i>Slope (<0.5°)</i>	0.5–2.5°	–0.0719	0.1270	0.571	
	2.5–10°	–0.1766	0.1413	0.071	§
	>10°	–0.0536	0.2070	0.795	
<i>Elevation (high)</i>	Low	–0.2111	0.2962	0.476	
	Medium	0.0336	0.2054	0.870	
<i>Guards (no)</i>	Present	0.3894	0.1174	<0.001	*

<i>Eat chimpanzee</i> (no)	Yes	-3.4093	0.5554	<0.001	*
<i>Ebola</i> (no)	Yes	-1.3726	0.2776	<0.001	*
Covariate	Interaction	Filter	EDF	P-value	Signif.
<i>HII</i>	Cameroon/Congo/Gabon		4.682	0.006	†
<i>HII</i>	CAR		2.001	0.032	‡
<i>HII</i>	E. Guinea		1.001	0.245	
<i>Latitude, Longitude</i>			28.671	<0.001	*

The following are shown for each parametric coefficient in the model: covariate name (with reference categories), estimate, associated standard errors (SE). Any interaction or filtering terms, and estimated degrees of freedom are shown for each smooth term in the model, namely *Time* (year of survey), *Distance to road*, *Human population density (HPD)*, *Human Influence Index (HII)*, and geographic location (*Latitude, Longitude*). P-values indicating the statistical significance of each term in the model, and significance codes are given (Significance: ‘*’<0.001, ‘†’<0.01, ‘‡’<0.05 and ‘§’<0.1)

table S2. Survey effort for the 82 survey sites included in the analysis.

Survey effort	Cameroon	CAR	Congo	Equatorial Guinea	Gabon	Angola	Totals
No. of surveys	20	1	39	1	21	0	82
% of survey effort	33.3	3.5	30.9	2.7	29.5	0	8,692 km
% total area surveyed	12.9	2.5	44.8	13.5	26.3	0	185,973 km ²

table S3. Details of the 82 survey sites included in the analysis. Site type: BR – biosphere reserve; CR – community reserve; LC – logging concession; NC – not classified; NP – national park; RS – presidential reserve; WR – wildlife reserve; WS – wildlife sanctuary

No.	Country	Survey site	Site type	Survey year	Survey area (km ²)	No. transect or recce sections	Effort (km)	Survey method	Effective strip width (m): chimps	Effective strip width (m): gorillas	No. of chimp nests	No. of gorilla nests	Guards
1	Cameroon	Boumba Bek	NP	2004	2389	47	46	Transects	12.17	3.36	53	85	Yes
2	Cameroon	Boumba Bek	NP	2012	2079	106	105	Transects	12.17	4.37	118	105	Yes
3	Cameroon	Deng Deng	NC	2009	358	26	52	Transects	11.56	7.03	3	72	Yes
4	Cameroon	Deng Deng	NP	2012	384	29	58	Transects	11.56	11.49	9	134	Yes
5	Cameroon	Lobéké	NP	2009	213	85	219	Transects	9.99	2.65	52	119	Yes
6	Cameroon	Mbam Djerem	NP	2007	1037	156	156	Recces	12.18	12.27	0	0	Yes
7	Cameroon	Mbam Djerem	NP	2009	1037	127	117	Recces	12.18	12.27	0	0	Yes
8	Cameroon	Ngoila Mintom	LC	2011	9829	376	920	Transects	10.53	2.73	800	1004	No
9	Cameroon	Nki	NP	2004	3235	256	240	Transects	7.78	1.57	126	227	Yes
10	Cameroon	UFA 10-008	LC	2005	730	77	75	Transects	9.99	1.09	15	33	No
11	Cameroon	UFA 10-009	LC	2005	917	91	91	Transects	9.99	1.09	25	50	No
12	Cameroon	UFA 10-010	LC	2005	669	70	69	Transects	9.99	1.09	13	26	No
13	Cameroon	UFA 10-012	LC	2005	590	76	75	Transects	9.99	1.09	7	14	No
14	Cameroon	UFA 10-013	LC	2003	507	51	52	Transects	9.99	3.43	52	84	No
15	Cameroon	UFA 10-021	LC	2003	660	120	61	Transects	10.53	2.73	32	54	No
16	Cameroon	UFA 10-023	LC	2006	580	86	89	Transects	10.53	2.73	14	19	No
17	Cameroon	UFA 10-064	LC	2004	1155	124	119	Transects	9.99	2.25	73	112	No
18	Cameroon	UFA 100-65	LC	2008	1029	179	178	Recces	11.56	4.69	0	66	No

19	Cameroon	UFA 100-65	LC	2010	449	28	82	Transects	11.56	4.69	2	49	No
20	Cameroon	UFA 100-65	LC	2012	500	30	90	Transects	11.56	4.69	3	86	No
21	CAR	Dzanga	NP	2012	4620	146	307	Transects	14.39	4.03	224	337	Yes
22	Congo	Bailly North	NC	2006	4210	13	27	Transects	23.32	9.49	47	61	Yes
23	Congo	Bailly North	NC	2011	4210	30	90	Transects	20.17	8.31	32	338	Yes
24	Congo	Bailly South	NC	2011	1920	15	36	Transects	20.17	8.31	16	47	No
25	Congo	Batanga	NC	2007	1087	21	42	Transects	23.32	16.06	13	344	Yes
26	Congo	Batanga	NC	2012	1087	29	73	Transects	23.32	16.14	0	544	Yes
27	Congo	Conkouati	NP	2010	4520	111	233	Transects	20.17	8.31	290	970	Yes
28	Congo	Conkouati	NP	2013	4520	148	72	Transects	9.90	7.38	209	39	Yes
29	Congo	Dimonika	BR	2009	867	50	50	Transects	17.29	6.64	57	49	No
30	Congo	Kabo & Pokola	LC	2006	7277	37	74	Transects	20.17	8.31	181	192	Yes
31	Congo	Kabo & Pokola	LC	2010	7277	37	93	Transects	20.17	8.31	153	538	Yes
32	Congo	Impfondo	NC	2008	1382	22	46	Transects	23.32	7.48	30	47	No
33	Congo	Lac Télé north	CR	2006	2755	29	58	Transects	23.32	9.49	61	390	Yes
34	Congo	Lac Télé north	CR	2011	2755	33	66	Transects	20.17	8.31	44	426	Yes
35	Congo	Lac Télé south	CR	2006	1380	24	47	Transects	23.32	9.49	9	52	Yes
36	Congo	Lac Télé south	CR	2011	1380	14	35	Transects	20.17	8.31	23	10	Yes
37	Congo	Lossi-Kelle	WS	2006	5052	45	45	Transects	20.69	6.49	0	2	Yes
38	Congo	Loundougou terra firma	LC	2006	2210	14	28	Transects	23.32	9.49	65	45	Yes
39	Congo	Loundougou terra firma	LC	2010	2210	34	68	Transects	20.17	8.31	116	125	Yes
40	Congo	Loundougou swamps	LC	2006	2515	7	12	Transects	23.32	9.49	17	8	Yes
41	Congo	Loundougou swamps	LC	2010	2515	28	56	Transects	20.17	8.31	66	156	Yes
42	Congo	Messok-Dja	LC	2013	1457	33	67	Transects	16.17	5.86	75	75	No

43	Congo	Mokabi	LC	2006	2669	15	29	Transects	23.32	9.49	7	8	No
44	Congo	Mont Fouari	WR	2005	816	184	169	Recces	17.29	6.64	0	13	No
45	Congo	Ngombe-Ntokou-Pikounda	LC	2007	17731	78	156	Transects	19.99	5.46	337	730	Yes
46	Congo	NNNP south	NP	2006	2696	14	31	Transects	23.32	9.49	65	46	Yes
47	Congo	NNNP south	NP	2010	2696	32	80	Transects	20.17	8.31	193	83	Yes
48	Congo	NNNP north	NP	2006	1266	6	12	Transects	23.32	9.49	95	27	Yes
49	Congo	NNNP north	NP	2010	1266	32	80	Transects	20.17	8.31	187	125	Yes
50	Congo	Odzala north	NP	2005	6086	30	30	Transects	20.69	6.49	7	27	Yes
51	Congo	Odzala north	NP	2012	6086	41	103	Transects	20.69	6.49	27	93	Yes
52	Congo	Odzala south	NP	2005	7681	43	43	Transects	20.69	6.49	50	210	Yes
53	Congo	Odzala south	NP	2008	7681	39	64	Transects	20.69	6.49	134	203	Yes
54	Congo	Odzala south	NP	2012	7681	42	105	Transects	20.69	6.49	135	270	Yes
55	Congo	Ogooué-Leketi	LC	2009	1484	29	73	Transects	18.92	19.55	168	93	Yes
56	Congo	Sangha	LC	2006	1015	8	14	Transects	23.32	9.49	38	31	Yes
57	Congo	Sangha	LC	2010	1015	25	75	Transects	20.17	8.31	80	163	Yes
58	Congo	Tanga	NC	2009	2789	43	160	Transects	23.32	14.59	7	325	No
59	Congo	Tchimpounga	WS	2009	239	48	24	Transects	15.93	8.31	192	0	No
60	Congo	Zanaga	LC	2012	2276	41	123	Transects	18.92	19.55	245	109	Yes
61	E. Guinea	Nationwide	NC	2011	25169	83	235	Transects	17.86	7.95	304	55	No
62	Gabon	Batéké	NP	2006	2037	411	411	Recces	18.92	19.55	12	0	Yes
63	Gabon	Birougou	NP	2006	1977	40	81	Transects	20.19	16.26	105	207	Yes
64	Gabon	Ivindo	NP	2004	2972	75	42	Transects	18.72	17.42	20	56	Yes
65	Gabon	Ivindo	NP	2008	2972	27	68	Transects	14.41	6.98	98	50	Yes
66	Gabon	Ivindo buffer south	LC	2009	921	22	49	Transects	18.72	9.9	57	63	Yes

67	Gabon	Kivoro	LC	2008	2511	177	168	Transects	15.13	15.13	36	39	No
68	Gabon	Loango	NP	2006	1907	212	213	Transects	19.24	15.23	91	124	Yes
69	Gabon	Lopé	NP	2004	4445	47	36	Transects	17.08	8.11	38	35	Yes
70	Gabon	Lopé	NP	2008	4445	49	125	Transects	17.08	8.11	357	267	Yes
71	Gabon	Lopé-Waka corridor	LC	2008	2910	24	60	Transects	23.99	19.19	144	66	Yes
72	Gabon	Mayombe	LC	2010	2716	37	93	Transects	19.24	15.23	24	202	No
73	Gabon	Mayumba	NP	2011	266	66	63	Recces	19.24	15.23	99	52	Yes
74	Gabon	Minkébé	NP	2004	7544	60	69	Transects	10.53	6.49	14	25	Yes
75	Gabon	Minkébé	NP	2012	11539	13	39	Transects	10.53	6.49	9	2	Yes
76	Gabon	Moukalaba-Doudou	NP	2011	609	60	177	Transects	23.32	9.49	101	502	Yes
77	Gabon	Monts de Cristal	NP	2005	5096	404	408	Recces	10.47	8.86	546	154	No
78	Gabon	Mwagné	NP	2004	3160	80	80	Recces	10.53	6.49	0	25	Yes
79	Gabon	Mwagné	NP	2012	1581	12	25	Transects	10.53	6.49	5	0	Yes
80	Gabon	Pongara	NP	2006	722	39	36	Transects	19.24	15.23	2	23	Yes
81	Gabon	Waka	NP	2006	1066	289	301	Recces	23.99	19.19	362	884	Yes
82	Gabon	Wonga Wongué	PR	2011	4025	9	23	Transects	19.24	15.23	5	3	Yes