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THE USE OF SINGLE-ROPE BRIDGES BY ARBOREAL MAMMALS IN AN ATLANTIC FOREST HOUSING DEVELOPMENT AREA

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Abstract: Forest gaps created by urban expansion and infrastructure construction pose a significant challenge to arboreal organisms by isolating habitat patches and increasing mortality. Single-rope bridges can alleviate the impacts of fragmentation by linear infrastructure. In this study, we monitored 15 single-rope bridges installed in an expanding urban area of Mata de São João, Bahia, Brazil. Our primary goal was to investigate their use by arboreal mammals, evaluate the effect of bridge material type, length, and canopy cover, and determine if usage increased over time. Using camera-traps, we recorded eight mammal species using bridges, with six species confirmed to be crossing: *Callithrix jacchus*, *Marmosa sp.*, *Chaetomys subspinosus*, *Guerlinguetus brasiliensis*, *Didelphis sp.*, and *Coendou insidiosus*. Species recorded but with no crossing confirmed were *Rhipdomys mastacalis* and *Bradypus torquatus*. Thick sisal ropes

showed a tendency to promote a higher crossing rate compared to nylon rope types. The bridge length and canopy cover were negligible factors. We also found that the time since installation (*i.e.* the time elapsed since bridge installation, measured by sequential campaigns) tends to reduce the frequency of records, but the frequency of crossings remained unaffected. Our findings reaffirm the functional use of low-cost rope bridges by arboreal mammals while crossing small gaps, and suggest that the success of crossing can be improved by the bridge material. Single-rope bridges offer a high benefit-cost ratio, enabling greater deployment and wider coverage for wildlife crossings. In urban and peri-urban contexts, this low-cost disposal can reduce threats that arboreal mammals face when descending to the ground.

Keywords: canopy fauna; connectivity; fragmentation; low-cost canopy bridge; wildlife crossing structure.

INTRODUCTION

Conversion of natural forests into fragmented landscapes poses a significant challenge for tropical forest biomes, including habitat loss and isolation, and a rise in anthropogenic disturbances (Hansen *et al.,* 2020). Despite its limited spatial coverage relative to other land-uses, anthropogenic infrastructure, such as buildings and linear structures, generates highly inhospitable matrices for native biodiversity (Ramírez-Delgado *et al.,* 2022). Furthermore, the isolation imposed by linear structures increases the incidence of wildlife accidents, such as vehicle collisions and electrocution, which may result in higher mortality rates and greater likelihood of local extinctions (Al-Razi *et al.,* 2019).

While species with low habitat specificity and mobility restrictions can easily move between isolated habitat remnants, those with such restrictions, as arboreal organisms, struggle to cross open areas and tend to remain isolated (Laurance et al., 2009). For most arboreal organisms,

canopy connection is extremely important, and minor discontinuities can limit their movement (Gracanin & Mikac 2023). However, when faced with habitat discontinuity, all may risk moving on the ground or utilizing built infrastructure, such as power lines, to reach new areas (Soanes & Van Der Ree 2015).

To mitigate the impacts of linear infrastructures, strategies generally focus on altering human behavior (e.g., speed-reducing radars; Dumalakas *et al*. 2025) or preventing animals from entering hazardous areas. This second approach includes insulating power lines to prevent electrocution (Al-Razi *et al*. 2019), using deterrents (Brieger *et al*., 2018), and installing crossing structures (Glista *et al.,* 2009). Specifically, canopy bridges have gained traction by providing safe passage for arboreal fauna between isolated remnants. Furthermore, these bridges foster community engagement in biodiversity conservation through active resident participation (Raño *et al.,* 2022). The use of these passage structures by wildlife serves as the primary indicator of their efficiency, which, in the long term, may contribute to a decline in accidents and the restoration of habitat connectivity (Glista *et al.,* 2009, Laidlaw *et al.,* 2021).

Management of biodiversity impacts should ideally follow a mitigation hierarchy, which prioritizes the avoidance of impacts, such as halting deforestation, as the primary conservation goal (Arlidge *et al*. 2018). Within this framework, crossing bridges function as a remediation strategy that can alleviate isolation and reduce wildlife mortality by preventing collisions and other anthropogenic threats. While they mitigate the effects of habitat fragmentation, they do not replace the need for preserving continuous forest and forest corridors. Furthermore, it is important to consider that as these structures facilitate movement, animals crossing bridged gaps may become more vulnerable to aerial predators during the transit (Gregory *et al*., 2017).

Greater mitigation impact will be achieved by installing appropriate bridges at optimal locations. The selection of materials and the engineering design of a crossing bridge depend on

the characteristics of the local fauna, the target ecosystem, the nature of the linear infrastructure, the distance to be crossed, and the financial resources available (Teixeira *et al*., 2022). The more expensive models require specialized design, machinery and services for transport and installation, and use materials such as concrete, metal, or plastic-coated stainless-steel braided cables (Weston *et al.,* 2011). Other designs employ wooden supports and cables (Garcia *et al.,* 2022), or complex rope configurations (Dias *et al.,* 2025). The simplest models consist of just a single rope or bamboo (Saralamba *et al.,*, 2022).

Single-rope bridges represent a low-cost solution for short-distance canopy crossings by small-to-medium-sized arboreal animals (Cunneyworth *et al*., 2022). While diverse designs exist (Mitchell *et al*., 2023), evaluating low-cost options and the comparative performance of rope materials remains an important knowledge gap (Teixeira *et al*., 2022). Moreover, low-cost structures facilitate higher-density installations and community engagement (Gregory *et al.,* 2022). In fact, through an initiative of local residents of the Quintas do Castelo residential development, in the municipality of Mata de São João, Bahia, Brazil, rope bridges have been used since October 2023 to maintain canopy connectivity over unpaved streets. In the current study, we investigated which species use these bridges, whether the rope characteristics (bridge type and length) and local canopy cover affect their use by the animals, and whether the use changes over time. Specifically, we tested three types of single-rope bridges that differed in material and thickness: simple nylon (⌀19 mm), braided nylon (⌀24 mm), and sisal (⌀32 mm). Each bridge was monitored by one camera-trap to identify the species and estimate usage based on two metrics: frequency of records (all events containing the animals, regardless of crossing) and frequency of crossings (events with confirmed movements along the bridge). We hypothesized that bridges of shorter length and made of thicker, natural-fiber ropes would be used more frequently and by more species (sisal > braided nylon > simple nylon), due to their greater stability

and resemblance to natural structures such as branches and lianas. We also hypothesized that ropes located in sites with greater canopy cover would be used more frequently and by more species, as denser canopies provide greater route possibilities and protection against aerial predators (de Almeida Rocha *et al.,* 2015). Considering that certain arboreal species may require several years of adaptation to artificial structures (Garcia *et al*., 2022), we hypothesized that, over time, usage would increase because of progressive habituation and integration of the structures into the local landscape (Yokochi & Bencini 2015).

MATERIAL AND METHODS

Study area

Our research was conducted at the Quintas do Castelo residential development, a peri-urban neighborhood adjacent to Praia do Forte village, located in the municipality of Mata de São João, Bahia, Brazil. The study area encompasses approximately 940 ha of predominantly forested land (known as "Floresta do Aruá"), intersected by 22.5 km of roads (mostly unpaved streets) and power lines, and containing houses and residential condominiums (Figure 1). The region is part of a coastal plain, situated at a distance of 3.5 km from the coast, and figures within the Atlantic Forest domain. The predominant vegetation consists of tropical ombrophilous forest on sandy soil (arboreal *restinga*), characterized by a dense understory and a canopy height ranging from 11 to 13 m, with some emergent trees exceeding 20 m in height (Mureb *et al.,* 2023). The region presents a humid tropical climate with an average temperature of 24.8 °C and annual precipitation exceeding 1,000 mm (IBMC, 2021). The study area connects with two other significant forest fragments: the Sapiranga Wildlife Refuge (REVIS) to the south and the Camurujipe Reserve to the north. The study region harbors a considerable species diversity, including threatened arboreal mammals, such as the northeastern maned sloth, *Bradypus torquatus* (Pilosa: Bradypodidae;

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Santos *et al*., 2025) and the thin-spined porcupine, *Chaetomys subspinosus* (Rodentia: Erethizontidae; Catzeflis *et al*., 2017). Other common arboreal and scansorial mammals include opossums and other small marsupials, porcupines and other small rodents, anteaters, coatis, felids, and small primates (*Callithrix jacchus*, Primates: Callitrichidae) (Amoedo *et al.,*, 2006), whereas larger primates (*Sapajus xanthosternos*, Primates: Cebidae and *Callicebus coimbrai*, Primates: Pitheciidae) are absent or extremely rare (Moraes *et al.,* 2020, Santana *et al.,* 2022).

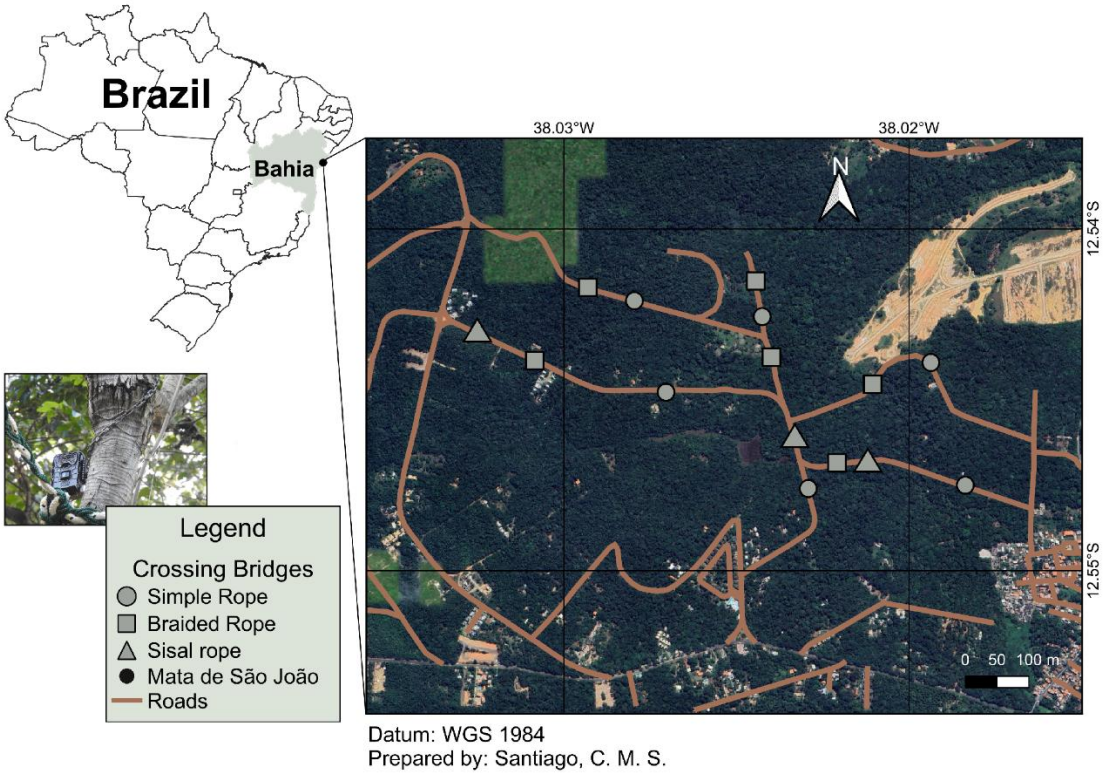


Figure 1. Map showing the location of the 15 crossing bridges monitored by camera-traps in the municipality of Mata de São João, Bahia, Brazil. The satellite image represents a part of the Quintas do Castelo residential development, indicating the local roads.

The advent of the pandemic caused the Quintas do Castelo residential development to undergo accelerated urbanization and real estate speculation, which led to deforestation and the disruption of the natural connection between tree canopies. Since then, residents began to more intensely record wild animals that had been either struck by or at risk of being struck by vehicles,

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135 attacked by domestic dogs, or electrocuted within the region (Figure 2), which motivated the
136 installation of the designated crossing bridges.



Figure 2. Photos of endangered species, victims of electrocution, or roadkill. (a) C. subspinosus victim of roadkill, (b) B. torquatus on electrical wiring, (c) B. torquatus with signs of burns in the ocular region. Data source: local residents.

137

138 *The canopy bridges and data collection*

139 We installed and monitored 15 single-rope bridges that were anchored to a tree on each
140 side of the road, spanning unpaved streets with widths of less than 15 m. Bridge lengths were

customized for each site, ensuring adequate tension between the anchor trees. Installation sites were selected based on reports from local residents, who had previously observed arboreal wildlife in roadside trees or performing ground-level crossing. Six were made of simple nylon (⌀19 mm), six of braided nylon (⌀24 mm), and three of sisal (a natural fiber extracted from the leaves of the *Agave sisalana* plant; Li *et al*., 2000; ⌀32 mm). Bridges were distributed across six unpaved streets, spaced at least 100 m apart (mean and maximum nearest neighbor are 170 and 315 m, respectively), without repeating the same bridge type within the same road to diversify the sampling design. Simple and braided nylon bridges were installed in October 2023 and sisal bridges in September 2024. All installations were carried out through a collaborative effort between local community members and the research team. The specific quantity of each bridge type and the staggered installation timeline were dictated by the availability of resources; as a community-driven initiative, the project relied on sequential material donations from local residents who actively participated in the acquisition and installation process. We adapted the installation of the rope bridges from the *Connected Gardens Project* of the Sloth Conservation Foundation (https://slothconservation.org), in Costa Rica, which has successfully implemented bridges to facilitate crossings by common sloths (*Bradypus variegatus*, Pilosa: Bradypodidae) in urban and peri-urban areas.

Each rope was fitted with a camera-trap at one of its extremities. The camera traps were affixed to a trunk to which the rope was tied and programmed to record three consecutive photographs and a 10-second video whenever the passive infrared sensor was triggered. This configuration, with the camera facing the opposite end, made it possible to confirm whether an animal crossed the entire bridge. The species detected by the camera traps were identified by researchers who co-authored this study, based on specialized references (Reis *et al.,*, 2006; Malukiewicz *et al.,*, 2020), and with posterior confirmation by specialists. The rope length was

165 measured, and the canopy cover was calculated from hemispheric photos taken from the center
166 of the street width, directly below the rope, using a zenith-oriented phone camera positioned 90
167 cm above ground. This ground-based approach was chosen to capture the micro-scale canopy gap
168 over the narrow streets, despite the inherent limitations of single-point sampling. The resulting
169 images were then analyzed using the *Gap Light Analysis Mobile App* (Tichý 2014). Across the
170 study sites, bridge length ranged from 6.5 to 17 m (mean ± SD = 11.50 ± 3.24 m) and canopy
171 cover ranged from 3 to 55% (35.98 ± 17.44%). The study was conducted from October 2023 to
172 October 2025, divided into seven campaigns (C1: Oct23–Jan24; C2: Feb–May24; C3: Jun–
173 Aug24; C4: Sep–Dec24; C5: Jan–Mar25; C6: Apr–Jul25; C7: Aug–Oct25; Table 1). The camera-
174 traps were checked at intervals of three to four months due to the logistical and financial
175 challenges of traveling a distance of 482 km between our research base and the study site. The
176 sampling effort for each bridge was quantified as the total operating time (in days) of the camera
177 installed at that bridge. The sampling effort for each bridge varied due to equipment damage,
178 theft, and malfunctions, particularly excessive false triggers that led to the rapid depletion of some
179 batteries and memory cards (Table 1).

180 Table 1 – Campaigns showing the sampling effort (number of days camera traps were functional) for each
181 rope bridge. The campaign periods correspond to: C1 = Oct 23–Jan 24; C2 = Feb–May 24; C3 = Jun–Aug
182 24; C4 = Sep–Dec 24; C5 = Jan–Mar 25; C6 = Apr–Jul 25; C7 = Aug–Oct 25 *Campaign when simple and
183 braided ropes were installed; ** Campaign when sisal ropes were installed.
184

Bridge	Bridge ID	Rope type	Campaingns							
			C1*	C2	C3	C4**	C5	C6	C7	Total
1	1Smp	Simple	46	37	56	96	20	94	52	401
2	2Smp	Simple	53			1	3	6	52	115
3	3Smp	Simple	97					13	52	162
4	4Smp	Simple	114	22						136
5	5Smp	Simple	115	36						151
6	6Smp	Simple	76	59	56	1	2	93	52	339
7	1Brd	Braided	50	37	56	96	88			327
8	2Brd	Braided	19			91	88	94	52	344

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Bridge	Bridge ID	Rope type	Campaingns							
			C1*	C2	C3	C4**	C5	C6	C7	Total
9	3Brd	Braided	50					94	52	196
10	4Brd	Braided	79	22						101
11	5Brd	Braided	1							1
12	6Brd	Braided	109	59	56	76	16	93		409
13	1Ssl	Sisal				96	24	94		214
14	2Ssl	Sisal				29	17	94		140
15	6Ssl	Sisal				77	2	5		84
		Total	809	272	224	563	260	680	312	3120

Data analysis

Each set of three consecutive photographs and a 10-second video with a mammal species was considered one event. Following previous studies with camera trap (e.g. Tobler *et al*., 2008), we excluded repeated events of the same species at the same camera trap within a 1-h period to account for independent events. We then considered two types of independent events: (1) species' records, and (2) confirmed crossings (Figure S1). The first represents all independent events, regardless of crossing the bridge. The second is a subset of the first and represents confirmed bridge crossings, with confirmed movements along the bridge. The frequency of species' records and crossings and the species richness were calculated per bridge to test the effect of bridge type, length, and canopy cover. Additionally, the frequency of species' records and crossings was calculated per bridge per campaign to test the effect of time elapsed since installation.

After initial inspection confirmed non-normality and overdispersion in our data, we fitted Generalized Linear Models (GLM) in R (R Core Team, 2025). To test our first and second hypotheses, we evaluated the effect of each predictor variable associated to rope (bridge type and length) and local characteristic (canopy cover) on the frequency of species' records and crossings by fitting GLMs with negative binomial distribution (glm.nb function, package MASS, Venables

& Ripley, 2002) to address data overdispersion. To test the effect of predictor variables on the number of species recorded per bridge, we employed GLM with Poisson distribution (glm function). To account for the varying sampling efforts and ensure that each bridge served as an independent and comparable replica, the sampling effort (in days) was set as an offset (log(days)) in all GLM analyses. This ensured that the model directly measured the rate of events per day across all structures. To address our third hypothesis, regarding the habituation process on the species' records and crossings, we used time (the time elapsed since bridge installation, measured by sequential campaigns) as predictor variable, fitting GLMM, with negative binomial distribution and using bridge identity as random effect. The tests significance was determined by the p-value obtained from the Z-statistic of the model coefficients, which were evaluated individually. We assumed significant responses when $\alpha < 0.05$, and tendencies (trend toward significance) when $\alpha < 0.10$.

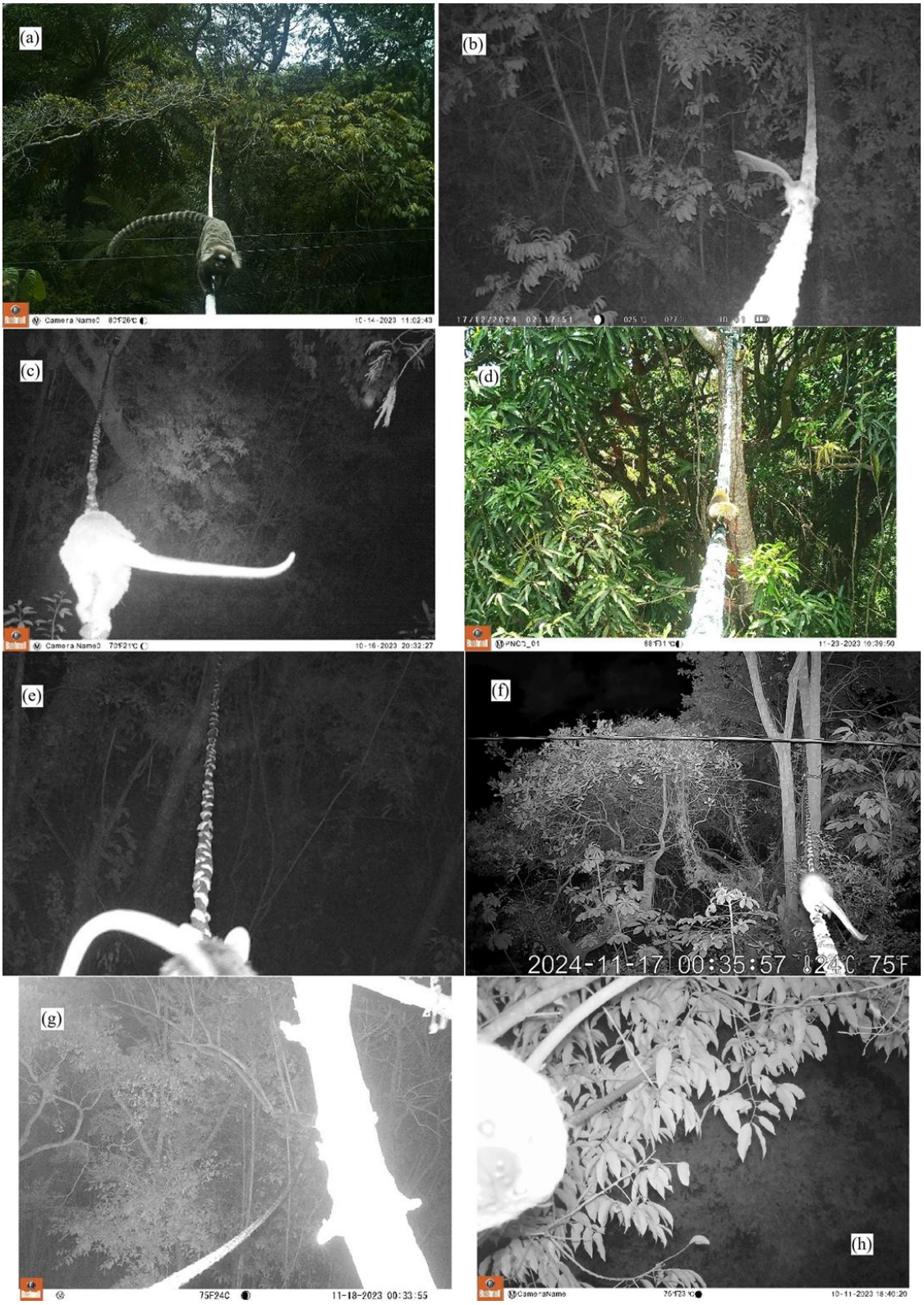
RESULTS

We obtained a total of 712 events (2136 photos and 712 videos). After filtering the sequential events with less than 1hr-interval we ended with 494 records of eight species, out of that, 250 were crossings of six species. Our total sampling effort was 3.120 trap-days (Table 1). A high volume of false triggers occurred, which impacted the camera monitoring effort, either by reducing battery autonomy or by occupying the memory card. While our models adjusted for active days, this uneven temporal coverage remains a potential confound when comparing rope types. Regarding the operational integrity of the infrastructure, we observed that most bridges required no maintenance and showed no signs of wear throughout the study period. Only two simple nylon bridges required replacement, likely due to the low quality of their specific material compared to the other tested ropes. *C. jacchus* was the most common species, with 217 records

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and 117 crossings, followed by *Marmosa sp.* (Didelphimorphia: Didelphidae, 124 records and 89 crossings), *C. subspinosus* (65 and 35), *Guerlinguetus brasiliensis* (Rodentia: Sciuridae, 30 and 5), *Didelphis sp.* (Didelphimorphia: Didelphidae, 8 and 3), and *Coendou insidiosus* (Rodentia: Erethizontidae, 43 and 1, Figures 3 and 4). *Rhipdomys mastacalis* (Rodentia: Cricetidae, 1 record) and *B. torquatus* (2 records) were detected by our cameras, but we could not confirm their movement on the bridge (Figures 3 and 4). Furthermore, we detected four records of Erethizontidae that could not be classified to genus level.

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Figure 3. Photos of the species detected by camera-traps. In the sequence: (a) C. jacchus crossing the simple rope bridge, (b) Marmosa *sp.* crossing the sisal rope bridge, (c) C. subspinosus, (d) G. brasiliensis, (e) Didelphis *sp.*, and (f) C. insidiosus crossing the braided rope bridge; and record of (g) R. mastacalis and (h) B. torquatus.

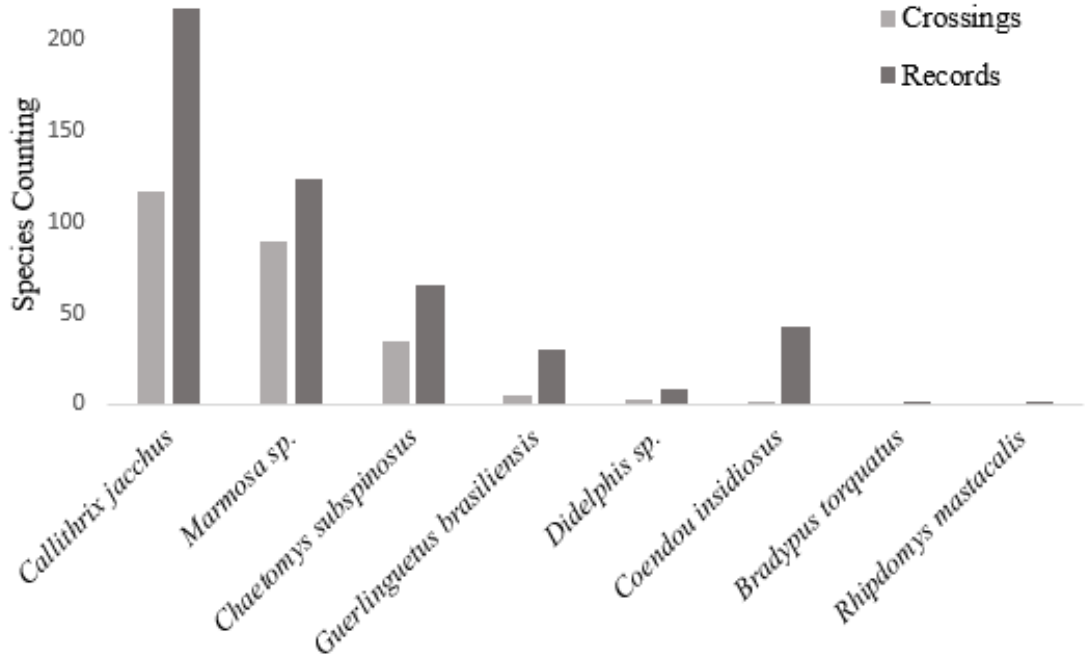
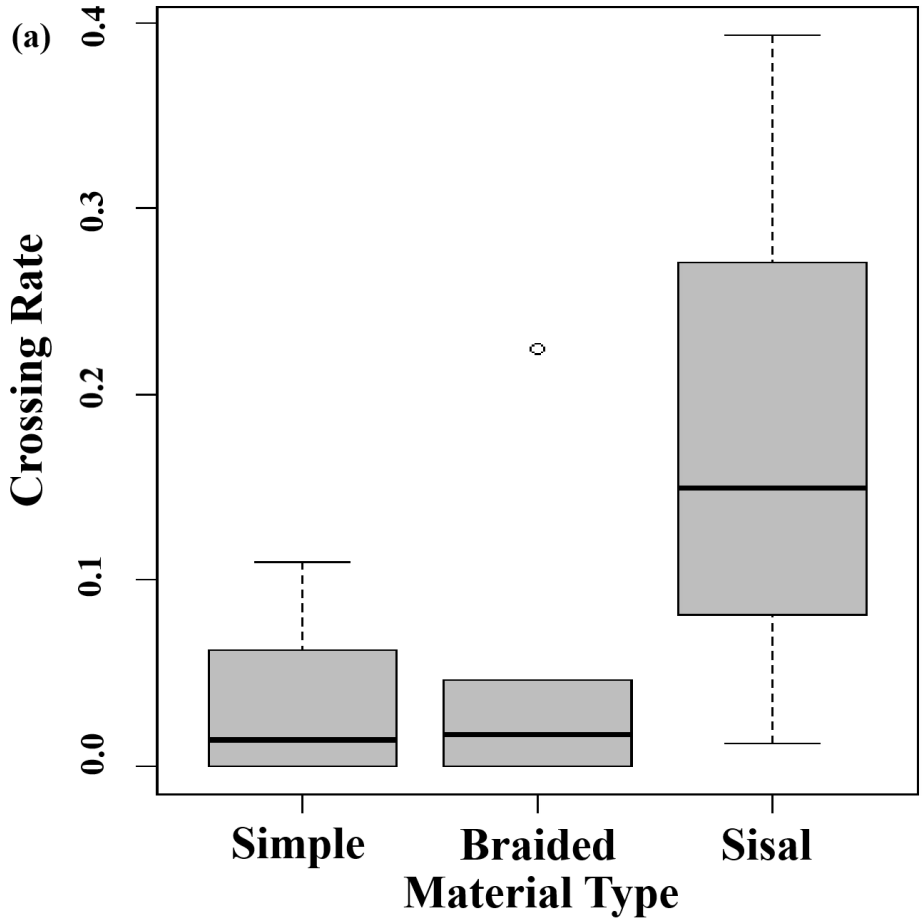
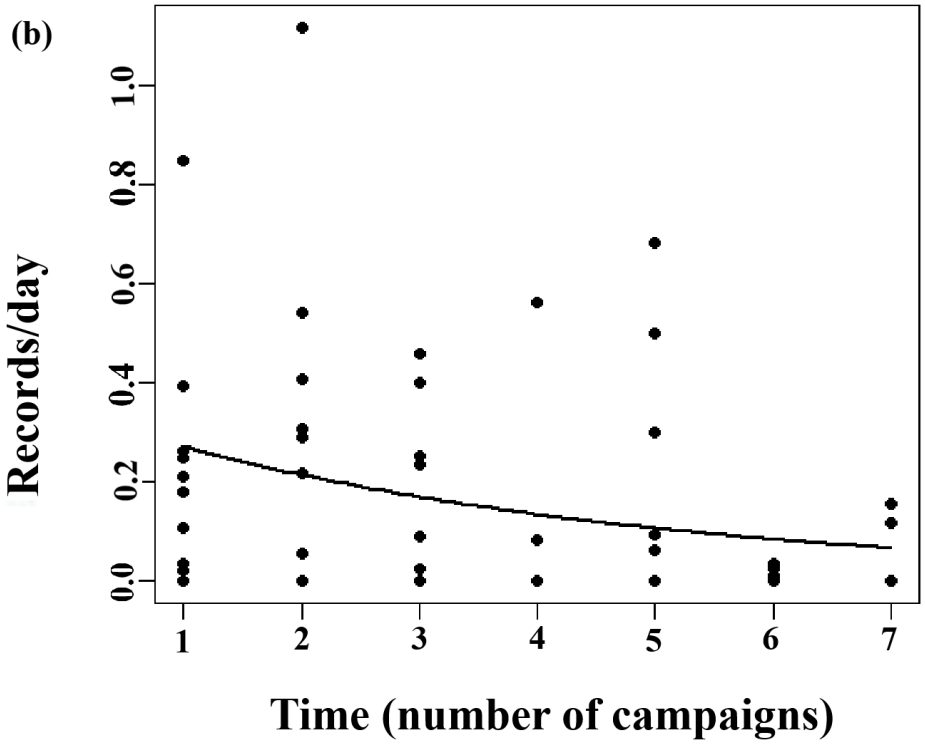


Figure 4. Frequency of records and crossings for each species detected by camera-traps.

Generalized Linear Models (GLMs) revealed that most predictor variables (namely canopy cover and rope length) did not influence the frequency of records, crossings or species richness (Table S1). However, our GLMs indicated a tendency (results significant at $\alpha<0.1$) of rope type effect on crossings, which were more frequent on sisal rope ($\beta = 1.69$, $p = 0.071$, Figure 5a). Additionally, the GLMM showed a decrease of records over time ($\beta = -0.24$, $p = 0.092$; Figure 5b).

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Figure 5. Responses of (a) crossings as a function of material and (b) records as a function of time.

DISCUSSION

Our results confirm that single-rope bridges are used by a range of arboreal mammal species registered in the study. Six species were observed successfully crossing the canopy bridges, suggesting that these structures are functionally used to promote movement (Laurance *et al.,* 2009, Mitchell *et al.,* 2022), including the threatened thin-spined porcupine (*C. subspinosus*). We found a tendency of higher number of crossings on the thicker sisal rope, than on other nylon rope types tested. However, our unbalanced sample size likely reduced statistical power, highlighting the need for future studies with greater replication to confirm this pattern. Different from our expectations, time led to a decrease in the frequency of records.

The importance of canopy connectivity bridges is evidenced by recent literature reviews (Teixeira *et al*. 2022; Gregory *et al*. 2022. In our study, the relevance of this strategy is highlighted by the detection of two threatened species highly susceptible to fragmentation given their strictly arboreal habit and lethargic movements. The thin-spined porcupine (*C. subspinosus*) is classified as 'Vulnerable' by IUCN (Catzeflis *et al*., 2017), it was never recorded using single-rope bridges before the current study and performed crossings at a relatively high frequency. We also showed a potential use by the northeastern maned sloth (*B. torquatus*), classified as 'Endangered' by IUCN (Santos *et al*., 2025), which occurs at a high density in the study area (dos Santos *et al.,* 2025). Although we did not record a crossing event by the northeastern maned sloth via camera-trap, we received personal communication from a resident who documented a successful crossing on one of the simple nylon-rope. We argue that several aspects of this species' biology may reduce detectability by camera traps positioned just above the ropes, including locomotion beneath the rope (with an inverted suspensory locomotion) (McKamy *et al.,* 2023), generally low body temperature (average ~32°C) (Cliffe *et al.,* 2018), and slow movement patterns (Spainhower *et*

al., 2018). To improve future monitoring, we suggest anchoring bridges to lateral branches and positioning an additional camera trap on the underside of the rope to test if it better captures the locomotion patterns of this species.

The relevance of canopy bridges extends beyond the persistence of single threatened taxa. Restoring canopy connectivity is a vital measure that directly supports several species that are canopy dependent and forest specialists by enabling essential movement, recolonization, and long-term persistence (Young *et al.,* 2023). This is the case of the non-threatened arboreal mammals recorded in our study: *C. jacchus*, *Marmosa sp*., *G. brasiliensis*, *Didelphis sp*., *C. insidiosus* and *R. mastacalis*. By benefiting movement and fauna persistence, this strategy sustains fundamental ecosystem functions, such as seed dispersal, that are performed by arboreal organisms and that often decline following habitat fragmentation (Teixeira *et al.,*, 2013). Additionally, artificial canopy bridges can mitigate human-fauna conflict by reducing the need for ground-level crossings (Saralamba *et al.,* 2022), and serve as instruments for environmental awareness, as evidenced in our study area by residents assistance in the installation process and the donation of materials.

The long-term success of single-rope bridges is an ongoing question, to be targeted by several future studies. We found a tendency for greater crossing in the sisal (thicker) ropes, a possible output of the material and thickness: its rough texture and greater diameter providing superior grip and stability. Although, this comparison should be interpreted with caution. While we accounted for the varying sampling effort by using the active camera days as an offset in our statistical models, this procedure does not control for temporal confounding factors. Seasonal variations and differing stages of animal habituation during the earlier months could have influenced crossing rates independently of the rope material, representing a limitation in our comparative design. Furthermore, we found no evidence that the bridge material influenced the

number of species recorded. This suggests that, among the species that utilized the bridges, their willingness to cross was not significantly restricted by the type of rope. We argue however, that our data was dominated by records and crossings of one species (*C. jacchus*), avoiding robust among species comparisons. The absence of evident preference may also reflect the relatively low arboreal species richness in the area (*e.g.*, no medium-sized primates), which limits the pool of potential bridge users. Beyond the use by arboreal fauna, the success of different single-rope bridges should also incorporate the durability and maintenance costs of the materials. Thick nylon ropes may offer the most long-term solution in tropical humid areas. This aligns with findings by Weston *et al.,* (2011), who observed minimal signs degradation after 15 years using UV-resistant marine nylon ropes without any intervention. Finally, the waste generation through the disposal of materials after their use should not be neglected, and assessments must consider the life cycle of the materials used to avoid undesirable conservation outputs.

The bridge length and canopy cover variables proved to be negligible factors for bridge use in our study area. Regarding bridge length, the absence of effect aligns with literature indicating that structural stability and material quality often override dimension, with use efficacy being more dependent on variables like the substrate's tactile security (Teixeira *et al.,* 2022). Regarding canopy cover, while a dense canopy cover is often a favored metric for increasing crossing frequency (Santiago & Swierk 2025), our findings suggest that species using the structures already accept the risk of traversing the open stretch. These absence of effect must be placed in the context of our sampled variation. Gradients covering greater bridge length and larger canopy gaps may be the case in urban and peri-urban areas, deserving local assessment on their impact on crossing frequency and species richness.

The analysis across campaigns indicates a decrease in the frequency of records, but notably, not in the frequency of crossings. A possible explanation for this pattern lies in the initial

exploratory behavior of the species: the introduction of a novel structure into the environment may have generated a detection peak (Gregory *et al.,* 2022), motivated by curiosity and investigation, without necessarily culminating in actual crossings. As the structure becomes known, this exploratory interest wanes, resulting in the observed drop in the recording rate. We also considered whether the accumulation of scent marks on the rope could lead to a decline in records over time. Scent marking is a fundamental tool for spatial orientation and communication among arboreal mammals (Rolland & Trull, 2022; Lopez-Ramirez *et al*., 2024). In this case, record reduction could stem from agonistic interaction within or between species, for example, the perception of territorial marks left by competitors. Finally, because our analyses focus on the entire assemblage, the mechanism of species-specific habituation should not be dismissed. In fact, the observed pattern may be influenced by the dominant species in the records and crossings (*C. jacchus*), a species with high behavioral plasticity and great adaptation to urban structures (Ribeiro de Albuquerque & Borstelmann de Oliveira, 2020), a synanthropic habit that is also shared by opossums (*Marmosa sp.* and *Didelphis sp.*) (Boullosa *et al.,* 2026).

While the natural habitat and the connectivity of tree canopies are essential for arboreal fauna (Gregory *et al.,* 2017), artificial structures offer a viable solution when habitat and connectivity loss are inevitable, facilitating the movement of multiple taxa (Lu *et al.,* 2022). Our study suggests that low-cost rope bridges have the potential to act as a complementary mitigation tool against the impacts of fragmentation in peri-urban areas. These structures may be important for the persistence of threatened species such as the thin-spined porcupine (*C. subspinosus*), which is highly dependent on the forest (Giné & Faria 2018) and exhibits low genetic variability (Oliveira *et al.,* 2011). While we cannot assure full mitigation of fragmentation effects, these bridges provide a safer canopy alternative to ground crossings, potentially reducing road mortality risks (Linden *et al.,* 2020) and providing a safer route, as confirmed by the frequent use of small

337 species, which tend to be more vulnerable to predation (de Almeida Rocha *et al*., 2015). Although
338 single-rope structures offer positive benefit-cost, they present certain limitations. Single ropes are
339 susceptible to oscillation and movement, which can create a sense of instability. This may deter
340 medium to large-sized mammals, or those that are not strictly arboreal (Gregory *et al*., 2017). To
341 actively promote the flow of sloths and other mammals that require greater stability across these
342 canopy gaps, future mitigation strategies should incorporate bridge designs that offer greater
343 stability and a broader grip surface. Implementing thicker braided ropes or integrating natural
344 lianas can provide the necessary structural support to accommodate their specific morphological
345 and locomotor requirements. Therefore, the choice of bridge model should be determined by the
346 local arboreal fauna, the width of the road, and the budget available. Based on our results, the
347 street gaps in peri-urban areas can be bridged by single-rope structures, with a priority on thick,
348 natural-fiber ropes. We also suggest continued monitoring to account for species-specific
349 habituation that may manifest over extended periods.
350
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Supplementary Material

Figure S1. Diagram illustrating the two types of independent events: species' records, and confirmed crossings.

Table S1. Results of GLMs showing the effect for predictor variables on the records, crossings and number of species. Braided and Sisal rope are compared to simple (intercept) rope; * indicate significant result for $\alpha<0.1$.

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