

# Variation in Jaguar Occupancy in Response to Differential Land Use Practices by Human Communities

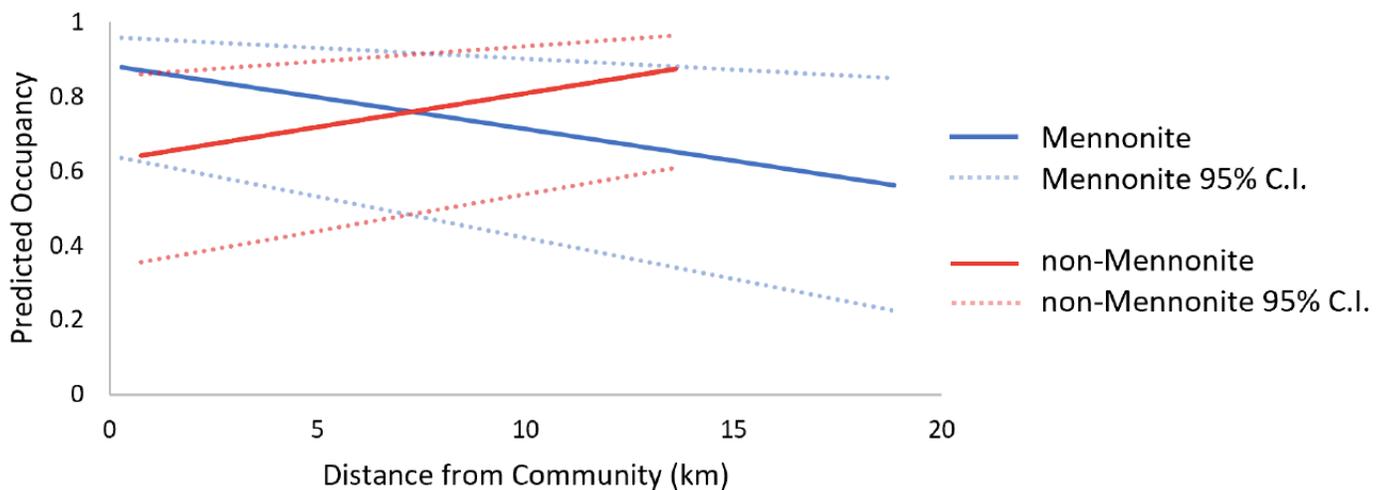
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Effective conservation necessitates an examination of human influences on wildlife, particularly large carnivores.<sup>1</sup> Jaguars (*Panthera onca*) face anthropogenic pressures (e.g., poaching, deforestation, habitat fragmentation) throughout their geographic range.<sup>2</sup> However, certain human communities may pose greater threats to jaguars and their habitats than other communities due to differential land use.<sup>1</sup> In Belize, many communities (e.g., Creole, Mayan, Mestizo) often practice localized slash-and-burn or small-scale farming operations.<sup>3</sup> Mennonites, originally of European descent, produce much of the food and materials on which the country relies, but also convert tracts of forest to agricultural land at a larger, more intense scale than other rural communities.<sup>3</sup> We hypothesized these current development practices could exclude jaguars from occupying habitat around Mennonite communities compared to other communities.

Using jaguar camera trap data from 2017 and environmental data from two study sites (Hillbank and Yalbac) in Belize, we conducted a single-season occupancy analysis to compare jaguar habitat use near Mennonite and non-Mennonite rural agricultural communities to determine whether jaguars respond differently to these communities. Occupancy analysis estimates presence across an area, while accounting for imperfect detection. We placed 55 cameras on trails and roads to increase jaguar detectability.<sup>4</sup> Using the unmarked package in R,<sup>5</sup> we modeled occupancy and detection and ranked models by AICc, a metric of model competitiveness. We reviewed the literature to pre-select occupancy variables important for modeling jaguar habitat use in the region: distance to rivers, distance to roads, canopy height, and sex.<sup>6,7</sup> We modeled detection with trail-width and sex as covariates.<sup>7,8</sup> We then incorporated our occupancy variables of interest: distance to Mennonite community, distance to non-Mennonite community, and distance to closest human community of either type.

We found jaguar trap success was 4.56 per 100 trap nights, with 119 male captures and 43 female captures, for 162 total jaguar captures. These figures do not refer to numbers of jaguars; rather, they are indicative of jaguar detectability and distribution within the study area. Our top model incorporated distance to Mennonites. Surprisingly, our results suggested occupancy may increase with proximity to Mennonites. Additionally, a marginally competitive model suggested occupancy may decrease with proximity to non-Mennonites. However, the evidence for these relationships is not conclusive due to wide confidence intervals and the presence of several competing models. We do not have the data to definitively explain these results; however, we suggest our findings may result from greater human density and activity at the edges of non-Mennonite communities, pushing jaguars away from non-Mennonites. Alternatively, habitat alteration at the edges of Mennonite communities may benefit jaguar prey species, which may attract jaguars to those areas. However, we cannot examine the validity of these hypotheses with the current data set.

In the coming months, we will collect more habitat data from the same study area and conduct more analyses to attempt to clarify these findings. Our results provide interesting insight into the spatial effects human communities may have on jaguars. Understanding how jaguar habitat use responds to human development will inform more effective conservation of jaguars, other wildlife, and Belize's tropical forests.



**Figure 1.** Jaguar occupancy trends with distance to human communities. Approximate estimated trends between male jaguar occupancy and distance from camera stations to human communities from two competing models (two other models were also competing). Trends for female jaguars (not shown) were similar. The solid blue line indicates estimated relationship between occupancy and distance to Mennonite settlements, while the solid red line indicates the estimated relationship between occupancy and distance to non-Mennonite settlements. Dotted lines indicate the 95% confidence intervals. Photo data were collected from 2 private reserves (Hill Bank and Yalbac) in Belize from May to October 2017.

## Statement of Research Advisor

Given the ever-increasing direct and indirect effects of humans on wild places, research into how human-driven habitat change influences wild animals is critical to wildlife conservation. This research is a much-needed direct examination of the effects of humans on a top predator; a species that can have wide-ranging impacts on entire ecosystems and is of considerable conservation concern.

– Todd Steury, *Forestry and Wildlife Sciences*

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