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## PRIMATES AT THE NEWLY ESTABLISHED CAMAQUIRI CONSERVATION INITIATIVE, LIMON, COSTA RICA

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### Abstract

In Costa Rica, Geoffroy's spider monkey (*Ateles geoffroyi ornatus*) is classified as 'Endangered' on the IUCN Red List of Threatened Species. Given the threats it faces, this spider monkey was included in the most recent 'Top 25 Endangered Primate Species' list published by the IUCN (Schwitzer et al. 2019). The newly established Camaquiri Conservation Initiative (CCI) site, located on 200 ha in northeastern Costa Rica in Caribbean lowland rain forest, harbors a population of these monkeys that has yet to be studied. The population size of these primates and the extent to which their habitat may be fragmented is unknown. We conducted transect surveys of spider monkeys, mantled howling monkeys (*Alouatta palliata*) and Panamanian white-faced capuchins (*Cebus imitator*) at Camaquiri in 2019, 2020 and 2021 over the course of 13.5 days, covering 32 km total, to establish baseline information important for this new reserve's conservation management plan, to provide a rough estimate of the number of study subjects available for potential researchers. We recorded, minimally, 10 spider monkeys in at least one community, at least three howling monkey groups and at least one capuchin monkey group resident at CCI. Given that large patches of healthy, intact tropical forest are rarely conserved in Central America, Camaquiri provides an opportunity to conserve endangered primate species and to contribute to our knowledge of these animals. Additionally, its proximity to other field stations provides opportunities for studies of patch connectivity, habitat quality and other characteristics that influence primate populations in this region.

**Keywords:** Costa Rica, conservation, *Ateles*, *Alouatta*, *Cebus*

### Resumen

En Costa Rica, el mono araña de Geoffroy (*Ateles geoffroyi ornatus*) está clasificado como "En peligro" según la Lista Roja de Especies Amenazadas de la UICN. Dadas las amenazas a las que se enfrenta, este mono araña se incluyó en la lista más reciente de las 25 principales especies de primates en peligro de extinción publicada por la UICN (Schwitzer et al., 2019). El sitio de la Iniciativa de Conservación Camaquiri (CCI), recientemente establecido, ubicado en 200 hectáreas en el noreste de Costa Rica en la selva tropical de las tierras bajas del Caribe, alberga una población de estos monos que aún no se ha estudiado. Se desconoce el tamaño de la población de estos primates y la medida en que su hábitat puede estar fragmentado. Realizamos censos transectos de monos araña, monos aulladores de manto (*Alouatta palliata*) y capuchinos cariblanco panameños (*Cebus imitator*) en Camaquiri en 2019, 2020 y 2021 en el transcurso de 13,5 días, cubriendo un total de 32 km, para establecer información de referencia importante por el plan de manejo de la conservación de esta nueva reserva y por proporcionar una estimación aproximada del número de sujetos de estudio disponibles para los investigadores potenciales. Registramos, como mínimo, 10 individuos diferentes de monos araña en al menos una comunidad, al menos tres grupos diferentes de monos aulladores y al menos un grupo de monos capuchinos residente en CCI. Dado que en América Central rara vez se conservan grandes parches de bosque tropical saludable e intacto, Camaquiri brinda la oportunidad de conservar especies de primates en peligro de extinción y contribuir a nuestro conocimiento de estos animales. Además, su proximidad a otras estaciones de campo brinda oportunidades para estudios de conectividad de parches, calidad del hábitat y otras características que influyen en las poblaciones de primates en esta región.

**Palabras clave:** Costa Rica, conservación, *Ateles*, *Alouatta*, *Cebus*

## Introduction

Approximately 60% of non-human primate species (hereafter, primates) are threatened with impending extinction, while 75% show population decline (Estrada et al. 2017). Recently, primatologists have called for increased emphasis on conserving primates in their natural habitats (Garber 2022). A review reveals that those more closely related to us, such as apes, have received greater attention than other species (Bezanson and McNamara 2019). Monkeys in the Americas are less studied than many other primate species, and these species are reliant on forested areas. Unlike many primates in Africa and Asia that are semi-terrestrial and live in more open and drier environments, the destruction of Neotropical forests is much more likely to cause local extinction of the arboreal monkey species that are reliant on Neotropical forest habitats (Benchimol et. al. 2014; Daily et al. 2003; Peres 1997) The converse is also true. The lack of primates in a forest may contribute to forest health decline, as most primate species are effective seed dispersers of tropical forest tree species, and are instrumental in the sustainability of biodiverse-rich areas of the world (Chapman and Onderdonk 1998).

In this article we provide information about the study site and describe our preliminary transect surveys to determine presence of monkey species along trails throughout the site. We also report the number of different groups observed for each species and average group sizes.

## Methods

### Study Site

The Camaquiri study site was established as a private reserve in 2018, following the formation of a consortium of professors and conservationists from the United States and Costa Rica. The site was privately owned by a single individual for >30 years, until it was sold to the Camaquiri Conservation Initiative (CCI). Two of the seven investors are Costa Rican, and they each hold 20% of shares of CCI. Israel Mesen serves as the manager of the station, hiring all local staff. Resources at the site include an excellent network of well-maintained trails, cabins for researchers and kitchen facilities, along with a site manager and cooks. CCI is community-based, serving as a site of employment, a food pantry and community garden, a site for environmental and conservation education for regional school children (when there is not a pandemic), and a site that collaborates closely with MINAE (essentially the Ministry of Environment and Energy) and the Barra del Colorado Wildlife Refuge of Costa Rica and the regional government entity for Pococí. The local elementary school is built on CCI property, and CCI supports costs associated with maintenance of the property. Activities that CCI hosts include a number of Environmental education and conservation projects such as the Barra del Colorado Annual Bird Count, Taller de Fincas Integrales and Consejo Municipal and programming with visiting college and university groups from the U.S. with regional K-12 schools.

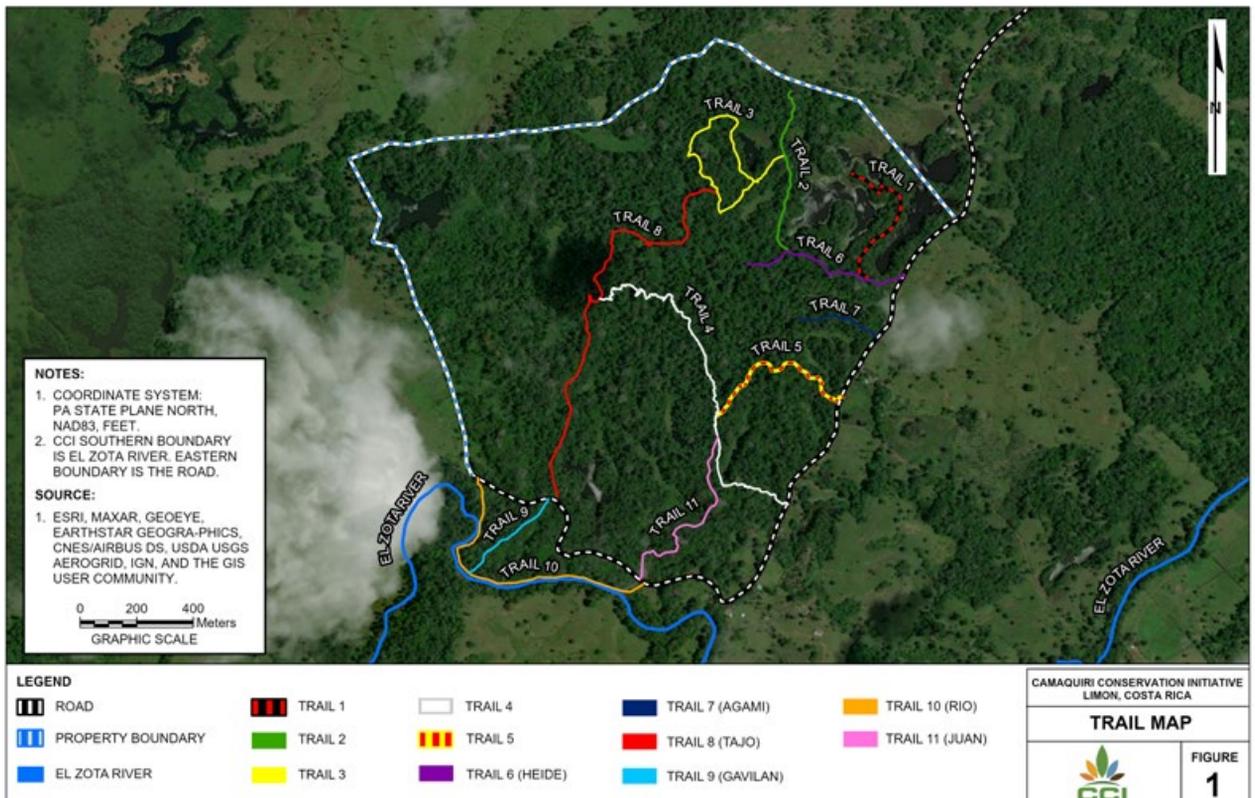


Figure 1. Map of Camaquiri Conservation Initiative, Limon, Costa Rica.

The site consists of approximately 200 ha (500 acres) of Caribbean lowland tropical rain forest that includes swampy areas and lagoons, located in northeastern Costa Rica (10.535458, -83.745436) (<http://www.camaquiri.com>). While Camaquiri is surrounded by a patchwork of pasture and forest, the forests on the property are mature with no signs of being logged (Figure 1). On the northern border CCI's forests are connected to forests in the Barra del Colorado Wildlife Refuge via a 0.3 km forest bridge and also a forested riparian corridor. Along CCI's eastern border its forest connectivity links it to forest within the El Zota biological station.

#### Data Collection

The swamp forest that characterizes this area of northeastern Costa Rica is suited to piecewise linear transects (Anderson et al. 1979) rather than random parallel transects given the topography and features of the site (i.e., designing transects around deep swamps and following natural contours, such as ridges or riverbanks). Transect sampling was scheduled such that the likelihood of recording the same monkeys on different transects was minimized, i.e., observers simultaneously surveyed transects that were more distant from each other than closer ones.

Our preliminary study followed standard methods used to quantify non-human primates involving systematic transect surveys (Paterson 2001; Elphick 2008). Surveying primates in swampy habitats is challenging, but recent work has attempted to standardize methods used in such environments (Nowak et al. 2019). Measuring and marking transects was done in December 2019. Trails were marked with a trail code and distance from the

start of the trail in 10 m increments with flagging tape (Table 1). A total of 11 trails were available for survey at Camaquiri, with six oriented north-south and five oriented east-west (Table 1). Total trail distance was 8,084 m (2,868 m of trails oriented east-west, 5,216 m oriented north-south), with trails averaging 735 meters in length (Figure 1). Trail heads started or ended at gravel access roads for seven of the 11 trails, and these two gravel roads formed the western (1.2 km) and eastern (1.2 km) boundaries of the Camaquiri property save for a narrow strip of forest bordering the El Zota River to the west of the western road.

A total of 10 survey days included six full survey days in late December 2019 and early January 2020, that included at least two observers walking two different transects of at least one kilometer simultaneously each morning and again each late afternoon. In 2021, one of these observers (JDP) again walked different transects each morning and late afternoon for 3.5 days (July 31-August 4, 2021). We walked transects at a speed of one to two kilometers per hour, slower than the recommended 3 km per hour rate suggested for most primate surveys (Paterson 2001). In order to meet the assumption that animals above the transect line are detected (Anderson et al. 1979) the slower rate of 1 km per hour, along with a 5-minute stop, look and listen point each 100 meters along the transect, provided a reliable means with which to detect unhabituated howling monkeys, in particular, over or near the transect line. Surveys began at approximately 0600 hours and ended before 1100 hours, when primates were more likely to be resting. Afternoon surveys started after 1430 hours and ended before 1730 hours, at dusk. A maximum of two people surveyed one transect together at one time,

Table 1. Trail system at Camaquiri Conservation Initiative during study\*.

Trail name/number	Length (meters)	Orientation	Intersects which trails?
Laguna Trail 1 (T1)	430 m	N-S	HT
Almendra Trail 2 (T2)	530 m	N-S	HT, T3
Ceiba Trail 3 (T3)	1066 m	N-S loop	T2, TT
Potoo Trail 4 (T4)	1153 m	N-S	T5, TT, PT
Danta Trail 5 (T5)	540 m	E-W	T4
Tajo Trail (TT)	1427 m	N-S	T4, T3
Agami Trail (AT)	290 m	E-W	-
Rio Trail (RT)	1195 m	E-W	GT
Gavilan Trail (GT)	283 m	E-W	RT
Juan's (pink) Trail (PT)	610 m	N-S	T4
Heide Trail (HT)	560 m	E-W	T1, T2

\*Total trail length 8,084 m., not including gravel access roads (East Road = 1.2 km, West Road = 1.2 km). As some trails were given names after our study, we have included these, along with the previous numbering and flagging color system.

and two observers surveyed transects simultaneously during the majority of surveys. When a monkey was detected: (1) the mode of detection was recorded (sight, sound, smell) as well as (2) the monkey species; (3) their location (via a Global Positioning System, Garmin brand, in addition to the nearest trail marker); (4) number of individuals and their age and sex (adult male, adult female, immatures); (5) the monkeys' activity (travel, feed, rest, alarm call or other reactions to observers); and (6) the straight line distance from the nearest monkey to the transect as well as (7) to the observer, and; (8) the estimated angle between the observer, monkey and transect line. Although standard methods allow for a 10-minute contact period with each group encountered, Pruett and Leason (2002) found that spending at least 20 minutes with primate social groups of the same species at the nearby La Suerte site gave a better estimate of the number of individuals and their age and sex classes comparing transect surveys and census of known groups at the nearby La Suerte site.

## Results and Discussion

Approximately 22 km (22,360 m) of trail and connecting roads were surveyed at Camaquiri during 15 transect walks by JDP and KD on six consecutive days between 27 December 2019 and 1 January 2020. Approximately 10 km (9,910 m) was surveyed by JDP on three consecutive days between 31 July and 3 August 2021, for a grand total of almost 32 km surveyed (n=31.9 km). Although preliminary, these data can provide a baseline for future surveys and allow comparison with the nearby El Zota and La Suerte Field Stations where students in primatology

field courses conducted similar survey exercises annually for many years.

Most contacts during trail surveys were with parties of spider monkeys. A total of 26 *Ateles geoffroyi* contacts, nine *Alouatta palliata* contacts and five *Cebus imitator* contacts were recorded (n=21 contacts with *Ateles*, 6 with *Alouatta*, 4 with *Cebus* in 2019-2020 and n=5 contacts with *Ateles*, 3 with *Alouatta*, and 1 with *Cebus* in 2021). Longer contacts with groups in 2021 compared to 2019-2020 records indicate groups may be better habituated. Contacts with subgroups or parties during the encounters with *Ateles* along transects lasted an average of 14.3 minutes per encounter in 2019-2020 and 17 minutes in 2021. In 2019-20, encounters with *Cebus* lasted on average 14.5 minutes per encounter, while those with *Alouatta* lasted 13.75 minutes per encounter, with 2021 surveys resulting in 20 minutes average with *Cebus* and 17.3 minutes average with *Alouatta*. Including an additional three encounters with spider monkeys outside of our transect surveys, we calculated party size to be 2.2 individuals per encounter (n=24 encounters; range 1-6 individuals) in 2019-20. In 2021, we recorded an average of 3 individuals (n=13 encounters; range 2-5 individuals) with parties during transect surveys and outside of survey times for spider monkeys.

Based on females' coloring and their accompanying offspring, we conservatively identified at least five different adult female spider monkeys at Camaquiri and at least three different adult or subadult male spider monkeys during our survey, for a total of eight different adults. In 2021, JDP observed a juvenile male that had a missing

Table 2. Frequency and distances surveyed along trails at Camaquiri in 2019-2021\*

Trail #	Distance surveyed	Date	Time
Laguna Trail 1 (red/black)	430 m, 430 m	12/29, 8/1	p.m., a.m.
Almendra Trail 2 (green)	530 m, 340 m, 340 m, 340 m	12/29, 12/31, 1/1, 8/3	a.m., a.m., a.m.
Ceiba Trail 3 (yellow)	1066 m, 1066 m, 1066 m	12/29, 1/1, 8/3	a.m., a.m., a.m.
Potoo Trail 4 (white)	310 m, 750 m, 750 m	12/29, 12/31, 8/1	a.m., a.m., p.m.
Danta Trail 5 (red/yellow)	544 m, 544 m, 544 m	12/28, 12/31, 8/3	a.m., p.m., p.m.
Heide's Trail	560 m, 400 m, 400 m, 400 m, 400 m	12/29, 12/29, 12/31, 1/1, 8/3	a.m., p.m., a.m., a.m., a.m.
Tajo Trail	690 m, 690 m, 1427 m, 737 m	12/29, 12/31, 1/1, 8/3	a.m., a.m., p.m.
Rio Trail	1195 m, 1195 m	12/30, 7/31	a.m., a.m.
Western Road	1000 m	8/4	a.m.
Agami Trail	290 m	12/31	a.m.
Juan's Trail (pink)	610 m, 610 m, 610 m	12/28, 12/31, 8/1	a.m., p.m., a.m.

\*As some trails were given names after our study, we have included these, along with the previous numbering and flagging color system.

lower right arm, bringing the estimate of five different female spider monkeys to six, when his mother was included, and the total number of individuals so far identified at CCI to at least 10. At least three howling monkey groups (Camp Group, Freddy's Group, Tajo Lagoon Group) were identified at Camaquiri in 2019–20, based on simultaneous encounters during surveys as well as location and membership information. This number increased to five in 2021, based on the use of a large fruiting *Ficus* tree by at least two howler groups (including one now called 'Eduardo's' group) near the southern boundary edge of CCI, at the end of Sendero Rio, along with sightings of the Camp Group, a group ranging near the Perezoso Pulperia (possibly Freddy's group) and near Tajo Lagoon (Tajo group), within roughly the same time period. At least one individual in the well-habituated Camp Group exhibited lack of pigmentation on her tail (Dunn et al. 2014; Ramos-Luna et al. 2022), while another in one of the groups using the *Ficus* on Sendero Rio was seen with a lack of pigmentation on its tail and right leg in 2021.

#### *Comparisons to other sites in the area*

Based on surveys using similar piecewise transects conducted during primatology field courses between 1999–2015 at the nearby El Zota Station, primate groups were contacted less frequently at Camaquiri. At the larger El Zota forest patch (~1000 ha), primate groups were contacted on average four times per km of transect (range 1–7 groups; Pruetz, unpublished data). However, most trails at El Zota are situated in the 200-ha regenerating forest patch, in contrast to the mature, unlogged Camaquiri site. This may explain the relatively infrequent contacts with howling monkey groups at Camaquiri compared to El Zota. However, the ability for howling monkeys to disperse between Camaquiri and other sites should also be considered. In a larger survey of the region, Tafoya et al. (2020) encountered primate groups in general at a rate of 0.35 per kilometer surveyed. Another explanation is that the howler monkey groups at Camaquiri are habituated to humans at forest edges along roads and adjacent to dwellings. The Camp Group of howling monkeys and Freddy's Group of howling monkeys, each observed at road edges almost daily during the survey, were better habituated to humans, while the Tajo Lagoon Group of howlers, which were frequently seen near a lagoon, 700 m from the main road, were observed to move away from approaching human observers. In 2021, a group on the Yellow Trail, which may have been the Tajo group, ceased vocalization until seen by the observer, after which two adult males of this group began howling at the observer until she finished the survey contact period and moved off. This group deeper within the Camaquiri forest patch was less habituated to people.

The spider monkeys at Camaquiri were surprisingly well-habituated, even in forest interiors, despite the fact that the establishment of the trail system began in March

2019. A likely explanation is that the El Zota South community of spider monkeys uses Camaquiri forest as well. Less than 0.5 km separates the northern edge of Camaquiri with the southern edge of El Zota, with a patchwork of forest and gallery forest corridors characterizing two properties between these field stations. Given the relatively large home and day ranges of this species, *Ateles* here might be transferring their habituation to humans in areas like roads and houses to interior forest areas. The trail system used for surveys at Camaquiri is spaced such that primate encounters are more likely to be independent than those at El Zota, where the narrowness of forested areas could result in a lack of independence in primate encounters (see map of El Zota in Pruetz and LaDuke 2001). Camaquiri is available for both field courses and research, which provides the intriguing opportunity to make comparisons with La Suerte and El Zota and to also examine the role of field stations in conserving primate species living in a patchy anthropogenic landscape in lowland Costa Rica.

While our sample sizes prevent us from calculating proper densities of the species, encounters with the three primate species at Camaquiri suggest that all three monkey species do not exhibit low densities here. Our contact with *Cebus* was relatively low but not surprising given the larger home ranges than *Alouatta* but shorter daily path lengths and more cohesive travel by this species when compared to *Ateles*, which travels farther per day and frequently splits into subgroups or parties.

Finally, the presence of a juvenile spider monkey with a partially missing limb should be further investigated. To our knowledge, this is the third such individual within the larger *Ateles* population surrounding CCI. At the El Zota site, two immature spider monkeys were also observed with partially missing limbs in previous years: A juvenile female missing her left arm and a juvenile male missing most of his right (Wackerly 2016). Future studies that take into account gene flow, possible inbreeding and potential environmental toxins could shed light on this phenomenon. The underlying explanations for such disabilities make for important research topics, as we have yet to observe adults with missing limbs, implying that spider monkeys may not survive to adulthood with such afflictions and therefore of concern to conservation of this endangered primate species at Camaquiri and El Zota.

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