

Research report

Camera-trap detection of the bush dog: Further evidence for extreme rarity

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Keywords: *Speothos venaticus*, detection probability, Relative Abundance Index, terrestrial carnivores

Abstract

The bush dog *Speothos venaticus* is widely regarded as one of the rarest Neotropical carnivores, yet empirical evidence supporting this perception remains limited. Here, we synthesize one of the most extensive camera-trap datasets assembled for the species to quantitatively assess its rarity in South America, a portion of its Neotropical range. We compile camera-trapping data collected by the Wildlife Conservation Society between 2001 and 2025, encompassing 125 surveys at 97 sites in seven countries, totalling 6,756 camera-trap stations and 611,159 camera-trap nights below 2,500m a.s.l. Bush dogs were recorded on only 12 occasions across 12 sites, yielding a capture rate of 0.002 independent events per 100 camera-trap nights and an estimated detection probability of 0.011. No detections were obtained in Paraguay, Peru, or Venezuela despite substantial sampling effort. To contextualise these results, we compared bush dog encounter rates with those of other widely distributed South American carnivores using the same dataset. Relative abundance indices for bush dogs were approximately 50 times lower than those of the short-eared dog *Atelocynus microtis*, 100 times lower than those of jaguar *Panthera onca*, and nearly 280 times lower than those of ocelot *Leopardus pardalis*. Comparisons with independent regional datasets further corroborate the species' extreme rarity. Differences in body size, sociality, or detectability are unlikely to fully account for such low encounter rates. Our findings indicate that bush dogs occur at exceptionally low densities—likely well below one individual per 100km² across much of their range—rendering the species highly vulnerable to habitat loss, disease, and other anthropogenic pressures. We conclude that current evidence helps support reassessment of the species' conservation status.

Introduction

The bush dog *Speothos venaticus* is a poorly understood social canid of Latin America (Eisenberg 1989, Emmons and Feer 1990, Peres 1991, DeMatteo 2008, Michalski 2010, DeMatteo et al. 2011). Weighing up to 7kg and living in small groups of up to 12 individuals (Wallace et al. 2010), it is distributed across much of the tropical lowlands of Central and South America, occupying continuous forests and forest-grassland mosaics below

2,500m a.s.l. from Costa Rica south to south-eastern Brazil and north-eastern Argentina (DeMatteo et al. 2011, Sáenz-Bolaños et al. 2019, Reyes et al. 2025). Bush dogs are cooperative hunters that prey on a wide range of species (Wallace et al. 2010) and maintain large home ranges, reaching up to 140km² for a single-family group in the partially fragmented Brazilian Cerrado (Lima et al. 2012).

Despite its wide distribution, the bush dog remains one of the least documented carnivores in the Neotropics (de Oliveira et al. 2018). It is currently

The following is the established format for referencing this article:

Wallace, R.B., Lizcano, D.J., Ayala, G., Viscarra, M., Zapata-Rios, G., Valenzuela, L., Isasi-Catalá, E. and Ramos, Y. 2026. Camera-trap detection of the bush dog: Further evidence for extreme rarity. *Canid Biology & Conservation* 29(5): 15-20.

categorized as Vulnerable on the IUCN Red List based on a 2011 assessment that identified apparent rarity and inferred population decline (DeMatteo et al. 2011). Detection remains exceptionally low (de Oliveira et al. 2018), and experienced field biologists and indigenous guides report only sporadic encounters (R.B. Wallace pers. obs.). With more than a decade of camera-trap data from across South America (de Oliveira et al. 2018, Nagy-Reis et al. 2020, Antunes et al. 2022), outputs consistently demonstrate extremely low detection probabilities, reinforcing the need for additional research and a prompt reassessment of the species' threat category. The limited availability of data on bush dogs further justifies the continued publication of occurrence records, including new localities and opportunistic detections (Saldivar Bellassai et al. 2020, Giordano et al. 2024, Reyes et al. 2025). Indeed, previous efforts to systematise camera trap data for bush dogs in Brazil emphasised the extreme rarity of the species (de Oliveira et al. 2018).

In this note, we further assess the rarity of the bush dog by systematising *Speothos* occurrence records obtained from Wildlife Conservation Society surveys across South America, with an emphasis on the western Amazon, and conducting comparative analyses with selected broadly distributed carnivores. We aim to provide additional robust empirical evidence regarding the species' extreme rarity—data that are essential for conservation assessments.

Methods

We compiled Wildlife Conservation Society (WCS) camera-trap datasets from across South America, spanning Venezuela to Paraguay, collected between 2001 and 2025 (Figure 1). Sampling effort varied among countries and sites, totalling 6,932 camera-trap stations and 712,321 trap-nights. For bush dog analyses, we restricted effort to sites below 2,500m a.s.l., consistent with the species' known elevational range (Reyes et al. 2025), resulting in a reduced dataset of 6,756 stations and 611,159 trap-nights (Table 1).

Most surveys were designed to estimate and monitor jaguar *Panthera onca* population densities (Wallace et al. 2003, 2012, Silver et al. 2004, Isasi-Catalá 2013, Isasi-Catalá et al. 2016, Ayala et al. 2020, 2022, Maffei et al. 2022), with camera placement guided by the likelihood of jaguar or prey presence, particularly at locations with recent tracks. At locations with roads, cameras were placed along roads to increase jaguar detection probability, with additional stations placed in the forest using animal tracks and trails to form a sampling polygon. However, for many survey sites in the western Amazon roads were absent, and instead we used river beaches to increase jaguar detection probability, again with additional stations in the surrounding forest. In both cases roughly 35% of stations were placed along roads or rivers and the remaining 65% in the forest. Camera-trapping was predominantly conducted during the dry season (84% of surveys). At each site, between 36 and 110 stations were deployed, covering areas of approximately 35–280km², with camera trap stations typically separated by between 1.6 and 2.5km. Most camera trap campaigns covered at least 100km² and employed more than 60 stations and, as such, sampled a wide range of habitats. Early surveys (2001–2009) primarily used Camtrakker® film cameras (Camtrakker, Watkinsville, Georgia, USA) alongside other film-based models (Leaf River, DeerCam, TrailMaster), whereas later efforts (2011 to

2025) relied mainly on digital cameras, including Reconyx HC500®, HC550® and HP2X® digital camera traps, supplemented by other brands (Bushnell). Table 2 details camera trapping effort according to each camera type and camera trap location categories (Beach, Stream, Forest, Savanna, Animal Trail, Human Trail).

Standard jaguar survey protocols were followed, typically employing paired cameras at each station to capture both flanks of passing animals, thereby facilitating individual jaguar identification. Cameras were positioned opposite each other at heights of approximately 40–50cm and at least 1m from the expected travel path. Units operated continuously (24h/day), generally with a minimum interval of five minutes between events, although settings varied among sites and over time. Digital camera traps were programmed to capture 1–10 images per trigger event. We defined a trap-night as a 24-hour sampling period at a station with at least one operational camera. All images were time- and date-stamped.

Camera traps were also deployed as part of broader biodiversity surveys. In these surveys, a single camera was installed per station, with 60–120 stations placed opportunistically at intervals of approximately 1–2km across study areas ranging from 60–250km². Camera models and settings (film and digital) followed those described for jaguar surveys, with the exception that only one camera was used per station.

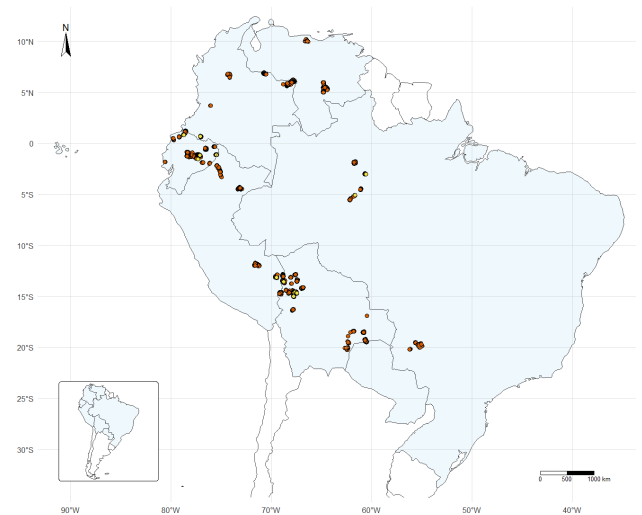


Figure 1. Map of camera-trap survey locations (orange dots) conducted by the Wildlife Conservation Society between 2001 and 2025 below 2,500m a.s.l. across seven South American countries (blue background), with locations where bush dog was recorded shown with yellow dots.

Table 1. Camera-trap surveys conducted by the Wildlife Conservation Society between 2001 and 2025 below 2,500m a.s.l. across seven South American countries, summarizing the number of surveys, sites, elevational range, trap stations, trap nights, photographs, and independent events.

Country	Years	Num Surveys	Num Sites	Elevation range (m)	Num Trap Stations	Num Trap Nights	Num Photos	Num Events
Bolivia	2001–2025	77	69	150–2,500	3,789	341,010	1,412,479	235,400
Brazil	2007–2021	6	4	150–800	483	36,375	46,542	7,750
Colombia	2015–2023	9	6	100–2,500	785	74,490	506,944	84,500
Ecuador	2009–2018	23	12	200–2,500	824	78,395	47,256	15,750
Paraguay	2012–2013	1	1	250–800	36	3,564	1,789	290
Peru	2014–2018	4	3	200–700	476	42,840	64,554	10,800
Venezuela	2009–2014	5	2	100–2,500	363	34,485	37,278	6,300
Total		125	97	100–2,500	6,756	611,159	2,122,841	362,210

We compiled all bush dog records obtained from these camera-trapping campaigns. Relative abundance indices (RAI) were calculated following O'Brien et al. (2003) as the number of independent photographic events per 100 trap-nights (RAI2). Photographic events were considered independent if: (a) consecutive images from the same camera depicted clearly distinguishable individuals; (b) consecutive images of bush dogs were separated by at least 30 minutes; or (c) records were non-consecutive images from the same camera.

To account for imperfect detection, we modelled detection as Bernoulli process, where presence at a given site results in detection with probability p and non-detection with probability $1 - p$. Detection histories (1 = detection, 0 = non-detection) were generated for each camera station using repeated

sampling intervals of seven days. Detection probability was defined as the likelihood of a bush dog passing a camera and being successfully recorded during a sampling interval (MacKenzie et al. 2018). Analyses were conducted using the function `occu` in the `unmarked` package (Kellner et al. 2023) in R (R Core Team 2025), assuming constant detection probability across sites (null model).

To contextualize bush dog results, we calculated equivalent indices for other widespread South American carnivores (Table 3), including ocelot *Leopardus pardalis*, jaguar, and for the Amazonian sites, the short-eared dog *Atelocynus microtis*.

Table 2. Summary of camera-trapping effort across the seven surveyed countries. Each row represents the number of stations and survey effort for each camera type-model combination within a country, categorised by camera placement relative to habitat and trail type. Entries with ‘-’ denote 0 trap nights.

Camera				Trap Nights by Habitat				Trap Nights by Trail Type	
Country	Type	Model	No. Stations	Beach	Stream	Forest	Savanna	Animal	Human
Bolivia	Film	Trail Master	644	-	120	34,920	3,600	29,760	7,320
Bolivia	Film	Camtrakker	822	6,000	-	43,320	-	49,200	120
Bolivia	Film	DeerCam	153	3,600	2,820	3,600	600	9,000	180
Bolivia	Film	LeafRiver	214	900	-	11,940	-	12,840	-
Bolivia	Digital	Reconyx HC 500	1,583	53,640	14,100	18,900	8,340	90,060	4,920
Bolivia	Digital	Reconyx HC 550	244	9,300	1,200	3,600	540	14,640	-
Bolivia	Digital	Reconyx HP2X	116	-	-	6,960	-	6,960	-
Bolivia	Digital	Bushnell HD	9	-	-	540	-	540	-
Bolivia	Digital	Bushnell E2	4	-	-	240	-	120	120
Venezuela	Digital	Bushnell HD	6	-	-	-	-	180	180
Venezuela	Digital	Cuddeback	119	540	600	5,400	600	7,140	-
Venezuela	Digital	Moultrie	65	120	180	3,600	-	3,900	-
Venezuela	Digital	Reconyx HC 600	82	120	2,400	2,400	-	4,800	120
Venezuela	Digital	Reconyx HC 500	82	-	2,460	2,460	-	4,800	120
Venezuela	Digital	Reconyx PC 900	9	-	240	300	-	540	-
Colombia	Digital	Reconyx HC 500	325	300	1,200	14,400	3,600	19,500	-
Colombia	Digital	Reconyx HC 550	294	-	1,200	14,400	2,040	17,640	-
Colombia	Digital	Bushnell HD	166	1,200	1,200	7,200	360	9,960	-
Ecuador	Film	Camtrakker	479	-	3,600	25,140	-	24,300	4,440
Ecuador	Film	DeerCam	25	300	-	1,200	-	1,500	-
Ecuador	Digital	Reconyx HC 500	320	540	600	18,060	-	18,000	1,200
Perú	Digital	Bushnell HD	115	600	300	6,000	-	6,060	840
Perú	Digital	Reconyx HC 550	107	420	600	5,400	-	6,420	-
Perú	Digital	Reconyx HC 500	207	-	480	11,940	-	12,420	-
Perú	Digital	Reconyx HC 600	47	420	-	2,400	-	2,820	-
Paraguay	Digital	Bushnell Trophy	32	-	-	1,920	-	1,920	-
Paraguay	Digital	Cuddeback	4	-	-	240	-	240	-
Brazil	Digital	Cuddeback	483	2,640	1,440	20,760	4,140	28,980	-

Results

Across a total sampling effort of 6,756 camera-trap stations on 611,159 trap-nights below 2,500m a.s.l., spanning 125 surveys at 97 sites in seven countries (Table 1), bush dogs were recorded on only 12 occasions at 12 sites. These detections corresponded to 14 individuals and 55 photos (33 in Bolivia, five in Brazil, five in Colombia and 12 in Ecuador; Table 3). Estimated detection probability was extremely low ($p = 0.0106$, $SE = 0.0203$; Table 4). No records were obtained in Paraguay, Peru, or Venezuela, despite these countries accounting for >13% of total sampling effort (>80,000 trap-nights).

The RAI2 for bush dogs was 0.002 independent events per 100 trap-nights (Table 4). In contrast, values derived from the same dataset were substantially higher for other widespread carnivores: 0.1014 for the short-eared dog, 0.2159 for the jaguar, and 0.5298 for the ocelot, corresponding to rates approximately 50, 100, and 280 times greater than those of bush dogs, respectively (Table 4).

Discussion

Although our camera-trap dataset is geographically biased toward the western Amazon and is not exhaustive, it represents a massive sampling effort. The large number of detections for other carnivores further demonstrates the effectiveness of our survey design for wildlife detection. Comparison with other published datasets reinforces the extreme rarity of bush dogs in South America. Very low detection rates (0.06–0.185 individuals per 100 trap nights) were recorded at several Amazonian locations across Brazil (de Oliveira et al. 2018). However, whilst the Brazilian study used a slightly different measure (individuals vs. events), detection rates in Brazil were notably higher than in our study (de Oliveira et al. 2018), which may reflect greater abundance in the central Amazon as opposed to the western Amazon.

In the Amazon Camera Trap dataset (Antunes et al. 2022), only 38 bush dog events were recorded among more than 150,000 independent vertebrate events. WCS contributed roughly one-third of the vertebrate records in that dataset, including the bush dog records reported here, which account for 11 of the 38 total events. This indicates that our capture rates in the western Amazon are consistent with broader regional patterns.

The Neotropical Carnivore dataset (Nagy-Reis et al. 2020), which compiles records from camera traps, scats, observations, roadkill, literature, and museum collections, similarly highlights bush dog rarity. This dataset included 8,391 ocelot records, 5,176 jaguar records, 384 short-eared dog records, and 313 bush dog records. While differences are somewhat less extreme than in our dataset, the pattern remains: bush dogs and short-eared dogs are less frequently detected than ocelots or jaguar.

It is possible that bush dog biology could reduce their detectability. Bush dogs are smaller and lower to the ground than short-eared dogs, ocelots, or jaguars, potentially reducing capture probability. However, their body size

and shape are similar to the paca *Cuniculus paca*, the most frequently detected vertebrate in the Amazon Camera Trap dataset (11,865 records; Antunes et al. 2022). Bush dogs are also social, which would theoretically increase detection rates. In our dataset, pacas produced 46,679 photos, 39,861 independent events, a RAI2 of 6.522 independent events/100 trap-nights, and a detection probability of 0.871. This suggests that body size and shape cannot explain the extremely low bush dog encounter rates. However, it is important to note that the increased detection rates in Brazil (de Oliveira et al. 2018) might be attributable to their lower placement height (30cm) as opposed to 40–50cm in our study.

DeMatteo et al. (2011) proposed that bush dogs may avoid forest or animal trails used for camera trap placement. Given our intensity of camera-trapping effort, this explanation seems unlikely. Moreover, the use of randomly placed camera traps for Camera Trap Distance Sampling (Howe et al. 2017), which allows estimation of population density for non-identifiable mammals (e.g., Wallace et al. In Review), will soon clarify whether bush dogs avoid traditional camera-trap locations.

Our camera-trap dataset is geographically biased toward continuous rainforest sites in the western Amazon and complements and concurs with efforts in the Brazilian Amazon (de Oliveira et al. 2018). Nevertheless, sampling has also occurred in non-Amazonian ecoregions where bush dogs are predicted to occur, albeit with low capture rates (DeMatteo et al. 2011, Isasi-Catalá et al. 2015). Additional analyses of camera-trap efforts across other major ecoregions—such as the Caatinga, Cerrado, Llanos de Moxos, Llanos de Orinoco, Venezuelan Coastal Range and Pantanal—are needed to determine whether the extremely low capture rates observed here are consistent across the species' range (DeMatteo et al. 2011).

Our results indicate that bush dogs are at least an order of magnitude rarer than iconic Neotropical carnivores, including the jaguar, the elusive ocelot, and the rarely observed short-eared dog (also known as the “ghost dog”). None approach the extraordinary rarity of bush dogs. For context, jaguar densities in the western Amazon are estimated at 2–3 individuals per 100km² (Jędrzejewski et al. 2018), while mean ocelot densities across Latin America are approximately 20 individuals per 100km² (Villas Boas Concione et al. 2025). Based on relative encounter rates, bush dog densities can be extrapolated to roughly seven individuals/groups per 10,000km². This estimate is extremely low but should be interpreted cautiously, given uncertainties in detection probabilities and the fact that bush dogs occur both in small groups and as solitary individuals (Wallace et al. 2010, DeMatteo et al. 2011).

Overall, our findings, supported by regional databases, underscore that bush dogs are among the rarest mammals in tropical South America. Relative encounter rates suggest densities typically well below one animal per 100km², and in Amazonian forests—the core of their range (DeMatteo et al. 2011)—possibly less than one animal per 350km². Such extremely low densities, combined with large home ranges (>140km²) or potentially semi-nomadic behaviour (Lima et al. 2012), render the species highly vulnerable to habitat destruction, fragmentation, climate change, fires, road development, and direct persecution.

Table 3. Total number of photographs for five widespread terrestrial mammals recorded in camera-trap surveys conducted by the Wildlife Conservation Society between 2001 and 2025 below 2,500m a.s.l. across seven South American countries.

Country	Years	Jaguar	Ocelot	Short-eared dog	Bush dog	Paca
Bolivia	2001–2025	8,692	18,271	4,067	33	26,810
Brazil	2007–2021	55	295	24	5	1,837
Colombia	2015–2023	317	2,253	0	5	8,712
Ecuador	2009–2018	304	783	107	12	3,732
Paraguay	2012–2013	31	90	0	0	46
Peru	2014–2018	164	675	145	0	5,321
Venezuela	2009–2014	27	63	0	0	221
Total		9,590	22,430	4,343	55	46,679

Table 4. Summary of photos, independent events, Relative Abundance Index, and detection probability for five widespread terrestrial mammals recorded in Wildlife Conservation Society camera-trap surveys conducted between 2001 and 2025 below 2,500m a.s.l. across seven South American countries.

Species	Num Photos	Num Events	Relative Abundance Index (RAI ₂)	Detection probability (SE)
Jaguar	9,590	1,320	0.2159	0.123 (0.055)
Ocelot	22,430	3,238	0.5298	0.491 (0.173)
Short-eared dog	4,343	620	0.1014	0.103 (0.083)
Bush dog	55	12	0.0019	0.011 (0.0203)
Paca	46,679	39,861	6.5220	0.871 (0.101)

Disease may represent an additional, and potentially severe threat. Social behaviour can facilitate rapid intra-group pathogen transmission, while low population densities, large home ranges, and limited inter-group contact likely reduce recovery potential after outbreaks. Pathogens transmitted by domestic dogs *Canis familiaris*—including canine distemper virus, parvovirus, and rabies—pose a particularly high risk in landscapes increasingly influenced by roads, human settlements, hunting camps, and extractive activities (DeMatteo 2008, DeMatteo et al. 2011). Even sporadic exposure could lead to local population collapse in small, isolated, or fragmented populations.

Our findings demonstrate comprehensive empirical evidence of the species extreme rarity, supporting previous analyses in Brazil (de Oliveira et al. 2018), and addressing a critical knowledge gap essential for reassessing its IUCN Red List status.

Acknowledgements

We thank the Wildlife Conservation Society (WCS) for support for camera trapping monitoring efforts across Latin America, as well as the dozens of local guides and researchers who helped generate camera trap data over the last 25 years. In Bolivia we also thank the Gordon and Betty Moore Foundation, Legacy Landscapes Fund, MacArthur Foundation, Blue Moon Fund, Beneficia Foundation, USAID, Gas TransBoliviano S.A., Disney Wildlife Conservation Fund, Woodland Park Zoological Society, and Liz Claiborne & Art Ortenberg Foundation for support for camera-trapping monitoring efforts. In Brazil we are grateful to the Gordon and Betty Moore Foundation. In Colombia, the Proyecto Vida Silvestre is a voluntary conservation initiative which supported camera trap efforts and is funded by Ecopetrol S.A., WCS, Fondo Acción, and Fundación Santo Domingo. In Ecuador we thank the Gordon and Betty Moore Foundation, the John D. and Catherine T. MacArthur Foundation, USAID, Woodland Park Zoo, and the Global Environmental Facility (GEF). In Peru we thank the Gordon and Betty Moore Foundation, USAID, and Servicio Nacional de Áreas Naturales Protegidas por el Estado (SERNANP). In Venezuela we thank Idea Wild, Banco Exterior, Río Verde, Iniciativa de Especies Amenazadas (IEA) de PROVITA, Fundación para la Defensa de la Naturaleza (FUDENA), and Programa de Estimulo a la Innovación e Investigación del Ministerio del Poder Popular para Ciencia, Tecnología e Innovación. We are also extremely grateful to the Ayers Wild Cat Conservation Trust and the Bezos Earth Fund for supporting a workshop to help bring together our databases for collective analysis. Finally, we thank Karen DeMatteo and an anonymous reviewer for helpful comments and suggestions on the manuscript.

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