

Brief Report

Community participatory action to build a canopy bridge for wild black and gold howler monkeys (*Alouatta caraya*) in northern Argentina

Mariana Raño^{a,*}, Mariana C. Palazzo^b, Alicia Soliz^d, Juan C. Holzer^c,
Dario A. Perez^d, Emilio M. Sánchez^c, Verónica L. Romero^a,
Francisco Sánchez Gavier^a and Martin M. Kowalewski^a

^aEstación Biológica Corrientes, CECOAL – CONICET, San Cayetano, Corrientes, 3400, Argentina

^bInstituto Pio XI – Club de Ciencias Arquímedes, Corrientes, 3400, Argentina

^cDirección de Parques y Reservas – Ministerio de Turismo, Corrientes, 3400, Argentina

^dColegio Secundario San Cayetano, Corrientes, Argentina

* Corresponding author; e-mail: marianarano@gmail.com

ORCID iD: Kowalewski: 0000-0002-6737-3771

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Abstract – The combination of urbanization and destruction of native forests commonly has forced wild animals to search for food and shelter in urban areas. Groups of black and gold howler monkeys (*Alouatta caraya*) are moving into urban areas in Northern Argentina as a consequence of rapid alteration and degradation of their habitats. In general, local people in the area are unaware of and disconnected from conservation actions, such as the protection of local biodiversity. We aimed to address this issue by organizing a group of high school students from both the city of Corrientes and outlying rural areas with the objective of transforming their perceptions on local non-human primates and to build the inaugural canopy bridge to instill biodiversity appreciation. With the students, we identified a location to install a bridge to facilitate the movement of *Alouatta caraya* across areas of discontinuous canopy. The students worked to build awareness within their community, obtained the necessary permission, and designed the bridge. From the beginning of the awareness campaign to the bridge installation, the process took four years. Afterwards, we installed two more bridges in the same region. From this single case study, we learned that participatory actions are a very important tool for residents of local communities to act collectively to promote biodiversity conservation.

Keywords – citizen science, Corrientes, mitigation, primates, roads, wildlife passage.

Introduction

Anthropogenic interventions in natural environments are the main cause of biodiversity loss worldwide (Moreno-Mateos *et al.*, 2017; Díaz *et al.*, 2019; Cepic *et al.*, 2022). The advance of the agricultural and cattle herding frontiers, logging, changes in land use and unplanned urbanization have been the main contributors to large-scale habitat loss, fragmentation, and widespread changes in habitat structure and

environmental diversity globally (Sha *et al.*, 2013; Kawata, 2014; Estrada *et al.*, 2017). On the other hand, cities and small towns represent unique ecosystems characterized by a human-generated matrix of buildings as well as roads, cables, and other infrastructure elements. The distribution of such dynamic landscapes can have direct effects on the distribution, activity patterns, movements, diet, and reproduction of non-human primates that live in these regions

(Printes, 1999; Printes *et al.*, 2010; Teixeira *et al.*, 2013). A typical urbanized landscape contains a series of very small forest remnants or forest corridors within an anthropogenic matrix in which natural vegetation is replaced by human-made structures that not only substantially limit wildlife movements, but also constantly threaten wildlife survival (Lokschin *et al.*, 2007; Gordo *et al.*, 2013; Sol *et al.*, 2013; Wellian and Smith, 2021). Within these landscapes, non-human primates often suffer serious physical injuries or die because of collisions with vehicles, electrocutions, and/or domestic dog attacks (Lokschin *et al.*, 2007; Corra *et al.*, 2018; Azofeifa-Rojas *et al.*, 2021; Chaves *et al.*, 2022).

Roads are an important cause of forest discontinuity and pose a variety of threats to wildlife by restricting movement and/or causing direct mortality (Beckman *et al.*, 2010; Teixeira *et al.*, 2013). Studies in many countries have reported such threats to primate species, such as in India (Das *et al.*, 2009), Brazil (Gordo *et al.*, 2013), Singapore (Riley *et al.*, 2015), Mexico (Hernandez-Perez, 2016); and Kenya (Katsis *et al.*, 2018). Wildlife crossing structures can mitigate some of these effects by simultaneously connecting fragmented habitat and reducing negative interactions between animals and human-made infrastructure (Downs and Horner, 2011; Teixeira *et al.*, 2013). Canopy bridges have been found to reduce disease transmission from wild to domestic animals, predation events by dogs, electrocutions, and roadkills (Printes, 1999; Lokschin *et al.*, 2007; Teixeira *et al.*, 2013; Riley *et al.*, 2015; Azofeifa-Rojas *et al.*, 2021).

The genus *Alouatta*, howler monkeys, comprises 12 species that range from Southern Mexico to Northern Argentina (Cortés-Ortiz *et al.*, 2015). In Argentina, black and gold howler monkeys (*A. caraya*) are folivore-frugivore, arboreal, diurnal primates characterized by bisexual dispersal (Di Fiore *et al.*, 2011; Kowalewski *et al.*, 2019). Adults of *A. caraya* are sexually dimorphic (males are larger than females) and sexually dichromatic (adult males are black and females are golden, all infants are gold

and males turn black during sexual maturation) (Bicca-Marques and Calegario-Marques, 1998; Mourthé *et al.*, 2019). This species has a high behavioral plasticity and can occur in small fragments in peri-urban landscapes where individuals face several threats to their survival (Kowalewski *et al.*, 2019)

In 2014, we formed the Mammal Study Group from Estación Biológica Corrientes (EBCo-CONICET-UNNE) due to the increasing reports of black and gold howler monkeys being attacked by dogs, electrocuted, or road killed (in this order of occurrence) at our study site in San Cayetano (Municipality of Riachuelo, Corrientes, Argentina). From our research projects in the EBCo area we identified potential locations for a series of canopy bridges where there are higher rates of human-wildlife conflict. Then, we decided that the local high school students should select the final location of the inaugural canopy bridge. We organized a group of students from both the cities of Corrientes and San Cayetano (the small village where the EBCo is located). Our objective was transforming their perceptions in relation to the population of non-human primates in the area. While a community-based conservation approach can be more time-consuming, studies suggest that inclusive participation and empowerment can enhance intrinsic motivation to conserve resources (Ardoin *et al.*, 2020). In addition, conservation projects that address local conservation challenges, partnerships, and actions have been found to be more effective (Ardoin *et al.*, 2020; Palmer *et al.*, 2020). Furthermore, several studies indicate that environmental education creates productive research-implementation spaces (Mordock *et al.*, 2001; Jerusalinky *et al.*, 2010; Monroe *et al.*, 2017; Ardoin *et al.*, 2018, 2020; Marcinkowski and Reid, 2019).

The main goal of this project was to contribute to the conservation of the biodiversity focusing on howler monkeys building on community awareness. This goal would be achieved by sensitizing and informing the local community on the importance of maintaining continuous native forests, through the promotion and

dissemination of environmental care, involving different social actors through collaborative actions.

Materials and methods

STUDY SITE

The Estación Biológica Corrientes (EBCo), a long-term research site, is located in San Cayetano (Municipality of Riachuelo), 20 km south of Corrientes, the provincial capital, within San Cayetano State Park (PPSC) (27°30'S, 58°41'W), Corrientes, Argentina (fig. 1). This research station is characterized by semi-deciduous natural forest fragments (up to 15 ha) in a grassland matrix. The inaugural canopy bridge described in this study was installed four kilometers of this site outside of the EBCo in a village, characterized by high proportions of exotic and garden shrub and tree species in combination with native plants

used by *A. caraya*. It is important to indicate that the first study focusing on black and gold howlers was developed more than 30 years ago in the EBCo (Rumiz, 1990), and several studies have been carried out on demography, ecology, behavior, and disease dynamics of *A. caraya* (i.e., Kowalewski and Zunino, 2004; Kowalewski, 2007; Zunino *et al.*, 2007; Pavé *et al.*, 2012; Pavé, 2013; Oklander *et al.*, 2014; Raño *et al.*, 2016; Kowalewski *et al.*, 2019). In the last years, the area around the EBCo suffered from substantial urbanization due to the installation of vacation houses, cattle ranches, and industries, which caused an increase in roadkill rates on provincial and other internal routes.

EDUCATIONAL ACTIVITIES

In order to make the canopy bridge project educational, we focused on exchanging experiences and knowledge related to the conservation

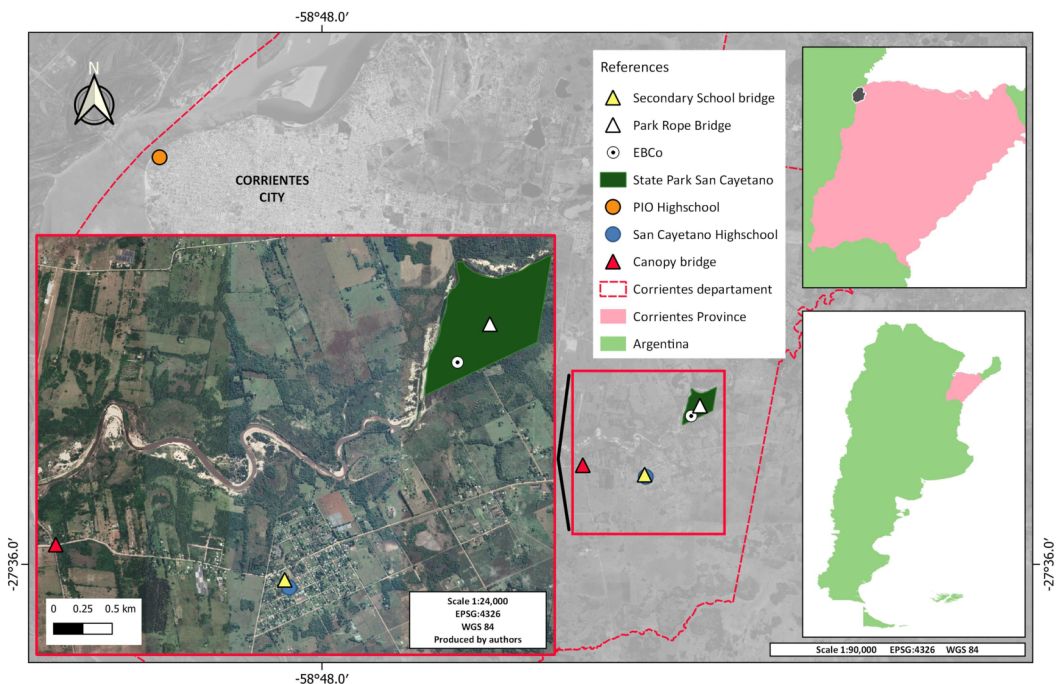


Figure 1. Location of the three canopy bridges. The map shows the relative position of the canopy bridge with respect to the two schools involved (PIO High School and San Cayetano High School), the San Cayetano State Park (PPSC), and the Estación Biológica Corrientes (EBCo). The black triangle (Canopy bridge) indicates the inaugural bridge built by the students, while the “Secondary School Bridge” and the “Park Rope bridge” indicate the two bridges installed later by the researchers.

of *A. caraya* from different perspectives and life experiences of students from the two areas. To develop conservation solutions, we started working with students from two high schools specifically: the Pio XI Institute (a middle-income private high school in the city of Corrientes) and the San Cayetano Secondary School (a low-income semirural public high school in San Cayetano, located two kilometers from where the bridge would be installed). We then worked with a group of 50 interested students from 13 to 17 years old that were part of the Pio XI Institute's Arquimedes Science Club and of the San Cayetano Secondary School Juvenile Activity Center (CAJ).

We designed a series of educational activities that included informative, integrative, and practical workshops, and we carried out 1) informal activities with the two groups separately at each school, where we provided similar information on conservation problems (through games and collective discussions), 2) guided nature walks at the PPSC, with the two groups together, during which we integrated their different life experiences and began to consider different solutions for the howler monkeys and the degraded native forests, and 3) workshops with the two groups together at both schools to develop ideas (i.e., canopy bridges) to solve conservation problems and to create different ways to tell our story to the rest of the community. During this phase, students identified and discussed locations to install the bridges, with guidance from the authors and based on our empirical data on *A. caraya* fatalities. Researchers, teachers, and students worked together combining these data, maps of forest fragments, and known locations of *A. caraya* groups along the road to find a location for the first canopy bridge. Students overlapped hotspots of howler roadkills and electrocutions with our data on *A. caraya* groups (i.e., group composition, home range) and the continuity of forest fragments on either side of the road. They selected some potential locations for the canopy bridge, then visited the locations and selected the best one. Then, students worked to build awareness within their community, obtained the necessary permissions from the Municipality of Riachuelo (Corrientes,

Argentina) to install the bridge, and designed and installed the bridge.

CANOPY BRIDGE

We organized several meetings with the students to develop and discuss the material and design of the canopy bridge and the different authorizations required for its installation. We worked on prototypes of the canopy bridges, with suggestions from the researchers, and finally had help from architects and engineers (parents of the students) that participated in the meetings and worked together to build the final bridge design (fig. 2).

Results

EDUCATIONAL ACTIVITIES

We had four meetings at each school, three visits to the PPSC with the two groups, and at least three meetings with both groups together (once at Pio XI Institute School, and twice at San Cayetano School). After the first four meetings, we began to work on potential solutions and dissemination of information to the community. For the construction of the canopy bridge, the students formed a series of working groups: communication, construction, negotiation, and finance (in charge of acquiring resources).

The communication group prepared a contest to choose a logo and a name for the project. The logo contest was launched during the 2014 National Science and Technology Week (from the National Ministry of Science and Technology) involving the entire community. Students from different science clubs in Corrientes participated in this competition. The name “#monosconectados” (#connected-monkeys) was selected. They then prepared brochures (fig. 3), contacted newspapers, visited radio stations, and televised promotional videos on local and national TV programs (<https://youtu.be/hqnsSqHSvnA>).

The construction group began with a prototype of a bridge made of dried sugar cane stalks as rungs and handcrafted cords from reused plastic bags. Although this bridge was strong enough, local authorities did not authorize its



Figure 3. Brochures (in Spanish) for the #connectedmonkeys (#monosconectados) project.

people or natural conditions. Although members of the community are interested and doing *ad libitum* observations, we still do not have confirmed the use of the bridge by howler monkeys or other animals.

OTHER ACTIONS TAKEN AFTER THE COMMUNITY INVOLVEMENT

From October to November 2020, we installed two additional canopy rope bridges (figs. 1 and 6): one in the town of San Cayetano, Corrientes (14 m long), close to the primary school, and the other one in PPSC (6 m long), Corrientes. There are differences between our participatory canopy bridge model and the rope overpass installed in the town (there were different requirements at the provincial and at the municipal levels that allowed certain flexibility in the bridge model installed). These two rope bridges were made following the model proposed by Teixeira *et al.* (2013) and installed

in Porto Alegre (Brazil) by the Urban Monkeys Program. Before installing these two additional rope bridges, we carried out educational sessions in the primary and secondary schools in San Cayetano, with rangers from the PPSC to inform the community about the function and importance of the canopy bridges. The rope bridges were installed at a height of 6 m and are part of a total of five bridges planned to be installed in San Cayetano town. During August and October 2020, massive forest fires occurred in the area, affecting several *A. caraya* groups (Heidt, 2020). All these new bridges are in strategic portions of the forest that have the potential to reconnect the surviving *A. caraya* groups in remaining fragments (figs. 1 and 4).

Discussion

Participatory construction of the canopy bridge within the Municipality of Riachuelo (Corrientes, Argentina) increased awareness



Figure 4. Images of the canopy bridge inauguration day, with the municipality staff, park rangers, teachers, and students from both high schools, and the team from Estación Biológica Corrientes (EBCo). Photo credits: Mariana Raño and Epoca Journal.



Figure 5. Students and teachers from San Cayetano and Pio XI high schools, with the mayor of the Municipality of Riachuelo and co-authors MK and MR on canopy bridge inauguration day in Riachuelo (Diario Epoca: <https://www.diarioepoca.com/993537-queda-inaugurado-el-puente-para-los-monos-en-riachuelo>).

concerning the threats to *A. caraya* and the native forest. Several stakeholders were included in the process, which resulted in broader community buy-in (Lokschin *et al.*, 2007; Teixeira *et al.*, 2013). Urbanization of *A.*

caraya habitat in Northern Argentina is a recent process that is occurring in many large cities and small towns in the region. This process results in human-wildlife conflicts that need to be solved to achieve a long-term coexistence



Figure 6. Canopy bridge installed by the researchers in San Cayetano Provincial Park (PPSC) and close to the San Cayetano Primary School, with authorities of the Municipality of Riachuelo, park rangers, and the team from Estación Biologica Corrientes (EBCo).

between humans and wildlife (Kawata, 2014; Pooley *et al.*, 2020).

Actions aimed at raising awareness about environmental problems through the dissemination of information at several levels emerged as an extremely important tool for this project. The local communities are affected by these conflicts but are also part of the possible solutions. Furthermore, canopy bridges may be important to mitigate the impact of roads and power lines on wildlife, but electric cables also need to be well insulated when present, to guarantee wildlife safety (Teixeira *et al.*, 2013; Birot *et al.*, 2019). From this single case study, we learned that actions aimed at raising awareness about environmental problems represent a very important tool for residents of local communities to act collectively to promote environmental conservation. Moreover, public awareness achieved by this project and other similar ones led by EBCo resulted in the passage of a state law that made *A. caraya* a state monument with the highest degree of protection (Corrientes Provincial Law N°6590).

We evaluated the results obtained with our project by registering the perceptions from the participants in this process over the years, especially students that finished high school during the COVID-19 pandemic and their families, with whom we still maintain contact. A common message from participants was that participatory processes do work and that we can and should protect our biodiversity in several creative ways. Unfortunately, a shortcoming for our project was that the cessation of school activities during the pandemic resulted in a cessation of the activities of community conservation education. This indicates that participatory involvement in conservation actions must be maintained constantly and over time with the formation and integration of the local community, authorities, and teachers.

Overall, this study provides evidence that involving different stakeholders in the conservation of biodiversity through collaborative action is a long-term process that can result in effective conservation projects to protect species such as *A. caraya*. It also indicates that it is important

to get support from the media and the press to provide visibility for these projects and promote similar initiatives in other locations. Our project allowed to connect students from two different areas and socioeconomic contexts to solve a conservation problem. #MonosConectados was a collective project that addressed a specific problem in the town of San Cayetano related to the mortality of *A. caraya* due to the advancement of the urban and agricultural-livestock frontier in the region. This long-term process resulted in empowerment of local communities that now own the bridge and take care of it, protecting the local fauna. Similar actions are being taken in another project led by students called “Karadja Rangers”, in which they are studying and collecting demographic data on howler groups living within Corrientes city and also conducting educational workshops in schools across the city (mainly in neighborhoods with howler groups) to raise awareness on how to protect and deal with wildlife in peri-urban areas. Unfortunately, this project was suspended due to the COVID-19 pandemic but we plan to reinstate soon.

Finally, although there is no systematic monitoring of the canopy bridges yet, the community is interested in the bridge and involved in making sporadic observations with the aim of recording animals crossing. We intend to formalize this monitoring and engage the community, and also install camera traps to monitor the bridges systematically. We expect that the black and gold howler monkey (*Alouatta caraya*), the crab-eating raccoon (*Procyon cancrivorus*), and the white-eared opossum (*Didelphis albiventris*) use the canopy bridges, but their use was not confirmed for any of these species yet. Besides the inaugural canopy bridge, we also installed two other rope bridges in the same town, and we plan to install three more with the support of the Municipality of Riachuelo, Re:Wild (rewild.org), and the high school of San Cayetano, increasing the involvement of these stakeholders. Our project also influenced other towns nearby, which are requesting our support for the installation of rope bridges, showing the long-term impacts of these kinds of projects.

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Conflict of interest statement

The authors have no conflicts of interest to declare.

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