Mammals persist near communities practicing subsistence livelihoods in southeastern Nicaragua

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Introduction

Figure 1: Study area within Nicaragua: The Southern Caribbean Autonomous Region (R.A.C.S.) is primarily composed of lowland tropical rainforest, palm savannah, palm swamp and mangrove swamps

Nicaragua and Working Forests

- In tropical regions, reliance on protected areas to conserve wildlife has come under increased criticism[1,2]
- Most of the remaining global biodiversity exists in working forests outside of PA's[2,3]
- Conservation in Nicaragua is critical to conservation throughout the Mesoamerican Biological Corridor
- Remote communities on the southeastern coast of Nicaragua are shifting from fisheries-based livelihoods to forest-based—creating challenges for conservation of terrestrial mammals[4]
- However, rare and threatened mammals persist in this region[5], warranting an investigation of potential impacts

Research Question

- What effects do subsistence livelihoods and human disturbance have on the occupancy of terrestrial mammals?

Hypothesis

- We hypothesized that as hunting and farming pressure increased, occupancy would decrease due to increasing human disturbance to the forest

Predictions

- We expected the high-sensitivity species group to experience the greatest decrease in occupancy, followed by the moderate-sensitivity species and, ultimately, low-sensitivity species

Methods

We placed camera traps in lowland rainforest adjacent to nine small villages to capture images of terrestrial mammals at 80 unique sites in 2010, 2012 and 2014

Study Area

- ≈70 km N/S x 40 km E/W

Site Selection

- Study area divided into a 2 x 2 km grid
  - Randomly selected cells
  - minimum 2 km buffer
  - 2 – 8 sites per community

Trapping Seasons

- May – October
- ≈ 70 day run time

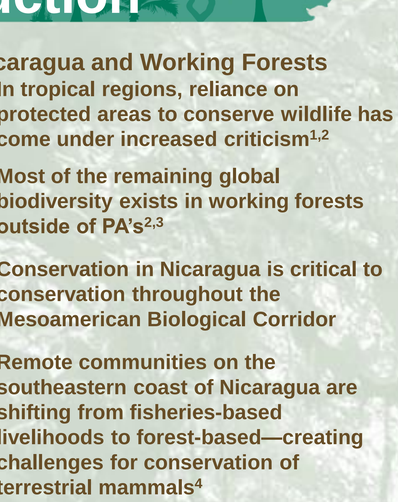


Figure 2: Camera sites, communities, and covariate features: Distance covariates were generated at the site level and measured using the nearest feature

Data Analysis

- We analyzed detection/non-detection data using single-season occupancy models with disturbance, livelihood, and habitat covariates
- Livelihood covariates obtained from concurrent socioeconomic surveys[6]
- Fitted for all three species sensitivity groups within each of three years

Results

- Results are organized by species sensitivity group

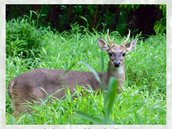
Table 1: Species sensitivity groups

Low	Moderate	High
Agouti	Ocelot	Jaguar
Armadillo	Margay	Puma
Coati	Jaguarundi	Tapir
Paca	Collared peccary	Red-brocket deer
White-tailed Deer	Tayra	White-lipped peccary

Anticipating low detections of rare target species, we combined the detection histories of 15 species into three species groups based on their sensitivity to human disturbance

Low-sensitivity species:


Agouti (*Dasyprocta punctata*)


White-tailed deer (*Odocoileus virginianus*)


Paca (*Cuniculus paca*)


Coati (*Nasua narica*)


Armadillo (*Dasypus novemcinctus*)

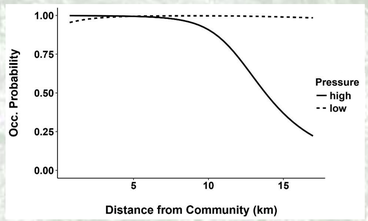


Figure 3b: Significant Interaction between distance from community and hunting, gathering or farming: Livelihood is a two-level categorical covariate with "high" or "low" pressure. This graph depicts the significant interaction effect in all three livelihood models because these models yielded nearly identical estimates.

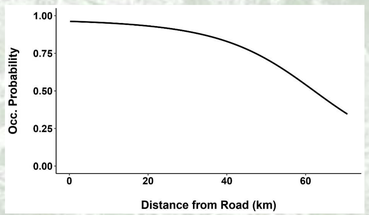


Figure 3a: Significant distance from road covariate effect in 2010: Occupancy probability decreases as distance from the road increases

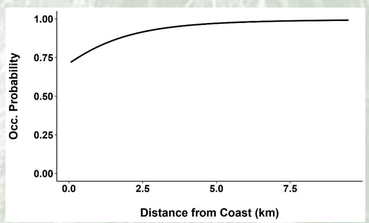


Figure 3c: Significant distance from coast covariate effect in 2010: Occupancy probability increases as distance from the coast increases.

Moderate-sensitivity species:

- Occupancy probability was also positively associated with gathering pressure in 2012


Ocelot (*Leopardus pardalis*)


Collared Peccary (*Pecari tejacu*)


Jaguarundi (*Puma yagouarundi*)


Margay (*Leopardus wiedii*)


Tayra (*Eira barbara*)

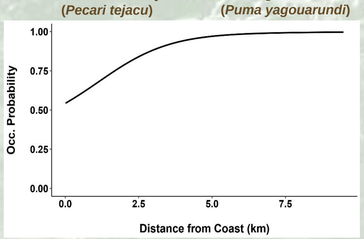


Figure 4a: Significant distance from coast covariate effect in 2014: Occupancy probability increases as distance from coast increases

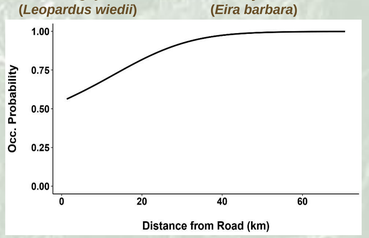


Figure 4b: Significant distance from road covariate effect in 2014: Occupancy probability increases as distance from road increases

High-sensitivity species:


Jaguar (*Panthera onca*)


Tapir (*Tapirus bairdii*)


Puma (*Puma concolor*)


White-lipped peccary (*Teyassu pecari*)


Red brocket deer (*Mazama americana*)

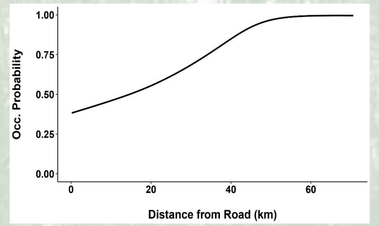


Figure 5a: Significant distance from road covariate effect in 2010: Occupancy probability increases as distance from road increases

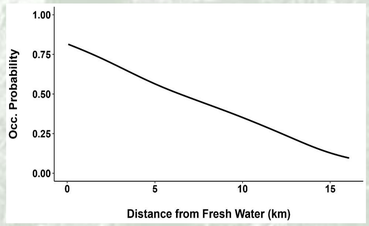


Figure 5b: Significant distance from fresh water covariate effect in 2010: Occupancy probability decreases as distance from road increases

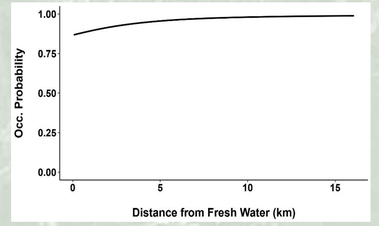


Figure 5c: Significant distance from fresh water covariate effect in 2014: Occupancy probability increases as distance from road increases

Discussion

- Low-sensitivity spp. declined from 2010 – 2012
  - possibly due to advance of cattle-ranching frontier
  - diet supplemented by small farms
- Moderate-sensitivity spp. declined rapidly throughout the study
  - poorly explained by covariates in models
- High-sensitivity spp. experienced major decline prior to study
  - responded negatively to riparian development

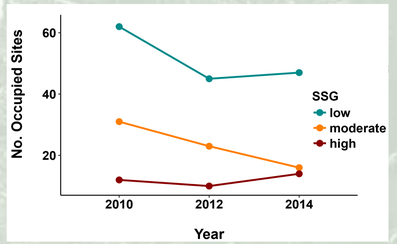


Figure 6: Number of sites occupied by each species sensitivity group (SSG) in each year: We observed an overall decline in occupancy from 2010 – 2014

Next Steps

- Create spatial covariates to directly evaluate the impact of the agricultural frontier

Conclusions

- Traditional livelihoods practiced in the forests surrounding small coastal villages may have a relatively lower impact on the mammal communities residing within their working forests
- The effects of an advancing cattle-ranching frontier may be very detrimental and warrants immediate action to prevent further decline in mammalian occupancy
- Empowering communities with resources needed to protect their lands is the most important step we can take to preserve working forests for both people and animals

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