BIOTA COLOMBIANA
ISSN impreso 0124-5376
ISSN digital 2539-200X
DOI 10.21068/c001

Nota

First verified high-elevation record of the jaguar (*Panthera onca*) on the eastern slope of the Western Andes, Colombia

Primer registro verificado de alta elevación del jaguar (*Panthera onca*) en la vertiente oriental de la Cordillera Occidental de los Andes, Colombia

Isabella López [a], **Gustavo Londoño** [a], **Sebastián Ovalle** [b], **Jorge Lizarazo** [c]

a Facultad Barberi de Ingeniería, Diseño y Ciencias Aplicadas, Universidad Icesi, Cali, Colombia
b Parques Nacionales Naturales de Colombia, Territorial Pacífico, Colombia
c Centre for Animals on the Move, Western University, Canadá

Recibido: mayo 10, 2025
Aceptado: noviembre 11, 2025
Publicado en línea: marzo 25, 2026

https://doi.org/10.21068/2539200X.1321

Abstract

The Jaguar (*Panthera onca*) is commonly found in tropical lowland forests, although occasional records have been reported at higher elevations. This work documents the first verifiable record of a jaguar on the eastern slope of the Western Andes in Colombia, in Parque Nacional Natural Farallones de Cali at 2,500 m a.s.l. The record was obtained in October 2024 during a camera-trap monitoring program. To contextualize this observation, we compiled recent high-elevation records of jaguars in Colombia and developed an ecological niche model using the Maxent algorithm and bioclimatic predictors. The best-performing model showed high predictive performance (AUC = 0.924; CBI = 0.891) and identified precipitation- and temperature-related variables as the main drivers of habitat suitability, indicating that both thermal and precipitation patterns may constrain jaguar distribution at elevational limits in Colombia. This observation constitutes the first confirmed record of the species on the eastern slopes of the Western Andes in Colombia in more than six decades. Although the presence of jaguars in high-montane environments is likely transient, this finding highlights the potential role of Andean landscapes in facilitating dispersal and connectivity among remnant populations.

Keywords: camera trapping, species distribution modeling, cloud forest, Andean biodiversity, landscape connectivity.

Resumen

El jaguar (*Panthera onca*) se distribuye principalmente en bosques tropicales de tierras bajas, aunque se han reportado registros ocasionales a mayores elevaciones. En este trabajo documenta el primer registro verificable de un jaguar en la vertiente oriental de la Cordillera Occidental de los Andes en Colombia, dentro del Parque Nacional Natural Farallones de Cali, a 2.500 m s. n. m. El registro se obtuvo en octubre de 2024 durante un programa de monitoreo con cámaras trampa. Para contextualizar esta observación, compilamos registros recientes de jaguar en zonas de alta elevación en Colombia y desarrollamos un modelo de nicho ecológico utilizando el algoritmo Maxent y variables bioclimáticas. El modelo con mejor desempeño mostró una alta capacidad predictiva (AUC = 0,924; CBI = 0,891) e identificó variables relacionadas con la precipitación y la temperatura como los principales determinantes de la idoneidad del hábitat, lo que sugiere que estos factores pueden limitar la distribución del jaguar en los límites altitudinales en Colombia. Esta observación constituye el primer registro confirmado de la especie en la vertiente oriental de la Cordillera Occidental de Colombia en más de seis décadas. Aunque la presencia de jaguares en ambientes montanos altos probablemente sea transitoria, este hallazgo resalta el posible papel de los paisajes andinos en facilitar la dispersión y la conectividad entre poblaciones remanentes.

Palabras clave: fototrampeo, modelo de distribución, bosque nublado, biodiversidad andina, conectividad del paisaje.

Introduction

The rediscovery of species in areas where they were previously presumed locally extinct may result from range shifts, recolonization following habitat recovery or occasional occurrences associated with environmental change. Changes in species distributions have been widely documented as responses to altered habitat conditions and other environmental drivers, providing insights into species' adaptability and resilience (Scheffers et al., 2011; Williams & Blois, 2018). The jaguar (*Panthera onca*), the largest feline in the Americas, is currently classified as Near Threatened (NT) on the International Union for Conservation of Nature (IUCN) Red List; however, recent assessments indicate that the species may soon qualify as Vulnerable (VU), reflecting an increasing risk of extinction in the wild (Jedrzejewski et al., 2023).

Historically, jaguars occupied an extensive range from central Argentina to the southwestern United States. Since the late nineteenth century, populations have declined substantially (De la Torre et al., 2018; Jedrzejewski et al., 2023; Medellín et al., 2016; Rabinowitz, 1999), and the species currently persists in only 33–40% of its original distribution (Bernal-Escobar et al., 2015; Hoogesteijn et al., 2011; Jedrzejewski et al., 2023; Quigley, 2016). In Colombia, jaguar populations have experienced marked reductions due to habitat fragmentation (approximately 36–43% of its habitat is no longer viable), hunting, and increasing human-wildlife conflict, leading to local extinctions in several regions (Machado-Aguilera et al., 2024; Rabinowitz & Zeller, 2010; Thompson & Velilla, 2017). These declines have been particularly pronounced in the inter-Andean valleys of the Cauca and Magdalena rivers, which together encompass approximately 150,889 km² (Medellín et al., 2016; Payán-Garrido et al., 2013). Across the country, areas overlapping with the species' distribution cover approximately 708,681 km², however only 557,792 km² (21.29%; currently provide suitable habitat for the species (Medellín et al., 2016). Jaguars are most commonly associated with tropical lowland forests, where they are frequently detected near water bodies and areas of dense vegetation (Jedrzejewski et al., 2023; Payán et al., 2013; Seymour, 1989).

Despite this strong association with lowland habitats, jaguars exhibit ecological adaptability across a wide range of environments, including savannas, dry

forest, wetlands, palm plantations (Boron et al., 2016; Pardo-Vargas & Payán-Garrido, 2015), coastal regions, Amazonian forests, and foothill forests. Sporadic reports also exist from high-elevation areas (above 2,000 m a.s.l.). Such records have been reported throughout the species' range, including Mexico (2,085–2,800 m; Villordo-Galván et al., 2010; Briones-Salas et al., 2012; Padilla Gómez et al., 2019), Honduras (2,200 m; Castañeda, 2016), Ecuador (2,300–2,660 m; Griffith et al., 2022), Bolivia (2700 m; Guggisberg, 1975), and Argentina (2355–2490 m; Lodeiro-Ocampo et al., 2016). These observations suggest that montane habitats may occasionally serve as movement corridors or for opportunistic foraging for jaguars. In Colombia, historical and anecdotal reports (Lizarazo, pers. comm., 2025), as well as published records and biodiversity databases (Chacón-Pacheco et al., 2014; Fernández-Rodríguez et al., 2020; Mendieta-Giraldo et al., 2021; Zárrate-Charry et al., 2018; GBIF, 2024) document occurrences in rural Andean landscapes above 2,000 m a.s.l. Collectively, these observations indicate that jaguars may occasionally use montane environments, either as part of their natural ecological range or in response to environmental conditions (Griffith et al., 2022; Machado-Aguilera et al., 2024).

In this communication, we report the first verifiable record of a jaguar at 2,500 m a.s.l on the eastern slope of the Western Andes, within Parque Nacional Natural Farallones de Cali (PNN Farallones de Cali). Although jaguars have been documented on the western slopes of this mountain range at lower elevations, the species has been presumed locally extinct for more than sixty years on the eastern slope facing the Cauca River valley (Jedrzejewski et al., 2023; Machado-Aguilera et al., 2024; Mendieta-Giraldo et al., 2021; Payán-Garrido et al., 2015). This sector of the PNN Farallones de Cali is characterized primarily by humid montane cloud forests interspersed with fragmented dry forests and bordered by agricultural landscapes subject to ongoing logging pressure. From an ecological perspective, this landscape may function as a potential corridor facilitating connectivity across the Andes toward southern regions (Jedrzejewski et al., 2023). In addition to documenting this high-elevation record, we conducted a targeted literature review and species distribution modeling to assess recent reports of jaguars at high elevations and to evaluate whether such occurrences reflect broader ecological patterns consistent with niche limits or represent isolated dispersal events outside the predicted suitable habitat..

Methods

During 2024, we conducted a camera-trap monitoring program led by Universidad Icesi, primarily aimed at detecting the oncilla (*Leopardus tigrinus*), at the Zygia Research Station in Parque Nacional Natural Farallones de Cali (PNN Farallones de Cali; 3.073° N, 76.666° W). The station is located at elevations between 2,300 and 2,600 m a.s.l. within a humid montane cloud forest ecosystem. The site lies near the park's buffer zone and is surrounded by smallholder agricultural landscapes below 1,800 m a.s.l., while the forest edge is affected by selective illegal logging.

In 2024, the mean annual temperature at the study site was approximately 15.14 °C, with recorded temperatures ranging from 10.41 °C to 33.33 °C. Total annual precipitation reached 1,664 mm. To implement the survey, a grid with 600 m spacing was overlaid on the study area, and eight cameras traps were installed in a subset of randomly selected grid cells (Behnke, 2015; Díaz-Pulido & Payán-Garrido, 2012; Kilshaw et al., 2011; Rovero et al., 2014). Within each selected cell, field surveys were conducted to identify wildlife trails likely used by felids and their prey. Camera traps were subsequently placed along these trails to maximize detection probability.

Literature review of high-altitude jaguar records

To contextualize our observation, we compiled recent records of *Panthera onca* from high-elevation areas in Colombia reported during the last decade. The review included peer-reviewed articles, technical reports, and publicly accessible biodiversity databases,

focusing on records above 1,600 m a.s.l. Geographic coordinates and elevation data were extracted from the original sources when available, or verified through direct communication with field researchers.

Ecological context and niche modeling

To examine whether the reported occurrence is consistent with broader ecological patterns, we modeled the potential distribution of jaguars in Colombia. Species distribution modeling was conducted using the Maxent algorithm implemented through the Wallace package in R (Kass et al., 2023; procedure in Supplementary 1). Presence records were obtained from the Global Biodiversity Information Facility (GBIF, 2024). Records lacking precise geographic information or corresponding to historical museum specimens were excluded from the analysis.

Environmental predictors included the 19 bioclimatic variables available from the WorldClim database (Hijmans et al., 2005), representing temperature and precipitation gradients across the study region. We evaluated alternative model parametrizations by testing different combinations of feature classes (Linear, Quadratic, and Hinge, and their combinations) to identify the configuration that best captured the ecological niche of the species in Colombia. Model performance was assessed using Akaike Information Criterion (AIC) to compare model fit, the Area Under the Curve (AUC) to evaluate discrimination capacity, the Continuous Boyce Index (CBI) to assess predictive reliability, and omission rates based on the 10-percentile and minimum training presence thresholds.

Results

A jaguar was recorded in a humid montane forest (tropical cloud forest) on the eastern slope of the Western Andes within PNN Farallones de Cali, Colombia (3.4368611° N, 76.6685278° W and 3.4367222° N, 76.6669722° N) (Figure 1). This record was obtained on 11 October, 2024 at 2,500 m a.s.l., when the same individual was captured sequentially by two camera traps located approximately 200 m apart along the same trail, with detections occurring five minutes apart. This observation was made in the eastern sector of PNN Farallones de Cali, less than 10 km from the Cauca River Valley, and constitutes the first verifiable evidence of jaguar occurrence above 2,000 m a.s.l. on this slope of the Colombian Andes (Figure 2A).

Our review identified 13 additional records of jaguars above 1,600 m in Colombia during the last decade. Most of these records are concentrated in the northwestern region of the country. Four correspond to the Cordillera Occidental, including the record reported here, with elevations ranging from 1,664 m to 2,100 m a.s.l. Two additional records originate from areas where the Western and Central Cordilleras converge, where jaguar occurrences remain relatively frequent and have been documented through data contributions from Corporación para la Gestión Ambiental Biodiversa, the Instituto de Investigaciones Ambientales del Pacífico (IIAP), and Empresas Públicas de Medellín E.S.P. (GBIF, 2024). Additional records include four from the Cordillera Oriental near the Venezuelan border (1,613–2,207 m a.s.l.; Fernández-Rodríguez et al., 2020) and three from the Sierra Nevada de Santa Marta in the Colombian Caribbean, where jaguars are regularly reported at elevations exceeding 1,600 m a.s.l. (1800–2200 m a.s.l.; Zárrate-Charry et al., 2018). A further record was documented in the department of Huila, southern Colombia, at approximately 1,800 m a.s.l., within the Guacharos-Puracé Biological Corridor Regional Natural Park (Comunicaciones CAM, 2022). This observation was later confirmed by staff of Parques Nacionales Naturales de Colombia and Ovalle (pers. comm., 2023), and is notable because jaguars had also been considered locally extinct in this region, located between the inter-Andean valleys of the Central and Eastern Cordilleras (Chacón-Pacheco et al., 2014; Jedrzejewski et al., 2023; Mendieta-Giraldo et al., 2021).

The Maxent model predicting the potential distribution of jaguars in Colombia indicated suitable environmental conditions for the species across extensive portions of the country (Figure 2B). The best-performing model used the feature class combination “LQ” (Linear and Quadratic; Table S1)

with a regularization multiplier of 1, achieving an AUC value of 0.924 and a Continuous Boyce index (CBI) of 0.891. Omission rates were within acceptable thresholds, with a 10-percentile training omission rate of 0.122 and a minimum training presence omission of 0.065. Among the 19 bioclimatic variables evaluated, the most influential predictors were temperature seasonality (bio04; λ = 8.27), precipitation seasonality (bio15; λ = 3.77), annual precipitation (bio12; λ = 4.19), and precipitation of the wettest quarter (bio16; λ = 3.98), as indicated by the permutation importance and response curves. The prominence of seasonality variables (bio04, bio15) suggests that climatic variability, rather than mean annual conditions, constrains jaguar habitat suitability at elevational limits in Colombia.

Discussion

Jaguars are not known to maintain resident populations in high montane environments (Guggisberg, 1975; Lodeiro-Ocampo et al., 2016; Zárrate-Charry et al., 2018). Nevertheless, sporadic records from Colombia and neighboring countries (Fernández-Rodríguez et al., 2020; Griffith et al., 2022; Lodeiro-Ocampo et al., 2016), along with oral accounts of their presence in highland areas, suggest that these environments may be ecologically relevant to the species. Rather than representing permanent habitat, montane landscapes may function as transient environments used for dispersal movements or opportunistic foraging. This interpretation is supported by the ecological niche model, which shows a sharp decline in habitat suitability above 2,000 m a.s.l., consistent with the upper elevational limit of compiled altitude records. In this context, the record reported here, together with the additional observations identified in the literature, supports the need to consider montane ecosystems as part of the broader ecological space used by jaguars, particularly under scenarios of habitat change or range re-expansion.

Historically, the Cauca and Magdalena river valleys supported jaguar populations and likely functioned as major movement corridors across lowland landscapes (Jedrzejewski et al., 2023; Machado-Aguilera et al., 2024; Payán-Garrido et al., 2013), with the possibility that individuals periodically traversed adjacent highland areas (Medellín et al., 2016). The restoration of these landscapes as functional corridors and suitable habitats could therefore contribute to reversing local extinctions. Recent reports from the department of Caldas, including records from mountain-edge areas bordering both the Cauca and Magdalena river valleys (Urrego, 2024), further highlight the potential importance of transitional landscapes between lowlands and montane regions. However, available evidence remains limited and does not yet allow robust inferences regarding consistent patterns of high-altitude habitat use, particularly in areas such as PNN Farallones de Cali.

Clarifying these distributional dynamics could inform strategies to restore jaguar populations in the lowland Cauca River valley adjacent to PNN Farallones de Cali, where the species was extirpated during the 1960s. Identifying potential dispersal routes and zones of connectivity between montane and lowland environments may be particularly relevant for understanding exploratory movements across the region. Continued monitoring across elevational gradients, including expanded camera-trap networks and the integration of observational data from local communities, will be important for determining whether records from the eastern slopes represent isolated events or part of a broader dispersal pattern. Such information could support conservation initiatives focused on landscape connectivity and contribute to ongoing efforts to strengthen Andean jaguar corridors within the framework of national conservation strategies for the species in Colombia.

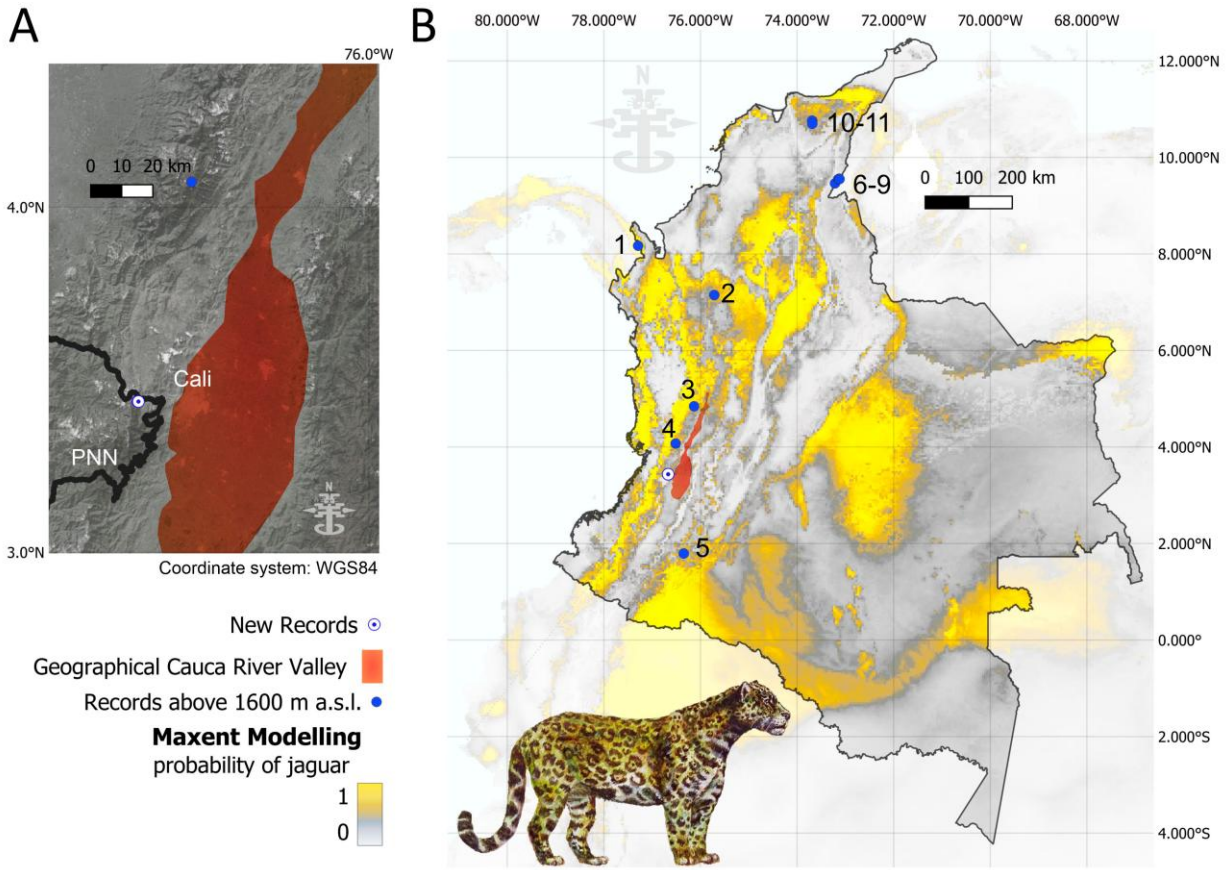
Acknowledgements

We thank Parques Nacionales Naturales de Colombia for providing camera traps and logistical support during fieldwork, and the staff at Universidad Icesi's biological research station for their continued assistance. We are especially grateful to former

university president Francisco Piedrahita Plata for his unwavering commitment to wildlife conservation and the dissemination of scientific knowledge, and for his key role in establishing Universidad Icesi's biological station, Zygia. His support has helped consolidate the station as an important site for scientific research for both the university and the city of Cali, Colombia. We also thank the Panthera Colombia Foundation for its contributions to strengthening technical capacity in camera-trap methodologies and for promoting research on large and small felines in Colombia.

Figure 1. Photographic record of a jaguar (Panthera onca) obtained by two camera traps on the eastern slope of Parque Nacional Natural Farallones de Cali, Colombia, on 11 October 2024 at 2,500 m a.s.l.

Figure 2. High-elevation records of the jaguar (Panthera onca) in Colombia and predicted habitat suitability based on ecological niche modeling.



Note. A) Detail of Parque Nacional Natural Farallones de Cali showing the location of the new record at 2,500 m a.s.l. on the eastern slope of the park and its proximity (~10 km) to the urban area of Cali. B) Maxent model depicting the predicted probability of jaguar occurrence across Colombia, with blue markers indicating records above 1,600 m a.s.l. Compilation and illustration by Lizarazo.

References

Behnke, R. (2015). *A camera-trap based inventory to assess species composition of large- and medium-sized terrestrial mammals in a lowland Amazonian rainforest in Loreto, Peru: A comparison of wet and dry season*. Universität für Bodenkultur Wien.

Bernal-Escobar, A., Payán, E., & Cordovez, J. M. (2015). Sex-dependent spatially explicit stochastic dispersal modeling as a framework for the study of jaguar conservation and management in South America. *Ecological Modelling, 299*, 40–50. https://doi.org/10.1016/j.ecolmodel.2014.12.002

Boron, V., Payán, E., MacMillan, D., & Tzanopoulos, J. (2016). Achieving sustainable development in rural areas in Colombia: Future scenarios for biodiversity conservation under land-use change. *Land Use Policy, 59*, 27–37. https://doi.org/10.1016/j.landusepol.2016.08.017

Briones-Salas, M., Lavariega, M. C., & Lira-Torres, I. (2012). Distribución actual y potencial del jaguar (*Panthera onca*) en Oaxaca, México. *Revista Mexicana de Biodiversidad, 83*(1), 246–257. http://www.scielo.org.mx/pdf/rmbiodiv/v83n1/v83n1a27.pdf

Castañeda, F. (2016). *A surprise at 2,200 meters*. Panthera. https://panthera.org/blog-post/surprise-2200-meters

Chacón-Pacheco, J. J., González-Maya, J. F., & Salas-Jiménez, M. A. (2014). Reaparición del jaguar (*Panthera onca*) en el departamento de Sucre, Colombia. *Mammalogy Notes, 1*(1), 8–9. https://doi.org/10.47603/manovol1n1.8-9

Comunicaciones CAM. (2022, August 17). Histórico: Por primera vez cámaras trampa registran un jaguar en el Huila. https://www.parquesnacionales.gov.co/sala-prensa/noticias/historico-por-primera-vez-camaras-trampa-registran-un-jaguar-en-el-huila/

De la Torre, J., González-Maya, J. F., Zarza, H., Ceballos, G., & Medellín, R. A. (2018). The jaguar's spots are darker than they appear: Assessing the global conservation status of the jaguar (*Panthera onca*). *Oryx, 52*(2), 300–315. https://doi.org/10.1017/S0030605316001046

Díaz-Pulido, A., & Payán-Garrido, E. (2012). *Manual de fototrampeo: Una herramienta de investigación para la conservación de la biodiversidad en Colombia*. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt.

Fernández-Rodríguez, C., Racero, J., & Calvano-Zúñiga, A. (2020). New records of jaguar (*Panthera onca*) in the department of Cesar, Colombia. *Mammalogy Notes, 6*(1), mn0119. https://doi.org/10.47603/manovol6n1.mn0119

GBIF. (2024). *GBIF occurrence download*. https://doi.org/10.15468/dl.c5z3p5

Griffith, D. M., Nivelo-Villavicencio, C., Rodas, F., Puglla, B., & Cisneros, R. (2022). New altitudinal records of *Panthera onca* (Carnivora: Felidae) in the Andean region of Ecuador. *Mammalia, 86*(2), 190–195. https://doi.org/10.1515/mammalia-2021-0136

Guggisberg, C. A. W. (1975). *Wild cats of the world*. Taplinger Publishing Company.

Hijmans, R. J., Cameron, S. E., Parra, J. L., Jones, P. G., & Jarvis, A. (2005). Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology, 25*(15), 1965–1978. https://doi.org/10.1002/joc.1276

Hoogesteijn, R., Hoogesteijn, A., Payán, E., & Marchini, S. (2011). Interacciones humanos–jaguares: ¿Son realmente peligrosos los jaguares para los seres humanos? *Mesoamericana, 15*, 343.

Jedrzejewski, W., Maffei, L., Espinosa, S., Wallace, R., Negrões, N., Morato, R., Tobler, M., Ayala, G., Ramalho, E., Payán, E., Hoogesteijn, R., González-Maya, J. F., Viscarra, M., Ferraz, K., Portugal, M., Parra, A., Polisar, J., Breitenmoser, C., & Breitenmoser, U. (2023). Jaguar conservation status in north-western South America. *Cat News, 16*, 23–34.

Kass, J. M., Pinilla-Buitrago, G. E., Paz, A., Johnson, B. A., Grisales-Betancur, V., Meenan, S. I., Attali, D., Broennimann, O., Galante, P. J., Maitner, B. S., Owens, H. L., Varela, S., Aiello-Lammens, M. E., Merow, C., Blair, M. E., & Anderson, R. P. (2023). Wallace 2: A shiny app for modeling species niches and distributions redesigned to facilitate expansion via module contributions. *Ecography, 2023*(3). https://doi.org/10.1111/ecog.06547

Kilshaw, K., Macdonald, D. W., & Johnson, P. J. (2011). *The use of camera trapping as a method to survey for the Scottish wildcat* (SNH Commissioned Report No. 479). Scottish Natural Heritage.

Lodeiro-Ocampo, N., Nigro, N. Á., & Falke, F. (2016). Seasonal use of upper montane forests by the jaguar in northern Argentina. *Cat News, 63*, 4–5.

Machado-Aguilera, M. C., Lemus-Mejía, L., Pérez-Torres, J., Zárrate-Charry, D. A., Arias-Alzate, A., & González-Maya, J. F. (2024). Preserving the spots: Jaguar (*Panthera onca*) distribution and priority conservation areas in Colombia. *PLOS ONE, 19*(3), e0300375. https://doi.org/10.1371/journal.pone.0300375

Medellín, R. A., De la Torre, A., Zarza, H., Chávez, C., & Ceballos, G. (2016). *El jaguar en el siglo XXI: La perspectiva continental*. UNAM.

Mendieta-Giraldo, L., Escobar-Lasso, S., Grajales-Suaza, E., & González-Maya, J. F. (2021). Not all gone: The rediscovery of jaguar (*Panthera onca*) and records of threatened monkeys in the Magdalena River Valley of Caldas Department, Colombia. *Journal of Threatened Taxa, 13*(3), 17865–17874. https://doi.org/10.11609/jott.6673.13.3.17865-17874

Padilla-Gómez, E., Santiago-Velazco, J., Lavariega, M., & Ramírez-Bautista, A. (2019). Noteworthy records of jaguar (*Panthera onca*), tayra (*Eira barbara*), and paca (*Cuniculus paca*) from southern Mexico. *Notas sobre Mamíferos Sudamericanos, 1*(1), 1–10. https://doi.org/10.31687/saremnms.19.0.13

Pardo-Vargas, L., & Payán-Garrido, E. (2015). Mamíferos de un agropaisaje de palma de aceite en las sabanas inundables de Orocué, Casanare, Colombia. *Biota Colombiana, 16*(1), 12–31.

Payán-Garrido, E., Carbone, C., Homewood, K., Paemelaere, E., Quigley, H., & Durant, S. M. (2013). Where will jaguars roam? The importance of survival in unprotected lands. In M. Ruiz-García & J. M. Shostell (Eds.), *Molecular population genetics, evolutionary biology and biological conservation of neotropical carnivores* (pp. 603–627). Nova Publishers.

Payán-Garrido, E., Moreno-Foglia, O., Mejía-González, A., & Valderrama-Vásquez, C. (2015). *Plan de manejo para la conservación del jaguar (Panthera onca) en el Valle del Cauca, Colombia*. Panthera Colombia; Corporación Autónoma Regional del Valle del Cauca.

Quigley, H., Foster, R., Petracca, L., Payán, E., Salom, R., & Harmsen, B. (2017). *Panthera onca*. The IUCN Red List of Threatened Species. https://doi.org/10.2305/IUCN.UK.2017-3.RLTS.T15953A50658693.en

Rabinowitz, A. R. (1999). The present status of jaguars (*Panthera onca*) in the southwestern United States. *The Southwestern Naturalist, 44*(1), 96–100.

Rabinowitz, A. R., & Zeller, K. A. (2010). A range-wide model of landscape connectivity and conservation for the jaguar (*Panthera onca*). *Biological Conservation, 143*(4), 939–945. https://doi.org/10.1016/j.biocon.2010.01.002

Rovero, F., Martin, E., Rosa, M., Ahumada, J. A., & Spitale, D. (2014). Estimating species richness and modelling habitat preferences of tropical forest mammals from camera trap data. *PLOS ONE, 9*(7), e103300. https://doi.org/10.1371/journal.pone.0103300

Scheffers, B. R., Yong, D. L., Harris, J. B. C., Giam, X., & Sodhi, N. S. (2011). The world's rediscovered species: Back from the brink? *PLOS ONE, 6*(7), e22531. https://doi.org/10.1371/journal.pone.0022531

Seymour, K. L. (1989). *Panthera onca*. *Mammalian Species, 340*, 1–9. https://doi.org/10.2307/3504096

Thompson, J. J., & Velilla, M. (2017). Modeling the effects of deforestation on the connectivity of jaguar (*Panthera onca*) populations at the southern extent of the species' range. *Endangered Species Research, 34*, 109–121. https://doi.org/10.3354/esr00840

Urrego, C. A. (2024). Registran jaguar en Caldas. *Revista Eureka*. https://eureka.umanizales.edu.co/registran-jaguar-en-caldas/

Villordo-Galván, A. J., Rosas-Rosas, O. C., Clemente-Sánchez, F., Martínez-Montoya, J. F., Tarango-Arámbula, L. A., Mendoza-Martínez, G., Sánchez-Hermosillo, M. D., & Bender, L. C. (2010). The jaguar (*Panthera onca*) in San Luis Potosí, Mexico. *The Southwestern Naturalist, 55*(3), 394–398.

Williams, J. E., & Blois, J. L. (2018). Range shifts in response to past and future climate change: Can climate velocities and species' dispersal capabilities explain variation in mammalian range shifts? *Journal of Biogeography, 45*(9), 2175–2189. https://doi.org/10.1111/jbi.13395

Zárrate-Charry, D. A., Massey, A. L., González-Maya, J. F., & Betts, M. G. (2018). Multi-criteria spatial identification of carnivore conservation areas under data scarcity and conflict: A jaguar case study in Sierra Nevada de Santa Marta, Colombia. *Biodiversity and Conservation, 27*(13), 3373–3392. https://doi.org/10.1007/s10531-018-1605-z