

# The impact of forest logging and fragmentation on carnivore species composition, density and occupancy in Madagascar's rainforests

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APPENDIX 1 Top models (model likelihood > 0.125) using the maximum-likelihood spatially-explicit capture-recapture method to estimate density of the fossa *Cryptoprocta ferox* and Malagasy civet *Fossa fossana* in primary and selectively-logged contiguous rainforest in Madagascar's eastern rainforests (Fig. 1) during May–October 2008 and October–December 2009, respectively.

	Models*	AIC <sub>c</sub>	ΔAIC <sub>c</sub>	w <sub>i</sub>	Model likelihood	k	Deviance
<b><i>Cryptoprocta ferox</i></b>							
Primary	HalfNormal g <sub>0</sub> (Sex) σ(.)	865.61	0.00	0.446	1.00	3	839.27
	HalfNormal g <sub>0</sub> (H) σ(.)	865.66	0.05	0.435	0.98	3	839.32
	HalfNormal g <sub>0</sub> (.) σ(.)	868.42	2.81	0.109	0.25	2	842.08
Selectively-logged	NegExp g <sub>0</sub> (H) σ(H)	438.14	0.00	0.713	1.00	4	465.41
	NegExp g <sub>0</sub> (Sex) σ(Sex)	442.02	3.88	0.102	0.14	4	469.29
<b><i>Fossa fossana</i></b>							
Primary	Hazard Rate g <sub>0</sub> (Sex) σ(H)	3,858.47	0.00	0.99	1.00	6	3,782.57
Selectively-logged	NegExp g <sub>0</sub> (Sex + Lure) σ(H)	2,479.68	0.00	0.99	1.00	6	2,426.87

\*Distance functions: g<sub>0</sub>, the detection probability when a single trap is located at the centre of an animal's home range; σ, the spatial scale detection probability away from the centre of the home range; Sex, males vs females; Lure, chicken meat used as a scent lure and unavailable for consumption by carnivores; H, individual heterogeneity

APPENDIX 2 Top models (model likelihood > 0.125) of site occupancy and detection probability for native and exotic carnivores in eastern Madagascar in two contiguous (primary and selective-logged) and two fragmented (< 2.5 and > 15 km from contiguous forest) rainforests (Fig. 1) during May–October 2008 and October–December 2009, respectively.

Species	Models*	AIC <sub>c</sub>	ΔAIC <sub>c</sub>	w <sub>i</sub>	Model Likelihood	k	–2*log likelihood
<b>Contiguous forest</b>							
<i>Canis familiaris</i>	ψ(DistVillage) p(Locals)	235.92	0.00	0.61	1.00	4	227.92
	ψ(Grid + DistVillage),p(Locals)	237.65	1.73	0.26	0.42	5	227.65
<i>C. ferox</i>	ψ(Grid + Locals) p(Trail + DistMatrix)	993.86	0.00	0.41	1.00	6	981.86
	ψ(Locals) p(Trail + DistMatrix)	995.92	2.06	0.15	0.36	5	985.92
	ψ(.) p(Trail + DistMatrix)	997.21	3.35	0.08	0.19	4	989.21
	ψ(Grid) p(Trail + DistMatrix)	998.02	4.16	0.05	0.13	5	988.02
<i>F. fossana</i>	ψ(.) p(Lure)	3434.08	0.00	0.99	1.00	3	3428.08
<i>Galidictis fasciata</i>	ψ(Grid + BasalArea)	528.36	0.00	0.92	1.00	6	515.21
	p(DistMatrix + Dogs)						
<b>Fragmented forest</b>							
<i>Canis familiaris</i>	ψ(Grid) p(Locals + ForestType + Lure)	1278.88	0.00	0.84	1.00	6	1266.88
	ψ(.) p(Locals + ForestType + Lure)	1282.34	3.46	0.15	0.18	5	1270.34
<i>Felis spp.</i>	ψ(DD) p(Dog)	373.05	0.00	0.66	1.00	4	364.22
	ψ(Grid + DD) p(Dog)	375.29	2.24	0.22	0.33	5	364.01
<i>Galidia elegans elegans</i>	ψ(ForestType) + Cat p(Grid)	973.43	0.00	0.85	1.00	5	962.25
<i>Galidictis fasciata</i>	ψ(Area) p(Grid)	456.53	0.00	0.99	1.00	4	447.76
<i>Viverricula indica</i>	ψ(ForestType + Locals) p(ForestType)	541.85	0.00	0.40	1.00	5	531.85
	ψ(ForestType) p(ForestType)	542.93	1.08	0.23	0.58	4	534.93
	ψ(ForestType + Cat) p(ForestType)	544.33	2.48	0.12	0.29	5	534.33
	ψ(ForestType + Dog) p(ForestType)	544.72	2.87	0.10	0.24	5	534.72

\*ψ, occupancy; p, detection probability; area, rainforest fragment area; BasalArea, basal area; Cat, *Felis spp.* trap success; DD, down/dead cover; DistMatrix, closest distance to non-rainforest; DistVillage, distance to closest village; Dog, *C. familiaris* trap success; ForestType, difference at fragmented grids between rainforest habitat and matrix; Grid, difference between contiguous rainforest grids or fragmented rainforest grids; Locals, people photographed by camera trap; Lure, effect of using lure vs not using in only selectively-logged and fragments < 2.5 km grids; Trail, maintained trails vs small trails

APPENDIX 3 Regression coefficients of occupancy analyses ( $\beta \pm SE$ ) for the top model for each carnivore species in two contiguous and two fragmented Sites in Madagascar's eastern rainforests (Fig. 1) during May–October 2008 and October–December 2009, respectively. For each parameter an empty cell indicates the parameter was not in the top model and bold indicates the estimate is statistically different from zero and that the parameter had a positive or negative influence on a species' occupancy.

Parameter <sup>1</sup>	<i>C. familiaris</i>	<i>C. ferrox</i> <sup>2</sup>	<i>Felis</i> spp. <sup>3</sup>	<i>F. fossana</i> <sup>3</sup>	<i>G. e. elegans</i> <sup>4</sup>	<i>G. fasciata</i>	<i>V. indica</i> <sup>3</sup>
<b>Contiguous forest</b>							
Intercept	-0.91 ± 0.51	1.85 ± 1.43		<b>3.95 ± 1.10</b>		-0.17 ± 0.42	
BasalArea						<b>0.99 ± 0.38</b>	
DistVillage	<b>-1.21 ± 0.54</b>						
Grid		2.33 ± 1.27				-0.10 ± 0.45	
Locals		3.15 ± 2.62					
<b>Fragmented forest</b>							
Intercept	0.188 ± 0.40		1.30 ± 1.17		1.19 ± 0.72	<b>6.34 ± 3.13</b>	0.28 ± 1.42
Area						<b>12.05 (4.74)</b>	
Cat					<b>-1.84 ± 0.80</b>		
DD			4.17 ± 2.17				
ForestType					<b>-2.71 ± 1.09</b>		<b>2.63 ± 1.06</b>
Grid	<b>1.18 ± 0.44</b>						
Locals							5.86 ± 8.37

<sup>1</sup>Area, rainforest fragment area; BasalArea, basal area; Cat, *Felis* spp. trap success; DD, down and dead cover; DistVillage, distance to closest village; ForestType, difference in fragmented areas between rainforest (1) and matrix (0); Grid, difference between fragmented areas (fragments > 15 km (0) and fragments < 2.5 km (1)) or contiguous rainforest (primary (0) and selectively-logged (1)); Locals, people photographed by camera trap

<sup>2</sup>*C. ferrox* was detected in the fragmented sites but no or few recaptures precluded occupancy estimation

<sup>3</sup>Species was not detected in either the contiguous or fragmented sites

<sup>4</sup>*G. e. elegans* was detected in both contiguous forests but naïve occupancy = 1 in these areas, thus precluding modelling