Assessing the Impact of Timber Extraction on the Habitats of Southeast Peruvian Amazon Primates

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Abstract

The Madre de Dios region in the southeastern Peruvian Amazon harbors diverse primate species reliant on the forest canopy for essential activities such as traveling, feeding, socializing and resting. However, escalating logging activities jeopardize their habitat and the region's ecological resilience. This study aims to assess the tree species utilized by primate species in the Finca las Piedras property and analyze the vulnerability of these trees to extraction industries. Field observations over a two-week period revealed that primates spent 61.80% of observed time in trees unthreatened by extraction and 38.20% in trees threatened by extraction, highlighting significant threats to primate habitats in the greater region. These results yield implications for improved conservation efforts in the Peruvian Amazon to preserve the biodiversity and ecological resilience provided by the presence of primates.

Introduction

Deforestation and Extraction in Madre de Dios

The Peruvian Amazon is home to diverse ecosystems and invaluable biodiversity, but it faces significant threats from deforestation and habitat degradation (Paiva, 2020). The region harbors several timber species crucial for both ecological stability and economic prosperity (Brandão, 2021). Shihuahuaco (*Dipteryx micrantha*), tornillo (*Cedrelinga cateniformis*), lupuna (*Ceiba pentandra*), and cumala (*Albidiflora ferrule*) are among the other valuable hardwoods still found in the Peruvian Amazon today (Quispe, S. B. et al., 2019). These species contribute to the region's biodiversity and play vital roles in forest ecosystems, but are nearing extinction due to overextraction (Montaño, 2022).

Shihuahuaco (*Dipteryx micrantha*) is renowned for its ecological importance, serving as a crucial carbon sink and providing
sustenance and shelter for numerous wildlife species (Cárdenas et al., 2023). It is a giant within the forest, reaching as high as 50 meters (Cárdenas et al., 2023). However, its future is jeopardized by rampant illegal logging and overexploitation (Cárdenas et al., 2023; Finer et al., 2014; Lay, 2022). In the decade between 2010 and 2020, 353,310 shihuahuaco (*Dipteryx micrantha*) trees were cut down and extracted from the Peruvian Amazon (Montaño, 2022). The tornillo (Cedrelinga cateniformis) also holds great ecological importance. These trees can reach heights of 30 meters and provide shade to trees closer to the ground, guiding their development (Envolvert, 2022). Additionally, they are nitrogen fixers which enhances the fertility of surrounding soils (Envolert, 2022). However, from 2010-2020, 379,302 tornillo (*Cedrelinga cateniformis*) trees were cut down in the Amazon (Montaño, 2022). The lupuna (*Ceiba pentandra*) tree is significant as

well. It is considered sacred to several Amazonian tribes (Van Loon, 2020). Ecologically, the lupana (*Ceiba pentandra*) is one of the tallest trees in its ecosystem, sometimes reaching 70 meters, meaning that it provides essential forest canopy for many species and provides shelter throughout its trunk and branches to many other organisms (Van Loon, 2020). Lastly, the cumala (*Albidiflora ferrule*) tree can live for 100 years and grow over 30 meters tall (Montaño, 2022). It serves important ecosystem functions by providing fruits that toucan and parrot species often feed on (Montaño, 2022). From 2010-2020, 341,402 cumala trees were cut down for timber (Montaño, 2022).

Despite regulatory measures aimed at ensuring sustainable logging practices, evidence suggests that Peru's legal logging concession system inadvertently facilitates illegal logging activities (Finer et al., 2014). Shockingly, official data indicates that a staggering number of shihuahuaco (*Dipteryx micrantha*) and tornillo (*Cedrelinga cateniformis*) trees have been harvested in recent years, exacerbating the species' vulnerability, and following in the steps of the other timber tree species in the region (Montaño, 2022). Timber tree species in the area are growing closer to extinction, and their conservation must be catalyzed to ensure their survival.

Significance of Primate Species

Primate species are a key indicator for tropical forest biodiversity and ecosystem resilience in the Amazon (Ryland et al., 1997). They perform crucial activities such as being efficient pollinators and seed dispersers that facilitate forest regeneration (Aquino et al., 2016; Terborgh, 2008). Additionally, primates contribute to insect control, keeping the food chain intact (Aquino et al., 2016). Lastly, they are also important prey for other animals, so their population numbers are essential to maintaining biodiversity at all predator and prey levels (Aquino et al., 2016). Thus, it is vital to prioritize primate conservation strategies to maintain the rich biodiversity and robust ecosystem resilience of the Amazon rainforest.

Logging as a Threat to Primate Species

The consequences of deforestation extend beyond the loss of individual species. Forest fragmentation and degradation pose severe threats to primate habitats, with illegal logging identified as a principal driver of habitat destruction (Shanee et al., 2023). Primate taxa in Peru face a myriad of challenges though, also including hunting, urban development, and smallholder farming (Shanee et al., 2023).

Fragmentation not only diminishes habitat availability but also alters forest dynamics, particularly affecting larger trees critical for primate survival (Shanee et al., 2023). Moreover, the negative effects of deforestation are exacerbated by the loss of crucial habitat for endangered species like the spider monkey (*Ateles chamek*), which is found in some Amazonian regions (Lay, 2022). The capuchin (*Cebus apella*), titi (*Callicebus toppini*), squirrel (*Saimiri sciureus*), tamarin (*Saguinus fuscicollis*) monkeys, and more are found in the Madre de Dios region, and are also threatened by the logging activity in the area.

It is important to assess potential forest degradation because the process reduces habitat availability and connectivity for primates in the Amazon (Shanee et al., 2023). These impacts are especially seen with larger trees, a category of which timber trees often fall into, because they offer protection and shelter (Shanee et al., 2023). Primates are an essential taxon to study in

this realm because species with larger bodies are more likely to be negatively affected by the ecology surrounding them (Shanee et al., 2023).

This field study aims to fill the gap of how primates specifically are likely to be impacted by extraction industries, focusing in on the Finca las Piedras property of the Madre de Dios region of the Peruvian Amazon. The goal of this study is to determine the extent that primates at Finca las Piedras rely on tree habitats that are threatened by timber extraction in the greater Madre de Dios region of the Amazon. I hypothesize that a significant portion of trees used by primates will be species that are commonly targeted for extraction.

Methods

Field Observations

Systematic field observations of primate species in the Amazon rainforest were conducted by observing which trees they were found in at different parts of the day and for how long they spent in each tree. Data was collected over the span of two weeks. I walked the trail system of the Finca las Piedras property, dividing the total system into two sections to rotate observation locations on a regular basis. The first section included the perimeter trails of the eastern side of camp and the second section was the perimeter of the western side of camp. My path remained on the designated trail system, unless primates were located that required off-trail navigation.

Observation times ranged from 6:11AM to 5:30PM and typically lasted between one and two hours. Observations were conducted 1-2x each day, on a rotating schedule of the time windows. I tracked the number of times I went out to each trail segment and what time of day it was on a digital note page. If primates were heard from camp, the rotating schedule was forgone to track the current group as opportunistic data. If I saw a group of primates, I followed them for as long as possible, or until they left the Finca las Piedras property. I went into the field 12 total times and was able to locate primates four of those times. The data collected on 6/7/24 was opportunistic because primates were heard nearby camp.

Table 1: Observation attempts and trail details throughout the two-week period.

Date	Trail Segment	Time of Day	Direction Traveled	Saw Primates?
6/5/24	E	4:55PM-5:30	L	N
6/6/24	W	11:30AM-12:35PM	L	N
6/7/24	E	10:23AM-11:23AM	R	N
6/7/24	W	5:00PM-5:30PM	L	Y
6/7/24	E	2:45PM-3:45PM	L	N
6/9/24	E	2:36PM-3:54PM	L	Y
6/10/24	E	9:15AM-10:45AM	R	N
6/11/24	W	11:40AM-12:45PM	L	N
6/11/24	E	3:30PM-4:45PM	R	Y
12-Jun	E	3:15PM-5:20PM	R	N
6/13/24	E	6:11AM-6:50AM	L	N
6/14/24	E	9:44AM-11:30AM	R	Y

Tree Species and Primate Behavior Analysis

When a group of primates was discovered, a focal individual was chosen to track its use of the habitat. The individual chosen was the closest to my point of observation. Immediately, a stopwatch segment was started on an iPhone to track how long the primate spent in the tree. Subsequently, I took a picture of the tree to help with identification.

Then, I logged the stopwatch lap number, activity (traveling, feeding, resting, socializing), and species in the Notes app to keep track of which stopwatch segment included which tree, behavior, and species. A fieldwork partner then tagged each inhabited tree with colorful tape so that the species could be identified by Alliance for a Sustainable Amazon staff later. Next, an Alliance for a Sustainable Amazon staff member versed in botany helped identify the tagged trees in the field and whether or

not the species is commonly extracted in the Madre de Dios region. This information was logged in the Notes app.

When returned from the field, the data was entered into an Excel sheet. Since only one photo was taken of each tree, each stopwatch lap aligned with the tree that the primate inhabited. The Photos app on the iPhone tracked what time each tree was captured. The Excel entries included time of observation, if the tree species is extracted in the region or not, time the primate spent in the tree, the activity the primate was performing, and lastly, the species of the monkey if identified to species level.

Threat of Logging Analysis

After collecting the data from the field, I calculated the proportion of timber trees to non-timber trees observed based on the information provided by the Alliance for a Sustainable Amazon staff member. The tree species that were included in the possible timber category were shihuahuaco (*Dipteryx micrantha*), tornillo (*Cedrelinga cateniformis*), lupuna (*Ceiba pentandra*), cumala (*Albidiflora ferrule*), and caspi (*Apuleia leiocarpa*), pashaco (*Schizolobium excelsum*), quillabordon (*Aspidosperma parvifolium*), azúcar huayo (*Hymenea coubaril*), moena (*Diospyros guianensis*), and some inga species that were identified as timber species by an Alliance for a Sustainable Amazon staff member, but the specific genus and species were left unidentified. Any other tree species fell into the non-timber category. All data points were entered into an Excel sheet and filtered to find the kind of trees that the primates spent the most time in. From here, I analyzed how much time the primates spent in trees that are threatened by logging versus trees not threatened by the industry and determined implications.

To determine whether the data fits a normal distribution and if it is statistically significant, I performed a Shapiro-Wilk test in RStudio. Because neither group was normally distributed, I performed a non-paramedic test, the Whitney-Mann test, to assess the significance of the difference between the two groups.

Results

Out of the twelve observation windows conducted, primates were located four times, each on separate days. The total logged observation time was 55 minutes. Within these 55 minutes of observation, four primate behaviors were observed: traveling, feeding, resting, and socializing. Three primate species were logged: capuchin monkeys (*Cebus apella*), tamarin (*Saguinus fusciollis*), and squirrel monkeys (*Saimiri sciureus*).

Primates were found to have spent 61.80% (30.83 minutes) of their observed time in tree species that are not threatened by extraction industries and 38.20% (19.03 minutes) of their time in threatened tree species. Of the total trees counted, 18 were species that are not threatened by logging and 15 were threatened.

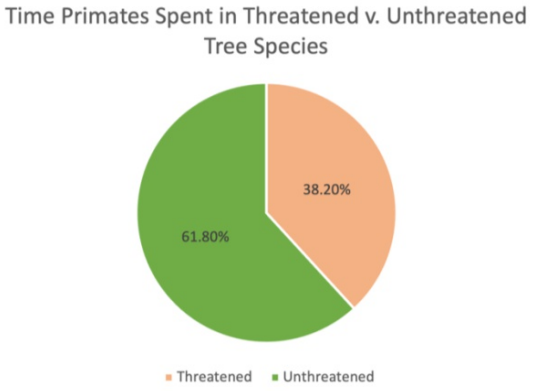

Figure 1: Time split for observed primates inhabiting trees threatened by the timber industry and unthreatened trees. Primates spent 61.80% of the time in unthreatened trees and 38.20% in threatened trees.

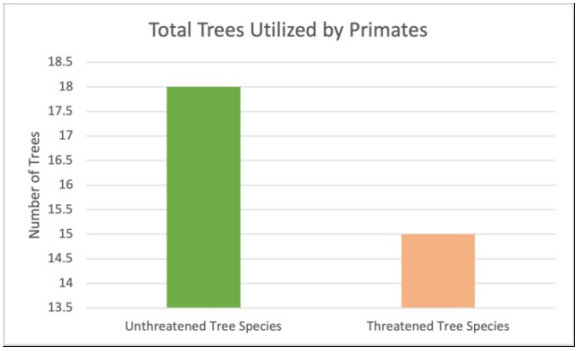

Figure 2: Number of unthreatened trees and threatened trees that the primates inhabited. They utilized 18 unthreatened species and 15 threatened species.

The distributions of time spent in trees were different depending on the activity observed. For feeding, primates spent 22.48 minutes in unthreatened trees and 11.40 minutes in threatened trees. For traveling, primates spent 6.1 minutes in unthreatened trees and 4.1 minutes in threatened trees. For resting, primates spent 39 seconds in unthreatened trees and 5.35 minutes in threatened trees.

The observed primates inhabited eleven unthreatened trees and six threatened trees when feeding. When traveling, they used six unthreatened trees and four threatened trees. Lastly, the primates used one unthreatened tree and five threatened trees for resting.

Figure 3: Number of threatened and unthreatened trees primates inhabited while resting. Primates utilized five threatened trees and one unthreatened tree.

The Shapiro-Wilk test for the unthreatened trees yielded a low W value of 0.58632 and a very small p-value of 4.967×10−64.967 /times 10^{-6}4.967×10−6. This indicates that the data for time spent in trees unthreatened by timber significantly deviates from a normal distribution. For time spent in trees threatened by timber extraction, the data showed a higher W value of 0.81727 and a p-value of 0.006179. While the W value is higher compared to the unthreatened data, suggesting less deviation from normality, the p-value is still less than 0.05 (assuming a typical significance level), indicating that the threatened data also significantly departs from a normal distribution. Therefore, neither dataset can be considered to follow a normal distribution based on the Shapiro-Wilk test results.

The Whitney-Mann test for both sets of data generated a p-value of 0.4638. The test compared the time spent in unthreatened and threatened trees and found that the p-value is above the significance level of 0.05.

Discussion

Implications

The findings of this study reveal compelling insights into the impact of timber extraction on primate habitats within the southeastern Peruvian Amazon, focused on the Finca las Piedras property. The results from the field study show that a significant proportion of the trees that primate species rely on in the Peruvian Amazon is threatened by extraction. Primates, including capuchins (*Cebus apella*), tamarins (*Saguinus fusciollis*), and squirrel (*Saimiri sciureus*) monkeys were often observed in trees that are targeted for extraction. This suggests that logging activities are encroaching upon critical

habitats essential for primate feeding, traveling, and resting behaviors.

From this study, we glean that almost 40% of trees used by primates for various activities are threatened by logging. Therefore, action is essential to mitigate further habitat loss in the Peruvian Amazon. Conservation efforts should prioritize the protection of key tree species such as shihuahuaco (*Dipteryx micrantha*), lupuna (*Ceiba pentandra*), and cumala (*Albidiflora ferrule*) because they are vital to primates' habitats and to the strength of the ecosystem as well (Montaño, 2022).

The Whitney-Mann test conducted shows that there is not enough evidence to suggest that the time spent in trees is significantly different between those threatened by timber extraction and those unthreatened. Since the null hypothesis assumes that there is no difference in the distribution of time spent in trees between the "Unthreatened" and "Threatened" categories and the alternative hypothesis suggests that there is a true location shift between the two groups, indicating a difference in the median time spent in trees between "Unthreatened" and "Threatened" categories, I failed to reject the null hypothesis. There is no sufficient evidence to conclude that there is a significant difference in the median time spent in threatened versus unthreatened trees. This indicates that the trees used by primates at Finca las Piedras is somewhat random, which means that they do end up relying on species threatened by timber due to the higher concentrations of timber species in the Madre de Dios region (Forest Trends, 2021).

The resting behavior exhibited by observed primates happened more often in trees threatened by logging than those unthreatened. The higher proportion of time spent in threatened trees during resting periods implies that these areas may provide important resources or safety benefits to primates, despite the associated risks (Shanee et al., 2023). This behavioral pattern underscores the complex interactions between essential primate behaviors and extraction activities.

In terms of conservation strategies, approaches that combine habitat protection with community engagement are crucial. Collaborative efforts involving local stakeholders, governmental agencies, and conservation organizations are essential for implementing effective land-use policies that promote sustainable forest management while protecting primate habitats and biodiversity in the Peruvian Amazon (Moorcroft & Smith, 2011).

Limitations

There were several limitations to this field study. Primarily, time was a constraint. This project was conducted over a four-week period, leaving two weeks for data collection in the field. Having a longer period for collecting data would have made the results more reliable and representative. Additionally, of the twelve times I went out into the field, I located primates on only four occasions. Therefore, the data in this study is limited to only four groups of primates in the Amazon.

There were limitations in identifying tree species and concluding if they are threatened by extraction. Some data points were omitted from the results of the study because the tree species could not be identified. This resulted in the behavior of socializing to be omitted too, since that behavior was only observed in unidentified tree species.

Additionally, species identification of the primates was limited. There were some data points that had definite species labels, but these were limited to one day of observation. Finally, some trees that were tagged to be identified in the field were unable to be located later for identification. This caused several data points to be excluded from the results.

To address these limitations and build upon the findings, future research should consider longer-term studies that cover broader geographic areas within the Madre de Dios region. Longitudinal studies could provide deeper insights into seasonal variations in primate habitat use and the cumulative impact of logging across different forest types. An analysis of species-specific behavior of primates could also be performed to provide insight on the different levels that various species are threatened by logging.

Acknowledgements

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Appendix

Figure 4: Time primates spent in each observed tree while feeding. During this activity, primates spent more time in trees unthreatened by timber extraction.

Figure 5: Time primates spent in each observed tree while resting. Primates spent more time in threatened trees while resting.

Figure 6: Time primates spent in each observed tree while traveling. Primates spent more time in unthreatened trees while traveling.

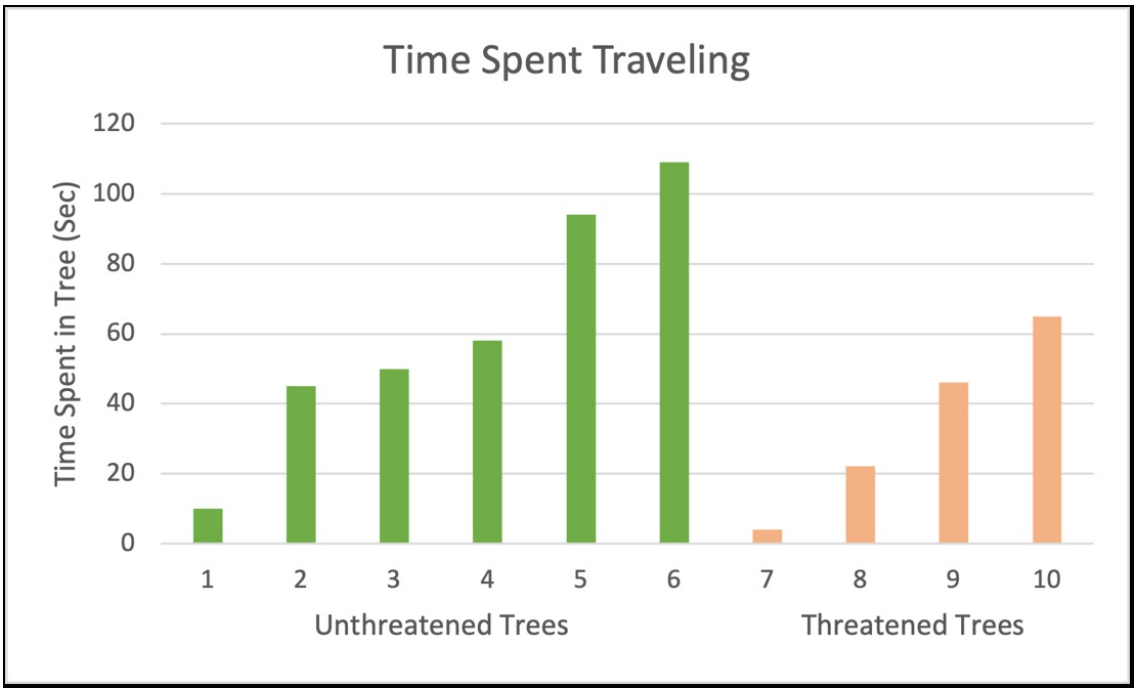

Figure 7: Number of threatened and unthreatened trees primates inhabited while feeding. Primates inhabited unthreatened trees more often than threatened trees while feeding.

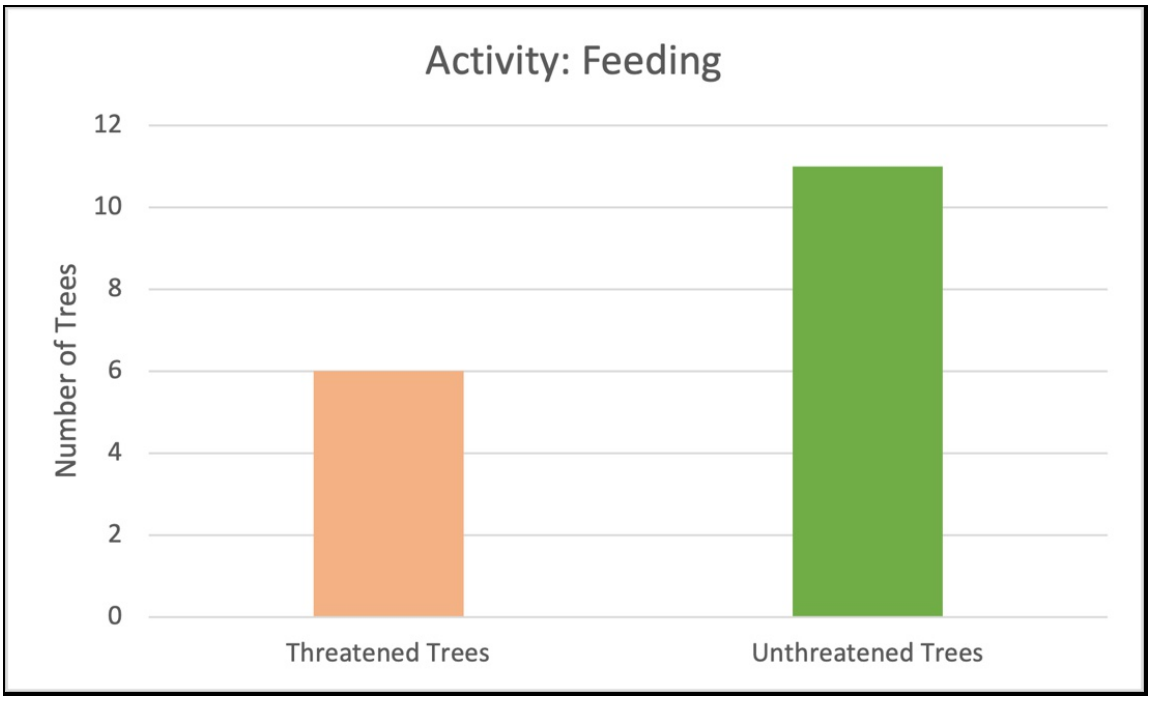

Figure 8: Number of threatened and unthreatened trees primates inhabited while traveling. Primates inhabited unthreatened trees more often than threatened trees while traveling.