

SHORT NOTE

Elevation as an occupancy determinant of the little red brocket deer (*Mazama rufina*) in the Central Andes of Colombia

Elevación como un determinante de la ocupación del venado soche (*Mazama rufina*) en los Andes centrales de Colombia

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ABSTRACT

We assessed the influence of terrain variables on the occupancy of the little red brocket deer (*Mazama rufina*) in the Central Andes of Colombia. Occupancy increased with elevation up to 3000, where it starts decreasing. This information is crucial to predict the potential effects of climate change on *M. rufina* and other mountain species.

Keywords. Andean mountains, camera trap, Cervidae, detection probability.

RESUMEN

Evaluamos la influencia de variables del terreno sobre la ocupación del venado soche en los Andes centrales de Colombia. La ocupación aumenta con la elevación hasta los 3000 m y por encima de este valor decrece. Esta información es crucial para predecir los posibles efectos del cambio climático sobre *M. rufina* y otras especies de montaña.

Palabras clave. Cervidae, montañas andinas, probabilidad de detección, trampa cámara.

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Understanding the factors influencing the spatial distribution of mountain-living species is important to predict their potential responses to climate change and other factors affecting their habitat availability and quality (Elsen and Tingley 2015). The little red brocket deer (*Mazama rufina* Pucheran, 1851) is found in Andean forests above 1500 m and goes up to paramos at 3800 m in Venezuela, Colombia, Ecuador, and Northern Peru (Lizcano et al. 2010). It is classified as vulnerable by IUCN due to the decrease in its populations associated to habitat transformation and habitat loss (Lizcano and Alvarez 2016). In this study we estimated the influence of mountain attributes (i.e., terrain variables) on occupancy (ψ) and detection probability (p) of *M. rufina*.

This study took place in the Central Andes of Colombia, at the Biological Station Estrella de Agua and its surroundings

in Salento, (Quindío department) and Ucumari Regional Park (Risaralda department). In these two localities elevation ranged between 1800 and 3880 m. We installed 28 camera traps (Bushnell HD) in three arrays between March and June 2017 at the Quindio locality where they remained active for 35 days. In Risaralda we installed 60 cameras (Bushnell Trophy Cam) in two arrays between March and July 2017. These remained active for 45 days. We installed the camera traps with at least 500 m distance from each other on a regular grid. Distance between cameras was based on travel distance estimates for the closely related species *Mazama gouazoubira* (Fischer, 1814), to ensure sampling independence (Grotta-Neto et al. 2019). Cameras were unbaited. We followed a variation of the TEAM Network protocol (TEAM Network 2011). We organized and tagged pictures using the software WildID (Fegraus et al.

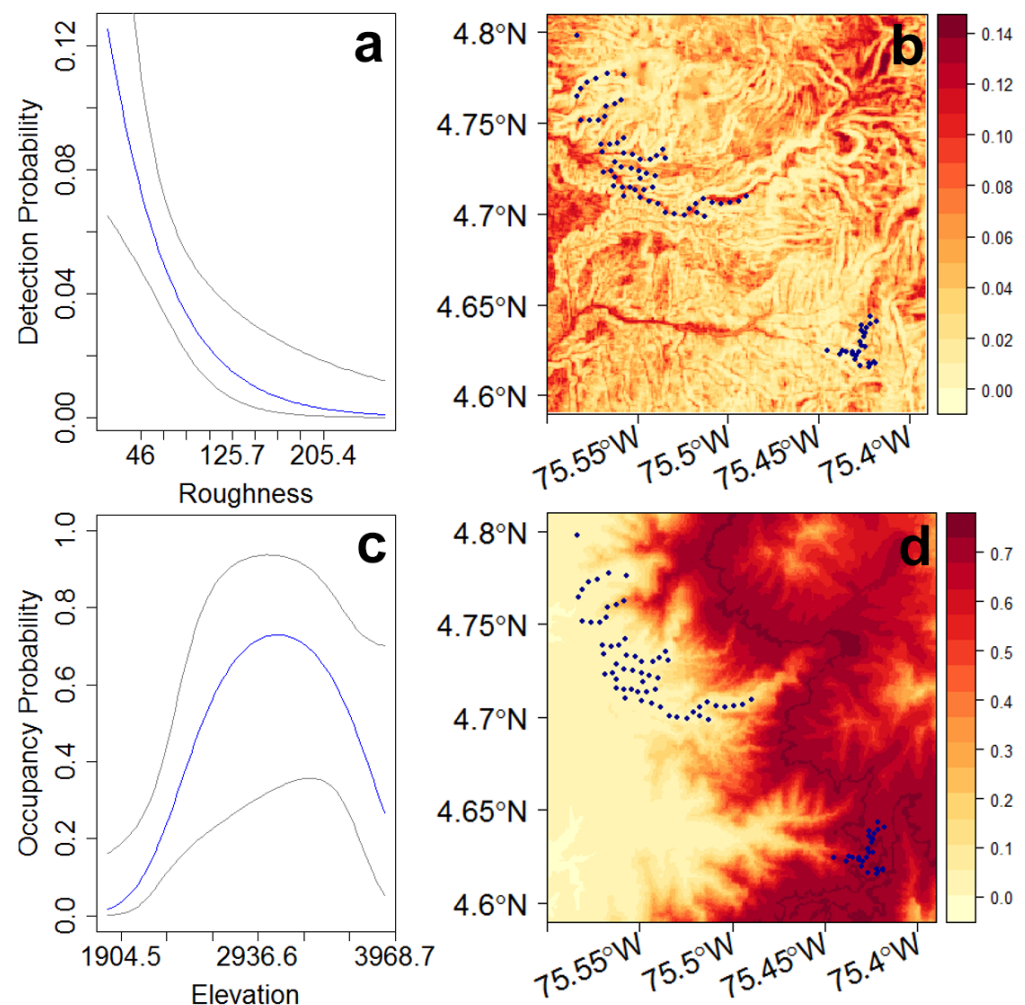


Figure 1. Functional relationships between covariates and detection probability and occupancy (left) and spatial predictions of detection probability and occupancy of *M. rufina* (right). **a** Detection probability as a function of roughness; **b** Predicted detection probability in a map; **c** Occupancy (ψ) probability as a function of elevation; **d** Predicted occupancy in a map. The blue line represents the predicted variable given the true value of the covariate coefficient with confidence intervals indicated by grey lines. Blue dots are camera traps

2011), using one-hour intervals to define independent sampling events (Meek *et al.* 2014). For more details on methods (see [Supplementary material](#)).

Based on elevation data (CGIAR-SRTM 90 m), we estimated three terrain variables slope, aspect, and roughness that can, in addition to elevation, influence the presence of *M. rufina*. We used the occupancy modeling framework to investigate the relationships between occupancy, elevation and terrain covariates, which were previously normalized and evaluated for correlation (MacKenzie *et al.* 2006). We assessed the effect of these covariates and combinations of them on occupancy and detection probability across a set of nine candidate models ([Supplementary material](#)) and used the Akaike Information Criterion (AIC) and cumulative weights for model selection, using a minimum difference of 2.0 between AIC values to differentiate models (Akaike 1973). We used the package ‘unmarked’ for model fitting, model selection, and assessing goodness-of-fit of the selected occupancy model (Fiske and Chandler 2011). We used the best-fit model to predict the occupancy across a spatial grid extending over both sampling localities. For reproducibility purposes, full code and data set are provided in https://github.com/dlizcano/Mazama_rufina.

A total of 9396 camera days were accumulated, with an average of 41.76 observations per site, based on records from 87 cameras. The best-fit model showed that detection probability decreased with increasing roughness while occupancy increased with elevation but decreased with values above 3000 m ([Fig. 1](#), [Supplementary material](#)). Naïve occupancy was 0.26, while estimated occupancy was 0.56 assuming the elevation average and correcting the detection process with roughness values.

The best model suggests that occupancy reaches a maximum around 3000 m. Elevation is a common variable influencing species distribution of tropical animals, which can be linked to physiological conditions as well as biotic interactions (Jankowski *et al.* 2013). Studies on physiological limitations, interactions with other species, and temporal variation in diet could help explain the occupancy peak around 3000 m of *M. rufina*. Elevation has also been observed to influence habitat use and movement of other deer species, especially of migratory ones outside the tropics (Mysterud 1999, Wyckoff *et al.* 2018). Determining whether migration is also present in this tropical deer is important

to predict its response to climate change, a factor that can further threaten its persistence in the tropical Andes.

AUTHOR'S CONTRIBUTION

DJL conceived the study and carried out the analysis. SJA, VD and DRG collected and organized the data, SJA and HMM provided input on the analysis design and manuscript writing.

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CONFLICT OF INTEREST

The authors declares that they do not have conflict of interest.

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