Drivers of Diel Activity in Tropical Mammals

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Factors affecting mammal's behavior

- Mammal's behavior is shaped by both their internal biological clock and external environmental conditions (Kronfeld-Schor & Dayan, 2003).
- External factors that influence activity are: (Aschoff, 1960; Kronfeld-Schor & Dayan, 2003)
  - Food availability
  - Temperature
  - Social interactions
  - Traits
  - Presence of predators

Threats to mammalian habitats

Habitat fragmentation:

"**A large expanse of habitat is transformed into a number of smaller patches of smaller total area, isolated from each other by a matrix of habitats unlike the original**" (Wilcove et al., 1986).

Effects of habitat fragmentation on mammals:

- lower probability of species presence (Chad et al., 2025)
- shift their daily activity patterns (Gaynor et al., 2018; Lee et al., 2024)
- alter predator–prey relationships (Chad et al., 2025)
- increase interspecific competition (Manlick and Pauli, 2020)

Brazilian Amazon photographed by Georg Gerster

How do we study the mammals?

- Camera Trapping as a tool.
- Use of photographic trapping rate (i.e., the number of independent photographs/number of days camera was active) as a proxy to estimate species abundance (Carbone et al., 2001; Debata & Swain, 2018).
- Information on presence-absence data correlates well with population size and can be used to track population trends (Joseph et al., 2006; Pollock, 2006; Ewing & Gangloff, 2016).
- Animal activity involves quantifying how species distribute their behavior across different times of the day.

Problem statement

- Wildlife may not completely avoid human presence and face tradeoffs in allocating their time.
- Fragmented habitats restricts apex predators' movement and disrupt ecosystem functions and services they play (Banks-Leite 2020).
- Most studies have concentrated on protected areas or heavily disturbed sites (e.g. Paemelaere et al., 2025; Harris et al., 2023; Pierre et al., 2020; Pickles et al., 2011).
- There are at least two gaps in understanding…
  - How different external factors affects mammalian behaviors.
  - How different factors are influencing apex predators' presence with their prey
  - How different human presence affect the mammalian behavior and distribution.

To develop conservation strategies that respect cultural traditions while ensuring species sustainability.

To assess their behavioral adaptations and coexistence.

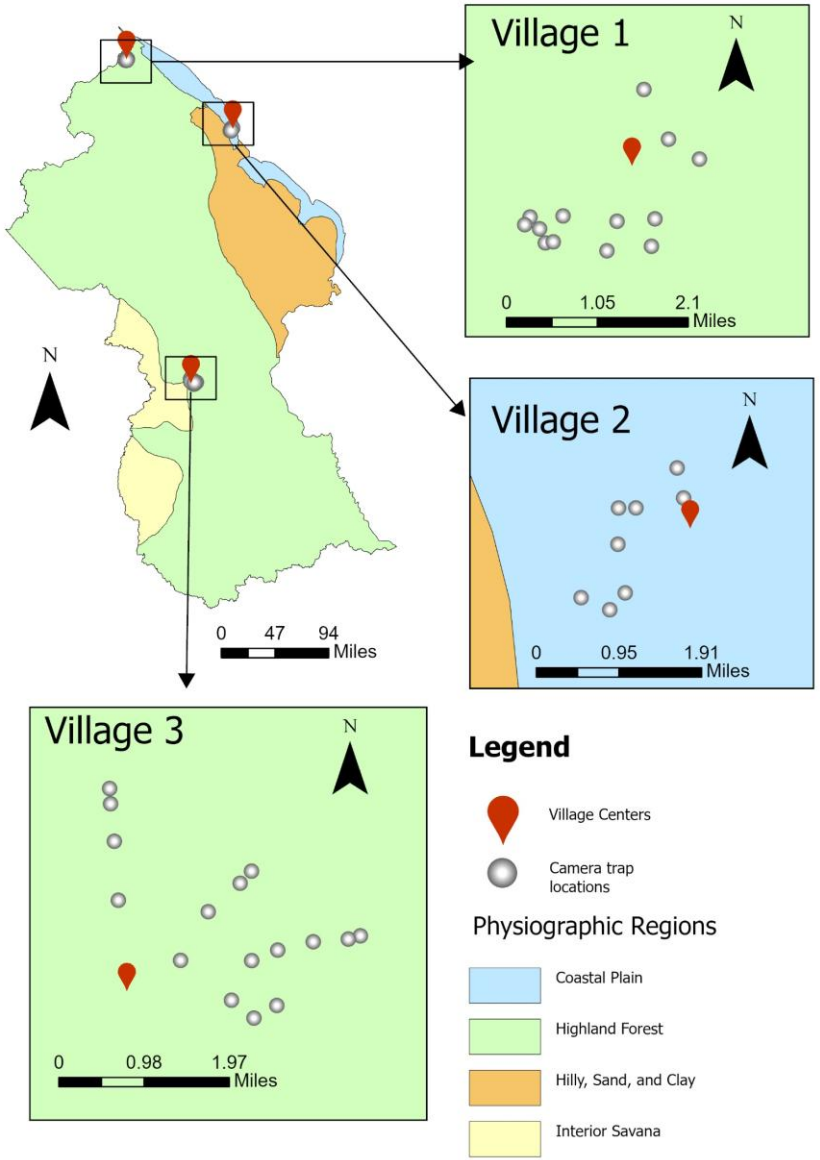
Animal behavior often provides the first warning signs of environmental degradation.

Forests in Guyana

- Guyana has 94% of its total land covered by forest (FAO, 2020).
- Guyana's forests remain largely intact and undisturbed (Guyana Forestry Commission, 2007).

Study areas peoples

- The rainforests are central to the lives of Guyana's nine Indigenous groups, also referred to as Amerindians, the pre-colonial inhabitants of the region.
- The Indigenous groups practice traditional lifestyles such as subsistence farming, hunting, and fishing.
- The subsistence farming method practiced by indigenous groups, referred to as swidden agriculture (Cummings et al., 2017; Arwida et al., 2024).
- Intensification from shortened fallow periods has raised concerns over habitat degradation and biodiversity loss (Henley, 2011; Li et al., 2014; Finch et al., 2022).
- Guyana's interior, rich in timber and minerals, drives extraction and road expansion, increasing human access. (Guyana Lands and Surveys Commission, 2013; Pierre et al., 2020).



Study Area

- Village 1: Mix of commercial agriculture + traditional swidden cassava cultivation.
- Village 2: High human influences — commercial pineapple, logging, and gold mining.
- Village 3: Low influences — traditional swidden cassava farming for subsistence.

Camera trap setup

- This study uses camera-trap data collected between December 2022 and March 2024.
- Animal species were manually identified from the camera trap images
- A new sighting was counted when 30 minutes passed between two photos of the same species at the same camera (Sollmann, 2018; O'Brien et al., 2003; Kelly & Holub, 2008).

Mammalian species recorded using camera traps:

(A) *Panthera onca*,

(B) *Puma concolor*,

(C) *Leopardus pardalis*,

(D) *Eira barbara*,

(E) *Tapirus terrestris*,

(F) *Myrmecophaga tridactyla*,

(G) *Pecari tajacu*,

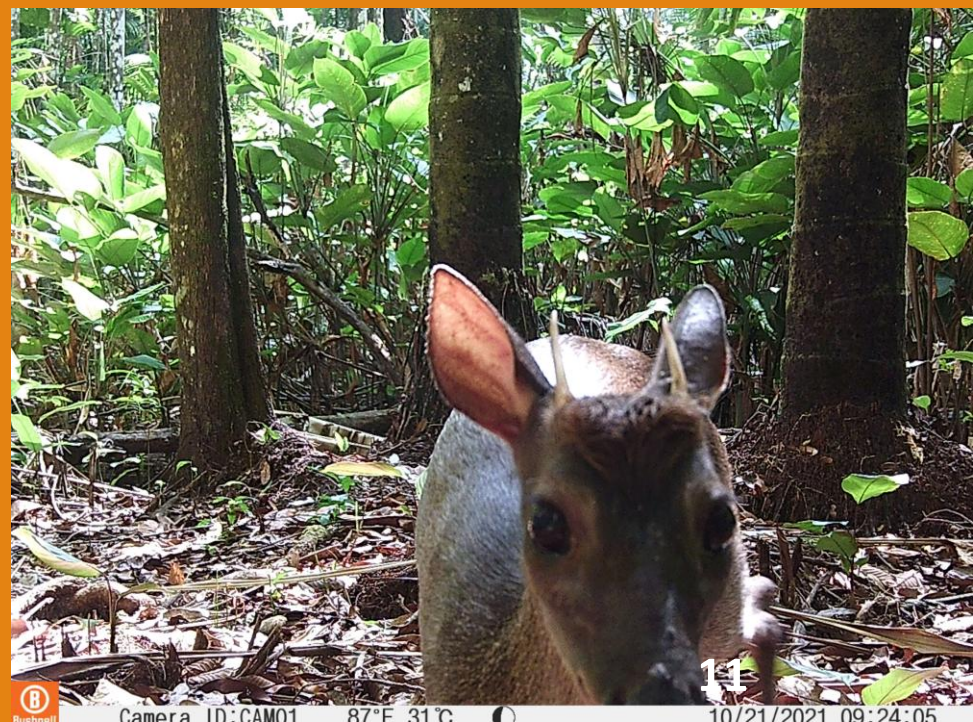
(H) *Mazama americana*,

(I) *Dasyprocta leporina*,

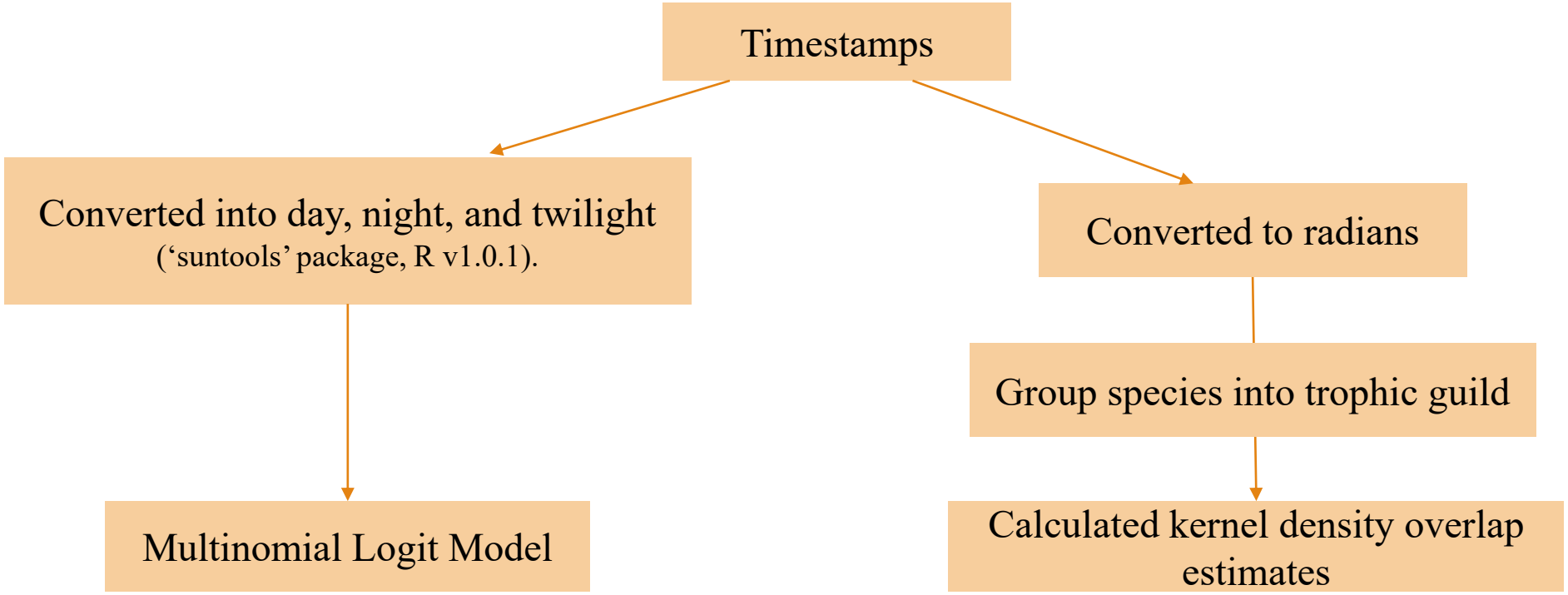
(J) *Cuniculus paca*, and

(K) *Dasypus kappleri*.

What is driving mammals' activities?



Chapter 2: Behavioral analysis



Factors influencing mammals' activities

Independent variable

Environmental Variable

- NDVI (Source: Landsat 8 Surface Reflectance from Google Earth Engine)

Anthropogenic Variable

- Distance from road (Source: OpenStreetMap)
- Distance from farms (Source: Research team)

Climate variables

- Temperature (Source: WorldClim; Fick & Hijmans, 2017).

Species Traits

- Body mass/weight (Source: Mass of Mammals database (v4.1); Smith et al., 2003)
- Trophic guild (Source: PHYLACINE database; Faurby et al., 2018)

Study site

- Categorical variable

Dependent variable

24-hour activity

- Twilight: dawn to sunrise, sunset to dusk
- Day: sunrise to sunset
- Night: dusk to dawn

Trophic guilds

Omnivore
Herbivore

Temporal overlap estimation steps

Data Preparation

- Convert to radians

Activity curve estimation

- Fit kernel density functions for each trophic guild

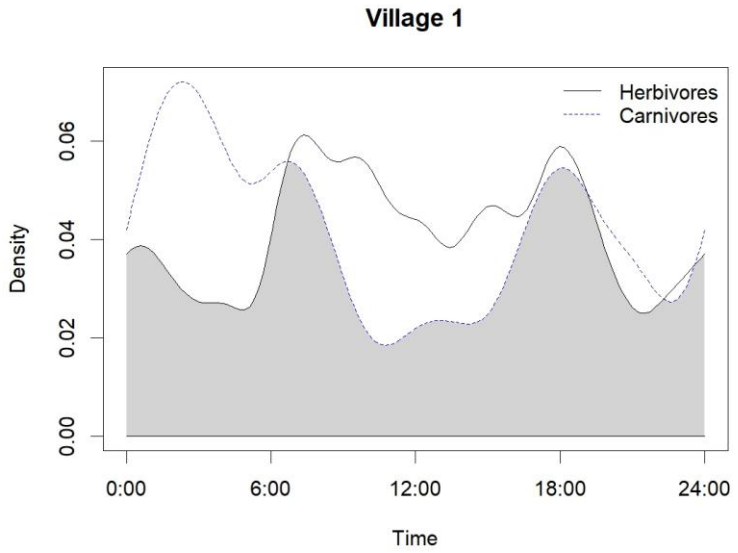
Overlap calculation

- Coefficient of overlap:

$$\Delta(f,g) = \int \min\big(f(x), g(x)\big)dx$$

Significance testing

- Randomization test with 1,000 iterations
- Generate null distribution of overlap values
- Calculate empirical p-value



So, how are different factors influencing the daily activity patterns of mammals?

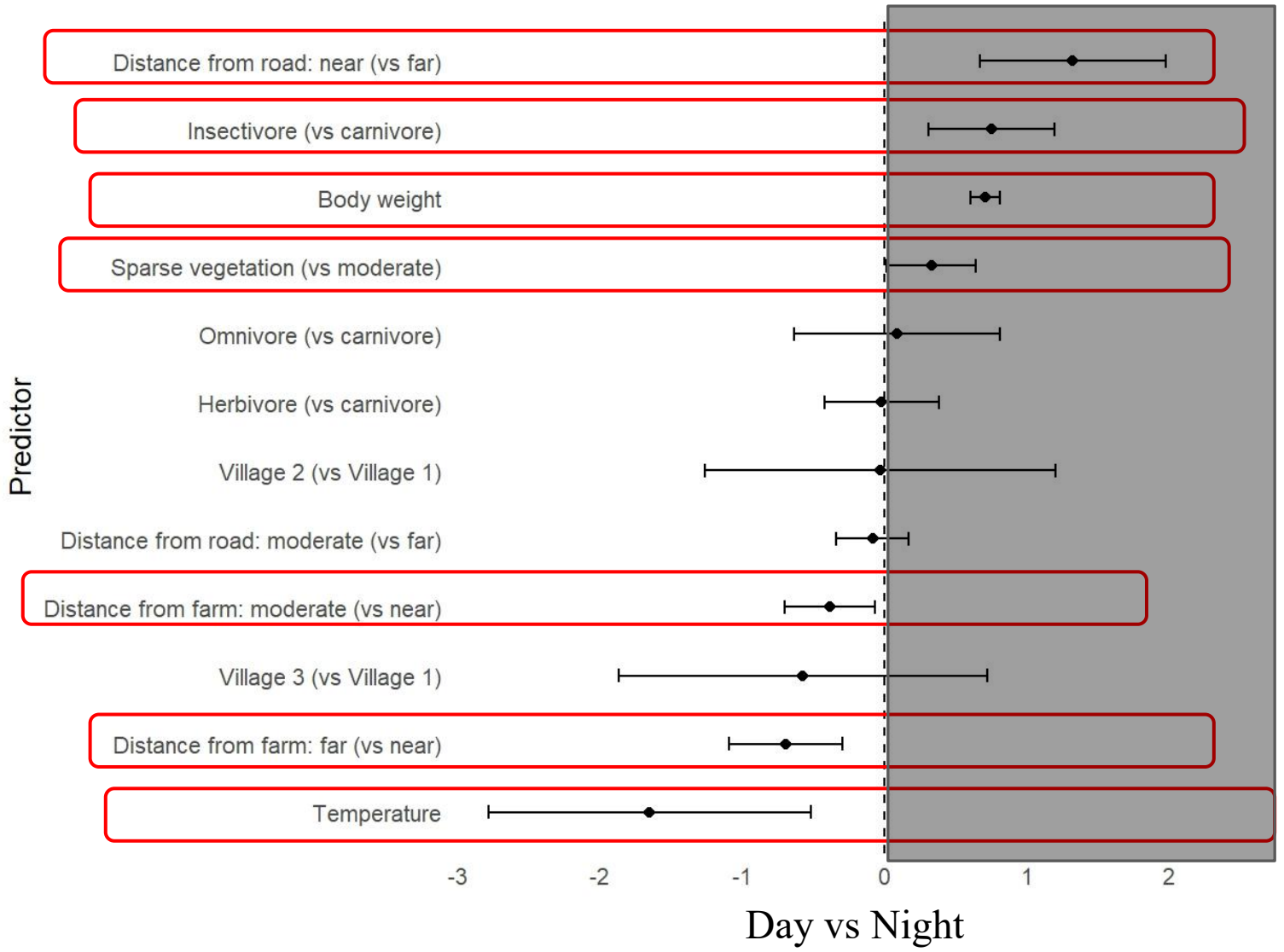
Result: Predictors affecting mammals' activities

- Only body mass significantly explained twilight vs day activity; all other covariates were non-significant
- No significant village-level differences in mammal activity patterns

Predictor	Estimate (Night vs Day)	Std. Error (Night vs Day)	p-value (Night vs Day)	Estimate (Twilight vs Day)	Std. Error (Twilight vs Day)	p-value (Twilight vs Day)
Intercept	**37.44**	**15.46**	**0.02**	14.42	14.39	0.32
Herbivore (vs carnivore)	-0.02	0.20	0.92	-0.38	0.43	0.38
Insectivore (vs carnivore)	**0.75**	**0.23**	**0.00**	-0.50	0.60	0.41
Omnivore (vs carnivore)	0.09	0.37	0.81	-0.24	0.75	0.75
Sparse vegetation (vs moderate)	**0.33**	**0.16**	**0.04**	-0.19	0.37	0.59
Distance from road: moderate (vs far)	-0.08	0.13	0.51	0.08	0.30	0.79
Distance from road: near (vs far)	**1.32**	**0.33**	**0.00**	0.34	0.61	0.57
Distance from farm: far (vs near)	**-0.69**	**0.20**	**0.00**	-0.08	0.42	0.84
Distance from farm: moderate (vs near)	**-0.39**	**0.16**	**0.02**	-0.04	0.36	0.91
Body mass	**0.71**	**0.05**	**0.00**	**0.34**	**0.12**	**0.00**
Temperature	**-1.65**	**0.58**	**0.00**	-0.71	0.54	0.19
Village 2 (vs Village 1)	-0.03	0.63	0.96	0.81	1.50	0.59
Village 3 (vs Village 1)	-0.57	0.66	0.38	0.2	1.54	0.89

Result: Predictors shown in coefficient plots

- Large-bodied mammals = more nocturnal/crepuscular.
  - To avoid human presence (Oberosler et al., 2017)
- Mammals more diurnal farther from farms.
- Mammals more nocturnal near roads.
- Higher temperatures associated with increased diurnal activity.
  - Response to microclimate conditions
- Insectivores (anteaters, armadillos) showed greater nocturnality than carnivores.
  - Greater nocturnal insects in the tropics (Wong & Didham, 2024)
- Mammals in sparse forest cover were more nocturnal.
  - could also reflect disturbed forest condition



How does the temporal overlaps among the trophic guilds vary?

Result: Temporal overlap among trophic guilds

- Temporal Overlap – Carnivores & Herbivores
  - Village 1 & 3: high overlap
  - Village 2: moderate overlap
- Temporal Overlap – Carnivores & Insectivores
  - High overlap in Village 1, moderate in Village 3.
  - Lowest overlap in Village 2
- Temporal Overlap – Carnivores & Omnivores
  - Village 1 & 3: greater segregation between carnivores & tayras.
  - Village 2: moderate overlap
    - Human disturbance increases competition among carnivores (Manlick and Pauli, 2020)

Predator	Prey	Overlap Coefficient	Village	pNull
Carnivore	Herbivore	0.79	Village 1	0.07
Carnivore	Herbivore	0.57	Village 2	0.00
Carnivore	Herbivore	0.64	Village 3	0.00
Carnivore	Insectivore	0.72	Village 1	0.00
Carnivore	Insectivore	0.51	Village 2	0.00
Carnivore	Insectivore	0.68	Village 3	0.01
Omnivore	Herbivore	0.64	Village 1	0.33
Omnivore	Herbivore	0.82	Village 2	0.79
Omnivore	Herbivore	0.81	Village 3	0.71

Predator	Predator	Overlap Coefficient	Village	pNull
Carnivore	Omnivore	0.49	Village 1	0.00
Carnivore	Omnivore	0.69	Village 2	0.02
Carnivore	Omnivore	0.49	Village 3	0.00

Key takeaways

- This chapter provided insights into the drivers of mammal activity patterns and how species adjust to habitat changes.
- Body size, prey availability, vegetation cover, temperature, and proximity to human activity influence daily activity.
- Human disturbance intensifies nocturnality, alters predator–prey overlap, and increases the tendency of competition.

Problem statement	Contributions of the study
How different external factors affects mammalian behaviors.	• Mammals are sensitive to forests' microclimate variation. • Prey availability are affecting their behavioral shifts.
How different factors are influencing apex predators' presence with their prey	Shows apex predators' vulnerability and resilience to climatic conditions.
How different human presence affect the mammalian behavior and distribution.	• Human presence are driving mammals towards nocturnality. • Agricultural landscape can increase predator prey co-occurrences.

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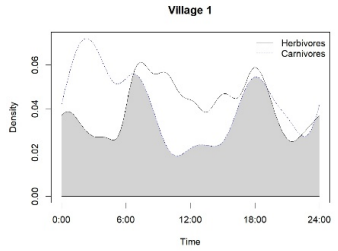
Village 1
Herbivores
Carnivores
Density
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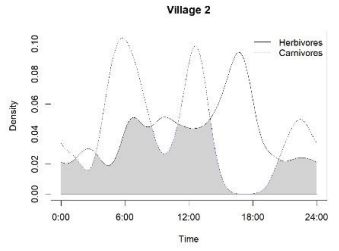
Village 2
Herbivores
Carnivores
Density
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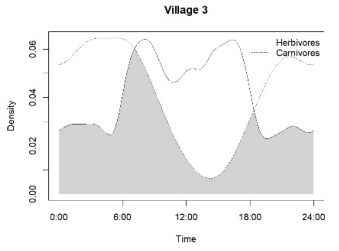
Village 3
Herbivores
Carnivores
Density
Time
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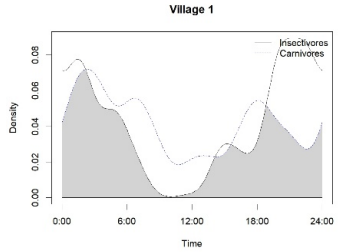
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Insectivores
Carnivores
Density
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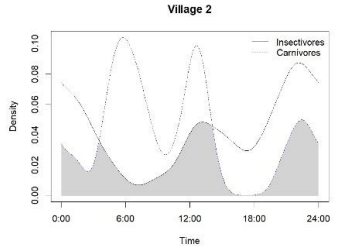
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Insectivores
Carnivores
Density
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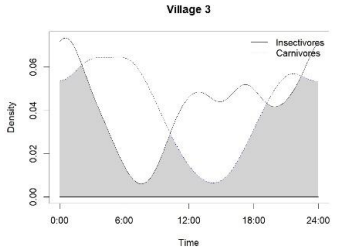
Village 3
Insectivores
Carnivores
Density
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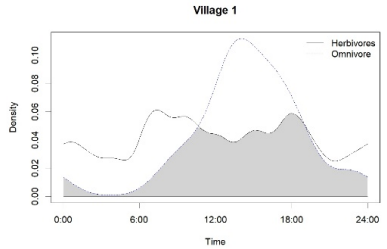
Village 1
Herbivores
Omnivore
Density
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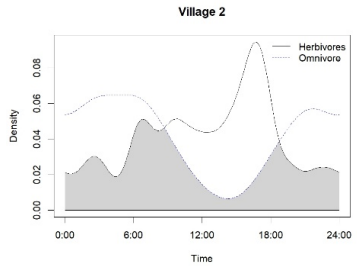
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Herbivores
Omnivore
Density
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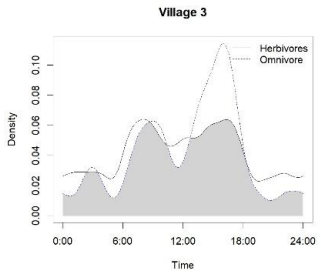
Village 3
Herbivores
Omnivore
Density
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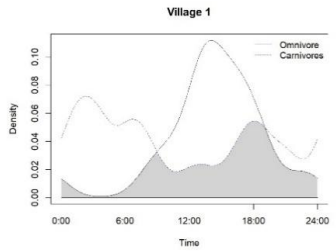
Village 1
Omnivore
Carnivores
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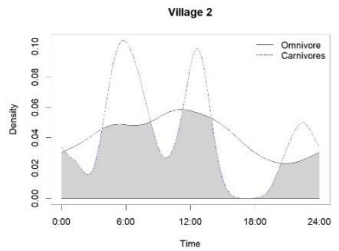
Village 2
Omnivore
Carnivores
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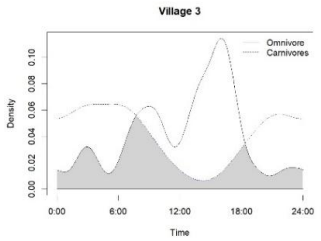
Village 3
Omnivore
Carnivores
Density
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