

Recent jaguar records confirm the conservation value of the Baritú–Tariquía corridor between Argentina and Bolivia

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Abstract Effective transboundary corridors play a crucial role in jaguar *Panthera onca* conservation. Local residents reported jaguar sightings along the Baritú–Tariquía Biological Corridor, which prompted us to carry out this camera-trap survey. We surveyed an area of 1,243 km² across the corridor to confirm jaguar presence. We used 50 single camera stations, with cameras placed c. 5 km apart. We placed the cameras along trails, streams and mountain ridges. We recorded jaguars at seven sites across the Corridor; at least three different individuals were identified. These records confirm the presence of the jaguar in the Baritú–Tariquía Biological Corridor between Argentina and Bolivia, a trans-frontier area of the Austral Yungas facing multiple threats but hosting one of the southernmost jaguar populations. Conservation efforts in border regions can promote collaboration and synergies between agencies and other conservation stakeholders, with important implications for wide-ranging predators such as jaguars and their habitats.

Keywords Argentina, Austral Yungas, corridor, felid conservation, jaguar, *Panthera onca*, transboundary conservation

Ranging from North America to Argentina and categorized as Near Threatened on the IUCN Red List (Quigley et al., 2017), most jaguar *Panthera onca* populations are declining because of habitat loss, prey depletion, retaliatory killings and the illegal trade of body parts (de la Torre et al., 2017; Nuñez & Aliaga-Rossel, 2017; IUCN Netherlands, 2020; Arias et al., 2021). Habitat loss at the extremes of the jaguar's range tends to increase isolation, dividing populations into smaller and more threatened subpopulations (de la Torre et al., 2017; Thompson et al.,

2021). In Argentina jaguars are categorized as Critically Endangered (Paviolo et al., 2019), with a 95% reduction of their historical distribution (Di Bitetti et al., 2016), whereas in Bolivia they are categorized as Vulnerable, with a 50% reduction of their historical distribution (Aguirre et al., 2019).

The mountain forests that make up the Austral Yungas ecoregion extend on both sides of the Argentina–Bolivia border, occupying an area of c. 56,000 km² (Malizia et al., 2012) and hosting the southernmost jaguar population of the Yungas (Perovic et al., 2015), one of the two southernmost jaguar enclaves (Di Bitetti et al., 2016). This is a diverse region, with an altitude range of 400–2,300 m, and high beta diversity and endemism (Brown et al., 2001). However, the Yungas face major threats: large-scale deforestation has occurred across all altitudes (Politi et al., 2012). In Argentina, 31% of this forest had been cleared by 2010 (Malizia et al., 2012) and 35% by 2021 (Global Forest Watch, 2022); in Bolivia, 32% of this forest had been lost by 2021 (Global Forest Watch, 2022). The loss of native forests is a result of large-scale agriculture, extensive livestock farming, timber extraction, infrastructure development, exploration for fossil fuels, and forest fires (Perovic et al., 2015; MMAyA, 2020; Thompson et al., 2021). Fires are often initiated by local people, ranchers, farmers and sugar refineries to clear land for crops, to supposedly improve pastures and to justify logging (Perovic et al., 2015; MMAyA, 2020). Fires cause drastic changes in forest cover, structure and species composition, and may be accompanied by mortality, or displacement of species, changing the supply of resources and the quality of habitat for jaguars and their native prey (Perovic et al., 2015). These multiple and largely uncontrolled threats could lead to the loss of connectivity between the remaining Yungas between Argentina and Bolivia (Perovic et al., 2015; Maffei et al., 2016; Quigley et al., 2017).

In 2005 a binational initiative proposed the creation of a 4,212 km² Baritú–Tariquía Biological Corridor linking the best-preserved sectors of the Argentine–Bolivian Yungas (PROMETA, 2005) and connecting two protected areas where jaguars are known to be present: Tariquía National Reserve (2,469 km², Bolivia) and Baritú National Park (724 km², Argentina). This initiative aims to maintain cross-border connectivity and facilitate the movement of animals between the two protected areas (Cuyckens et al., 2014; Perovic et al., 2015; Maffei et al., 2016). However, the Baritú–Tariquía Biological Corridor is still awaiting effective legal protection, despite it being essential for ensuring the connectivity of the jaguar population straddling the border.

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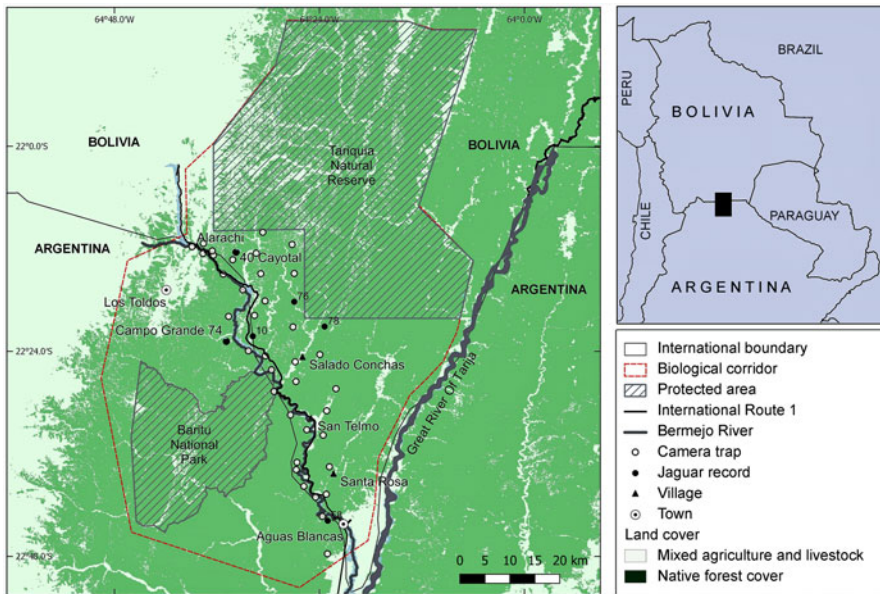


FIG. 1 Baritú–Tariquía Biological Corridor joining Baritú National Park (Argentina) and Tariquía National Reserve (Bolivia), indicating the locations of camera traps and cameras with jaguar records (the latter are numbered).

Local residents have reported jaguar sightings along the Baritú–Tariquía Biological Corridor (Cuyckens et al., 2014), prompting us to carry out a camera-trap survey. During June 2019–March 2020, we surveyed an area of 1,243 km² across the Corridor to confirm jaguar presence (Fig. 1). We used 50 stations, each with a single camera (Trophy Cam HD, Bushnell, Overland Park, USA), placed c. 5 km apart. We placed the cameras along trails, streams and mountain ridges. This resulted in a camera-trapping effort of 10,695 trap-days.

We recorded jaguars at six sites across the Corridor, and identified at least three individuals. In Bolivia during September–December 2019, jaguars were recorded at five sites, all between Tariquía National Reserve and Baritú National Park: a mountain ridge in Cayotal village (Fig. 1, site 40); a site 1.5 km from Angosto de Alarachi, suggested as a potential jaguar border-crossing point (Cuyckens et al., 2014; Fig. 1, site 42; Plate 1a); 1.8 and 2.0 km from Tariquía National Reserve (Fig. 1, sites 78 and 76, respectively); and near Campo Grande village c. 3 km from Bermejo River (Fig. 1, site 10). In Argentina three jaguars were photographed during March–April 2020: two by the same camera but 49 days apart, 1.45 km from Bermejo River and 5.00 km from Baritú National Park (Fig. 1, site 74; Plate 1b); and a third individual photographed in April 2020, 800 m from Bermejo River (Fig. 1, site 58).

From our survey we conclude that jaguars are present in the Baritú–Tariquía Biological Corridor, and that their occurrence at several sites and the presence of several individuals suggest that this is a functional corridor for this key jaguar population. The records reinforce the designation of this area as a Jaguar Conservation Unit (Baritú–Calilegua Jaguar Conservation Unit) and support the proposal to connect it with jaguar populations in

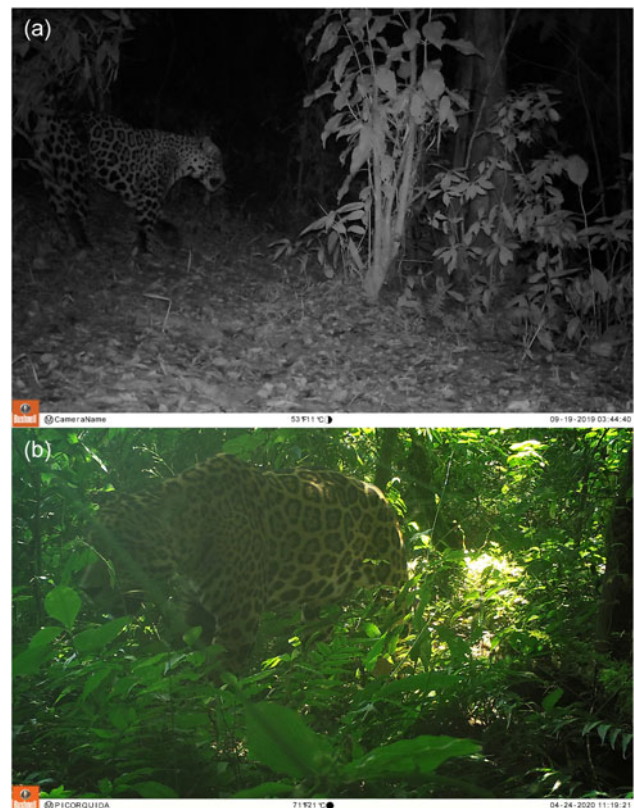


PLATE 1 (a) Adult male jaguar *Panthera onca* recorded by camera trap 42 on a mountain ridge in Sidras village (Bolivia). (b) Adult jaguar recorded by camera trap 74, 1.45 km from Bermejo River and 5.00 km from Baritú National Park (Argentina).

the Chaco and Gran Chaco (Thompson et al., 2021). Confirmation of jaguars in this area between Argentina and Bolivia provides a strong argument for securing legal protection for the Corridor and for involving the local

community in updating its management plan and demarcating strategic areas for the sustainable management interventions required to restore and maintain connectivity.

International borders are generally drawn for political rather than ecological reasons and consequently conservation targets on either side of a border are potentially subject to different laws and environmental management practices. Transboundary conservation is of paramount importance for jaguars and habitat connectivity but presents important challenges as cross-border collaborations can be complex, costly and time-consuming. Proposed priority sites and actions resulting from this research are being discussed by a number of institutions, including the Administración de Parques Nacionales of Argentina, the provincial governments of Salta and Jujuy, the Servicio Nacional de Áreas Protegidas of Bolivia, the departmental government of Tarija-Bolivia, NGOs and local people.

The implementation of cross-border conservation projects in the Baritú–Tariquí Biological Corridor can deliver multiple benefits. However, to achieve this, a set of conditions must be met, including achieving effective protected area management, recruiting, training and equipping rangers, and improving funding for monitoring and field research.

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Conflicts of interest None.

Ethical standards This research abided by the *Oryx* guidelines on ethical standards and followed proposed principles and the ethical code of conduct for the socially responsible use of technology and monitoring data (Sharma et al., 2020).

References

- AGUIRRE, L.F., TARIFA, T., WALLACE, R.B., BERNAL, N., SILES, L., ALIAGA-ROSSEL, E. & SALAZAR-BRAVO, J. (2019) Lista actualizada y comentada de los mamíferos de Bolivia. *Ecología en Bolivia*, 54, 107–147.
- ARIAS, M., HINSLEY, A., NOGALES-ASCARRUNZ, P., NEGROES, N., GLIKMAN, J.A. & MILNER-GULLAND, E.J. (2021) Prevalence and characteristics of illegal jaguar trade in north-western Bolivia. *Conservation Science and Practice*, 3, e444.
- BROWN, A., GRAU, R., MALIZIA, L. & GRAU, A. (2001) Los bosques nublados de la Argentina. In *Bosques Nublados del Neotrópico* (eds M. Kapelle & J.A. Brown), pp. 623–660. INBio, Santa Domingo, Costa Rica.
- CUYCKENS, G.A.E., FALKE, F. & PETRACCA, L. (2014) Jaguar *Panthera onca* in its southernmost range: use of a corridor between Bolivia and Argentina. *Endangered Species Research*, 26, 167–177.
- DE LA TORRE, J.A., 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, 300–315.
- DI BITETTI, M.S., DE ANGELO, C., QUIROGA, V., ALTRICHTER, M., PAVIOLO, A., CUYCKENS, G.A.E. et al. (2016) Estado de conservación del jaguar en Argentina. In *El Jaguar en el Siglo XXI: La Perspectiva Continental* (eds R.A. Medellín, J.A. de la Torre, H. Zerda, C. Chávez & G. Ceballos), pp. 449–481. Fondo de la Cultura Económica, Universidad Nacional Autónoma de México, Mexico City, Mexico.
- GLOBAL FOREST WATCH (2022) *Global Forest Watch: Forest Monitoring Designed for Action*. World Resources Institute. globalforestwatch.org [accessed 12 August 2022].
- IUCN NETHERLANDS (2020) *Unveiling the Criminal Networks Behind Jaguar Trafficking in Bolivia*. IUCN, Amsterdam, The Netherlands.
- MAFFEI, L., RUMIZ, D., ARISPE, R., CUÉLLAR, E. & NOSS, A. (2016) Situación del jaguar en Bolivia. In *El Jaguar en el Siglo XXI: La Perspectiva Continental* (eds R.A. Medellín, J.A. de la Torre, H. Zerda, C. Chávez & G. Ceballos), pp. 352–365. Fondo de Cultura Económica, Universidad Nacional Autónoma de México, Mexico City, Mexico.
- MALIZIA, L., PACHECO, S., BLUNDO, C. & BROWN, A. (2012) Caracterización altitudinal, uso y conservación de las Yungas Subtropicales de Argentina. *Ecosistemas*, 21, 1–2.
- MMAYA (2020) *Plan de Acción para la Conservación del Jaguar (Panthera onca) 2020–2025*. Ministerio de Medio Ambiente y Agua, La Paz, Bolivia.
- NUÑEZ, A. & ALIAGA-ROSSEL, E. (2017) Jaguar fangs trafficking by Chinese in Bolivia. *CATNews*, 65, 50–51.
- PAVIOLO, A., DE ANGELO, C., DE BUSTOS, S., PEROVIC, P.G., QUIROGA, V.A., LODEIRO OCAMPO, N. et al. (2019) *Panthera onca*. In: *Categorización 2019 de los Mamíferos de Argentina Según su Riesgo de Extinción. Lista Roja de los mamíferos de Argentina*. cma.sarem.org.ar/es/especie-nativa/panthera-onca? [accessed 12 August 2022].
- PEROVIC, P.G., DE BUSTOS, S., RIVERA, L., ARGUEDAS MORA, S. & LIZARRAGA, L. (2015) *Plan Estratégico Para la Conservación del Yaguararé (Panthera onca) en las Yungas Argentinas*. Administración de Parques Nacionales, Secretaría de Ambiente de Salta, Secretaría de Gestión Ambiental de Jujuy y Escuela Latinoamericana de Áreas Protegidas, Salta, Argentina.
- POLITI, N., HUNTER, M. & RIVERA, L. (2012) Assessing the effects of selective logging on birds in Neotropical piedmont and cloud montane forests. *Biodiversity and Conservation*, 21, 3131–3155.
- PROMETA (2005) *Corredor Ecológico Binacional Tariquí (Bolivia) – Baritú (Argentina). Plan de Conservación de Sitios 2005–2009*. Protección del Medio Ambiente Tarija, Tarija, Bolivia.
- QUIGLEY, H., FOSTER, R., PETRACCA, L., PAYAN, E., SALOM, R. & HARMSEN, B. (2017) *Panthera onca* (errata version published in 2018). In *The IUCN Red List of Threatened Species 2017*. dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T15953A50658693.en.
- SHARMA, K., FIECHTER, M., GEORGE, T., YOUNG, J., ALEXANDER, J.S., BIJJOOR, A. et al. (2020) Conservation and people: towards an ethical code of conduct for the use of camera traps in wildlife research. *Ecological Solutions and Evidence*, 1, e12033.
- THOMPSON, J., VELILLA, M., MORATO, R.G., DE ANGELO, C., PAVIOLO, A.J., QUIROGA, V. et al. (2021) Developing transboundary monitoring of the jaguar in southern South America. *CATNews*, 72, 11–16.