The impact of forest logging and fragmentation on the species richness and density of Malagasy rainforest carnivores

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Fossa *(Cryptoprocta ferox)*

Outline

Introduction

Study Objective

Study Area

General Methodology

Results

Conservation Implications

Why Madagascar?




- One of the most biologically rich areas on the planet.
  - Endemic: 78% of vertebrates, 100% of primates, 83% of plants

- ≈14% of primary forests remain; highly fragmented
  - Slash and burn agriculture, mining, and logging

Conservation International, 2010; Gautier and Goodman 2003; Harper et al., 2007; Mittermier et al. 2008

Why Malagasy Carnivores?

- Carnivores exert significant influence on ecosystem structure and function

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- 100% endemic, Family Eupleridae (9 species)
- IUCN listed as vulnerable to endangered and thought to be declining
- Very little is known
  - Abundance, diet, micro-habitat associations, anthropogenic impacts

Gerber et al.,2010; IUCN 2010; Noss et al. 1996; Terborgh et al. 1999

Fossa
(*Cryptoprocta ferox*)

Small-toothed Civet
(Eupleres goudotii)

Malagasy Civet
(*Fossa fossana*)

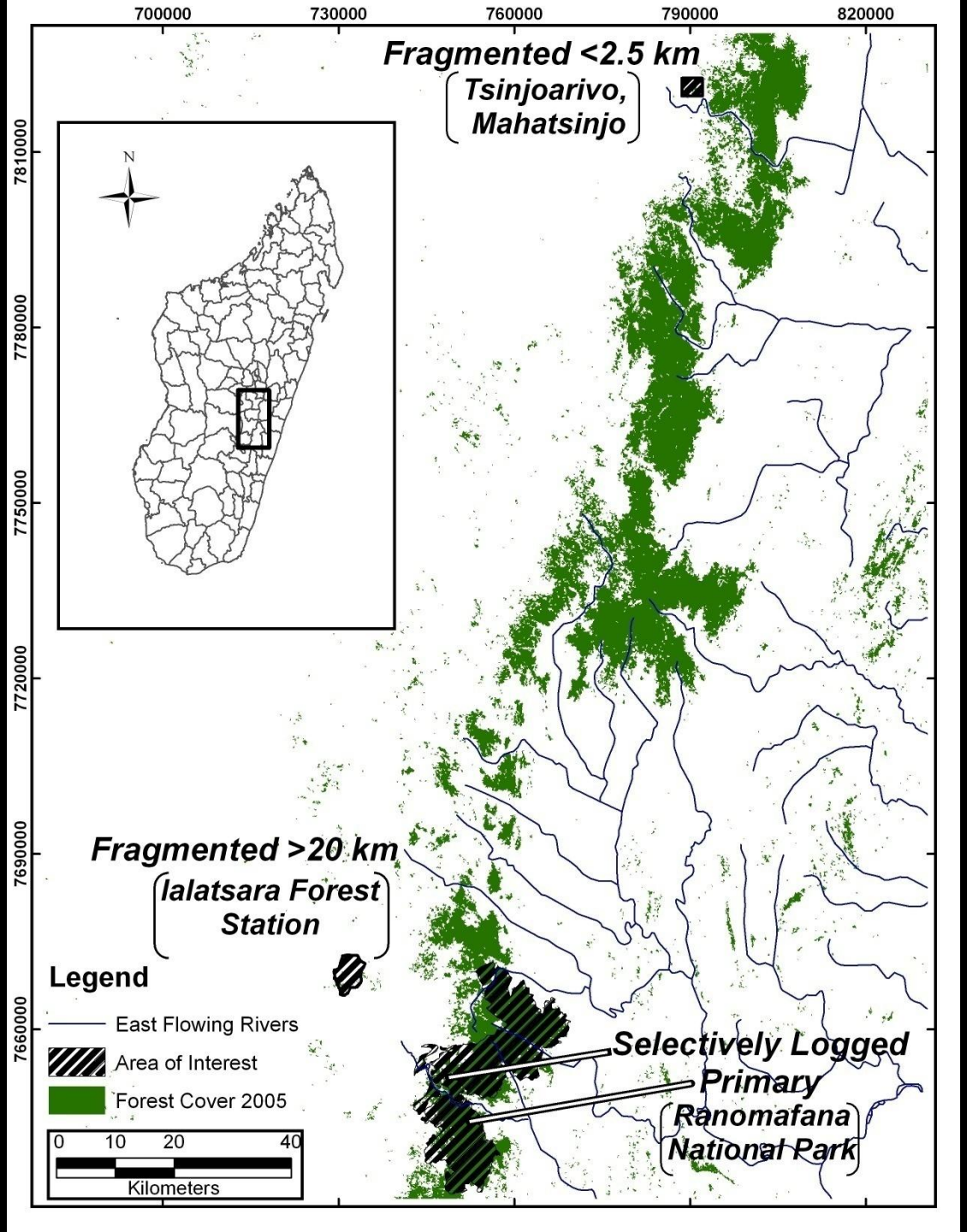
Ring-tailed Mongoose
(*Galidia elegans*)

Broad-striped Mongoose
(*Galidictis fasciata)*

Objective:

1. Estimate carnivore richness and density across a gradient of rainforests with increasing anthropogenic disturbance

   ↓ Primary
   ↓ Selectively-Logged } Contiguous
   ↓ Fragmented <2.5 km
   ↓ Fragmented >20 km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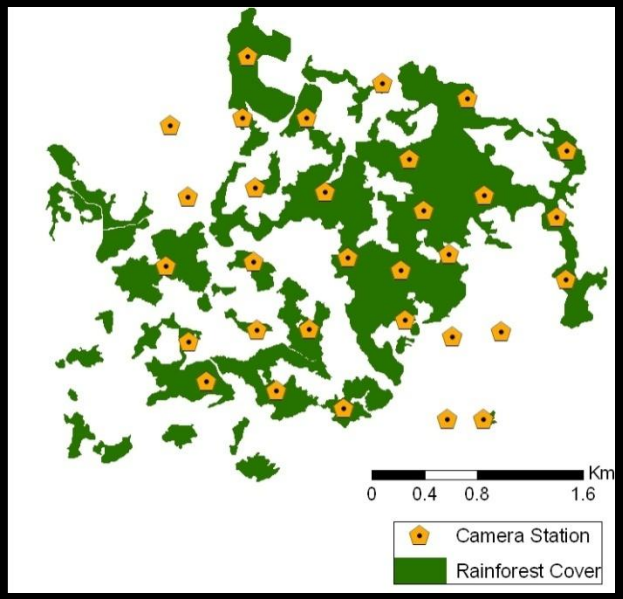
Fragmented >20 km
Ialatsara Forest Station
Selectively Logged Primary
Ranomafana National Park
Legend
East Flowing Rivers
Area of Interest
Forest Cover 2005
0 10 20 40
Kilometers

METHODS

Photographic-Sampling Design

Systematic Grid:

- ≥26 camera stations/grid
- 2 cameras/station
- ≈ 550 m camera station spacing
- > 50 days/grid for > 1300 trap nights



Example Grid: Fragments <2.5 km

Deercam DC300 (Film)

Reconyx PC85 (Digital)

Carnivore Richness

$$n = \frac{\ln(0.05)}{\ln(1-p)}$$

p = Capture Events/Trap Nights per species
n = Camera trap nights needed for 95% probability of a single detection

Tobler et al. 2008

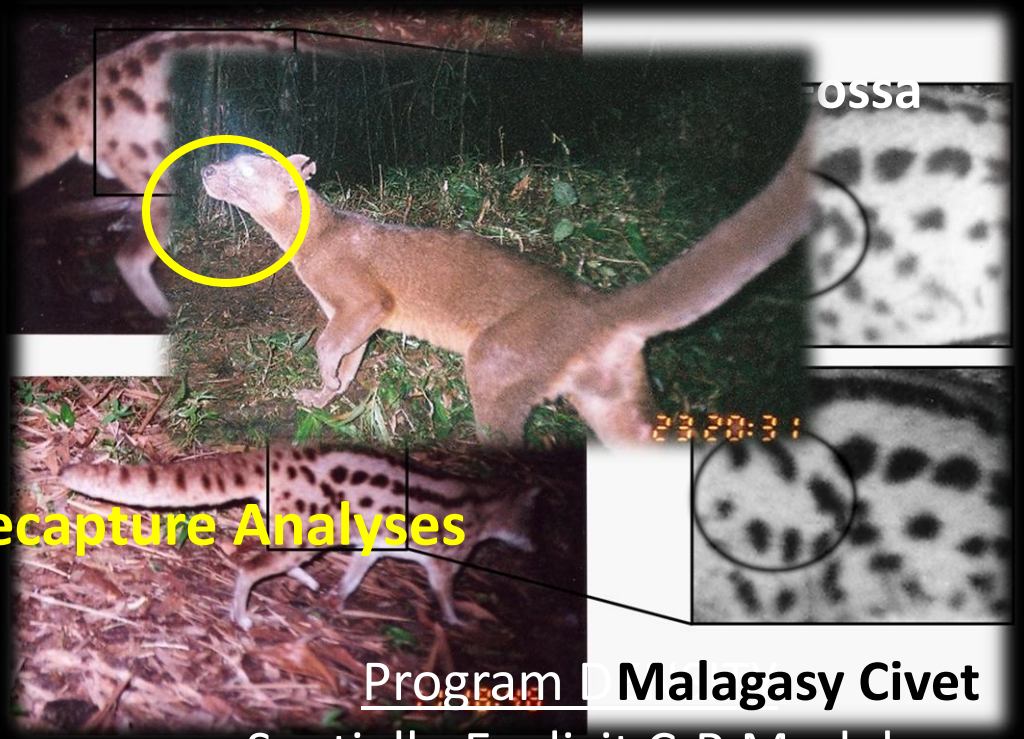
Abundance and Density Analyses

Photographic Capture of Carnivores

Individual Identification:

Capture Histories

(010110)



Capture-Recapture Analyses

Program MARK

Huggins Closed C-R Model

↓

Abundance Estimate

↓

Effective Sampling Area (MMDM)

↓

Density Estimate

Program D

Spatially-Explicit C-R Model

↓

Density Estimate

Mark-Recapture Analyses

Variables affecting detection probability

- Behavior (Trap happy vs. Trap shy)
- Camera Grid
- Heterogeneity (Pledger's mixture model)
- Mean distance to camera grid edge
- Sex
- Time

Program MARK (Malagasy Civet)

Model Selection	AIC_c	ΔAIC_c	w_i	Model Likelihood	Deviance
Grid+Behav+Het+DistEdge	619.76	0.00	0.67	1.00	609.68
Grid+Behav+Het+DistEdge+Sex	621.39	1.62	0.29	0.44	609.26
Grid+Behav+Het	626.42	6.67	0.02	0.04	618.36

RESULTS

Carnivore richness across rainforest sites

- Primary (contiguous): 5 native, 1 exotic
- Selectively-Logged (contiguous): 5 native, 1 exotic
- Fragmented <2.5 km: 3 native, 3 exotic
- Fragmented >20 km: 2, native, 3 exotic

Binomial Model: <1300 Trap Nights Needed
(95% probability of detection for each species across sites)

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Broad-striped Mongoose
(*Galidictis fasciata)*

Domestic Dog
(*Canis familiaris*)

Exotic-Small Indian Civet
(*Viverricula indica*)

Exotic-Wild Cat
(*Felis silvestris*)

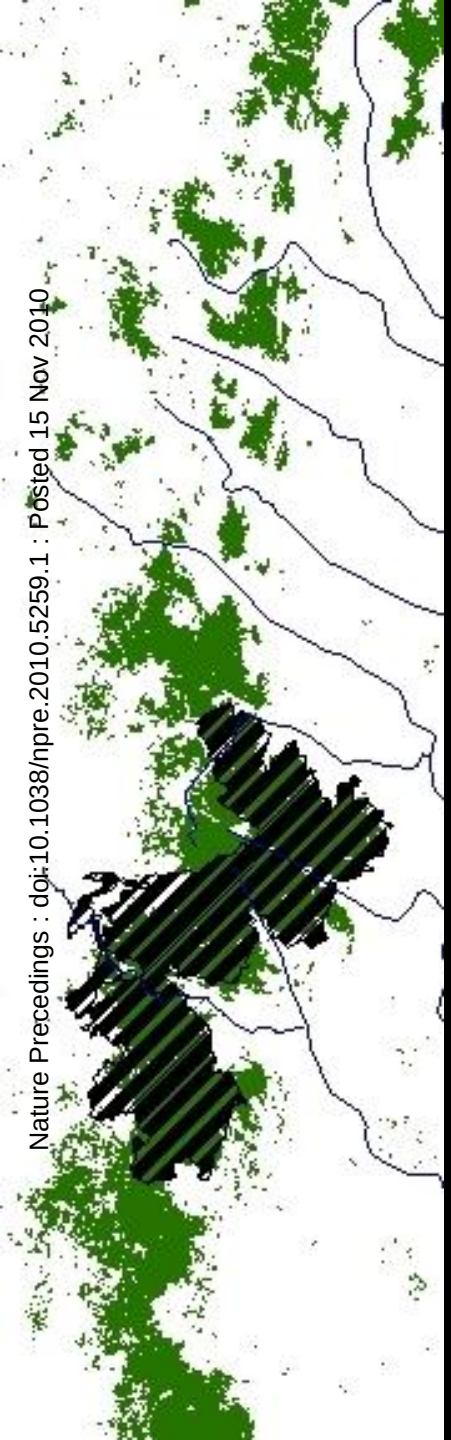
Density Variation

Malagasy Civet
(Individuals / km²)

Fossa
(Adults / km²)

Rainforest Site	MMDM Density	Spatial DENSITY	MMDM Density	Spatial DENSITY
Primary	2.47 ± 0.13 **A**	3.19 ± 0.55 **A**	0.14 ± 0.001 **D**	0.12 ± 0.05 **DE**
Selectively-Logged	1.23 ± 0.06 **B**	1.38 ± 0.22 **B**	0.09 ± 0.002 **E**	0.09 ± 0.04 **DE**
Fragmented <2.5 km	0 **C**	0 **C**	> 0	> 0
Fragmented >20 km	0 **C**	0 **C**	0 **C**	0 **C**

Nature Precedings : doi:10.1



Conclusions / Conservation Implications

- Disturbance sensitivity species-specific (body-size)
- Decreasing density and native carnivore richness with increasing anthropogenic disturbances

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- Rainforest fragments are limited conservation value for Malagasy carnivores
- Fragments may maintain connectedness of carnivore populations across the landscape.
- Restoring connectivity of protected areas and remaining forests is critical to carnivore conservation

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Questions?