Survey of Wildcat Populations in Premontane, Montane, and Highland Tropical Environments in Costa Rica

Simon Strazza | Gabriel Hadad-Larrieu | Kaia Artemas Kasdin | Wendy Welshans, MS

Abstract:

In the heart of Costa Rica, wildcats are teetering on the edge of extinction. Driven to the brink by deforestation, poaching, and illegal trade. This research aims to gather data on these Keystone species, focusing on their behavior and ecological interactions at high and mid-elevations. Data to be collected may contribute to improved policies to help curb the declining wildcat populations. The data will be collected via 30 trail camera traps placed throughout the jungle surrounding the research station, with factors such as weather conditions, GPS locations, dates, and times playing a significant role in the overall dataset for this project.

Keystone species[1]

- **Margay** (*Leopardus wiedii*)
- **Ocelot** (*Leopardus pardalis*)
- **Puma** (*Panthera pardus*)
- **Jaguarundi** (*Herpailurus yagouaroundi*)
- **Jaguar** (*Panthera onca*)
- **Oncilla** (*Leopardus tigrinus*)

Wildcat food sources:

- **Various species of Snakes**
- **Various species of Rodents**
- **Fish**
- **Capybara (***Hydrochoerus hydrochaeris*)
- **Central American Agouti** (*Dasyprocta punctata*)

[1] https://crie.cr/what-wild-cats-live-in-costa-rica/

- **Lowland Paca** (*Cuniculus paca*)
- **White-Tailed Deer (***Odocoileus virginianus)*
- **The nine-banded Armadillo** (*Dasypus novemcinctus*)
- **Common Opossum** (*Didelphis marsupialis*)
- **Two-toed sloth** (*Choloepus hoffmanni*)
- **Nasuella olivacea** (*Nasuella olivacea*)
- **Mountain Paca** (*Cuniculus taczanowskii*)
- **Little Red Brocket** (*Mazama rufina*)
- **South American Coati** (*Nasua nasua*)
- **Dice's Cottontail Rabbit** (*Sylvilagus dicei*)
- **Mexican Hairy Dwarf Porcupine** (*Coendou mexicanus*)
- **Brocket Deer** (*Mazama americana*)
- **Striped Hog Nosed Skunk** (*Conepatus semistriatus*)
- **Collared Peccary** (*Dicotyles tajacu*)
- **Baird's Tapir** (*Tapirus bairdii*)

Introduction:

"*Biodiversity is disappearing at a thousand times the natural rate,*"[2] Amina Mohammed claimed in March of 2018. Poaching, habitat loss, and loss of prey species have caused the already scarce number of big cat populations to dwindle even further. Six of the six wildcat species in Costa Rica have been placed on the CITES Appendices Level I[3]. Appendices level I means that the species is actively threatened with extinction and provides the most significant level of protection, including a prohibition on commercial trade. Level II indicates that the species is not threatened with extinction but may become so without trade controls. Since March 2018, steps have been taken in an attempt to curb the declining population levels in the form of more than 25 rule changes and bans regarding the use of wildcat products, hunting regulations, and treatment[4]. However, even with these changes, the species and the Rainforest find themselves in incredible trouble.

Any minor environmental alteration can significantly impact the entire ecosystem, meaning the rainforest as a whole is at risk of collapse with the potential extinction of a single predator species. Ecosystems are intricately balanced, with each organism playing a critical role in creating the symbiotic environments we rely on. If the predators disappear, the prey population will grow unchecked until no more food is left to sustain them. Without food, the prey species will die; without the prey species pollinating and fertilizing the plants, the plants will die. Slowly, the lush, species-rich areas we know to be the Tropical Rainforests will disappear. Rainforests are called the Lungs of the World for a reason: the world's Rainforests absorb a net 12 billion metric tons of CO2 each year, supplying the world with a vast amount of oxygen. Tropical rainforest plants also provide the materials needed for 25% of all medicines, while at the same time, less than 5% of rainforest plants have been inventoried. The rainforest is an incredibly untapped resource, and it is imperative that we must protect the species that keep the rainforest alive.

[2] https://news.un.org/en/story/2018/03/1003991
[3] https://checklist.cites.org/#/en/search/
[4] https://bigcatrescue.org/conservation-news/big-cat-bans-enacted

That is why this type of research is so important. Thankfully, Forman isn't the only group interested in the conservation of these magnificent species. Another large group in the effort to protect wildcats is Panthera[5], a group with a mission to protect all 40 wildcat species around the globe. In fact, Panthera recently assisted in encountering a Black Oncilla[6] - Black Oncillas are the smallest wildcat species in South America, to find them is rare enough, but to encounter a melanistic one seldom occurs. When discovered, the group managed to capture, collar, and release the tiny cat, thus leading to the tracking of its movements and habits. Learning more about the habits of the Black Oncilla helps protect and conserve their species. Other than Panthera, we can't forget to mention those at the University of Arizona and all of their efforts with their Wild Cat Research and Conservation Program[7]. Without their help and continued support, this project would be nowhere near the level it is today. Other notable groups include the Human Society[8] and WILDCRU[9], or the University of Oxford's Wildlife Conservation Unit. All of these incredible groups play massive roles in the conservation and preservation of our natural world.

Heading into the jungle, the team came up with three questions that we planned to answer during our time in the rainforest:

1. How much will the species population and diversity overlap at different altitudes?

2. What are the noticeable differences in animal behavior and activity at different altitudes?

3. How does the numeric population size of predatory species affect the behavior of prey species?

Notice that two of our questions pertain to the effects of change in altitude. This is due to the locations where our research was conducted this year. The first location was in San Gerardo. Located in the Children's Eternal Rainforest, San Gerardo is near the city of Santa Elena. San

[5] https://panthera.org/
[6] https://panthera.org/blog-post/small-cat-spotlight-oncilla
[7] https://www.wildcatresearch.arizona.edu/
[8] https://www.hsi.org/
[9] https://www.wildcru.org/

Gerardo is at an elevation of 1200m (3937ft), making it a midland rainforest and a cloud forest. The Children's Eternal Rainforest privately owns 22500 hectares of land, with San Gerardo having direct access to 10km (6 mi) of trails. The knowledge of wild cat populations within the Children's Eternal Rainforest is critical as the knowledge of wild cat populations can be used to better protect the land. This is a location that our teams have not been to in two years, so we are interested in seeing how our data compares to past years. The second location is Cuerici Biological Station. Cuerici is a small, remote area located in the southern tip of Costa Rica, in the Talamanca mountain range. It lies within the greater Talamanaca Biosphere Reserve, which is a UNESCO-designated site that includes diverse ecosystems and rich biodiversity. The station itself is located in the Rio Macho Forest within the San José Province[10]. At an elevation reaching 3353m (11,000ft)[11], it is also referred to as a cloud forest. Despite being in a tropical climate, it experiences far colder temperatures than the rest of the rainforest, ranging from 12-20°C (54-68°F), with even colder nights. The Rio Macho Forest encompasses 84,592 hectares of land, with the government managing most of the region, but private owners control about 30% of the land[12]. This reserve put a stop to rapid deforestation that has damaged Costa Rica's natural resources over the last few decades. It protects endangered species and habitats and is an essential part of Costa Rica's cultural heritage.

Methodology:

Bushnell Low-Glow Aggressor (Description and Setup)

Wildlife conservation has gained momentum through the use of non-invasive tracking methods. For the goals of this project, we will deploy infrared cameras. These cameras emit a red flash that is less disruptive. They are great for several reasons: they aren't hindered by intense rainfall during tropical storms, can survive freezing temperatures below -20 degrees Fahrenheit, can detect movement from up to 100 feet away, and feature a quick 0.5-second reset time allowing minimal missed time between video or image shots. Additionally, these cameras can be configured in hybrid mode, allowing them to capture both pictures and videos of moving fauna.

[10] https://aiteots.wordpress.com/tag/cuerici-biological-station/
[11] https://aiteots.wordpress.com/tag/cuerici-biological-station/
[12] https://www.govisitcostarica.com/region/city.asp?cID=449

Images by Bushnell.com

Setting up the cameras is straightforward.

- First, open the door of the camera and set it to “Setup” mode.
- From there, you can configure the date, time, reset time, and choose between photo, video, or hybrid modes. (Note: Before installation, an SD card must be formatted and inserted into the camera.)
- Once the camera is switched from “Setup” to “On,” the researcher has 10 seconds to step away without triggering the camera.

Multi-Camera Trap (Setup and Reasoning)

Images by NatureSpy.org

The procedure for setting up a trail camera array, either in a linear or polygonal format,

- begins with identifying tracks or signs of wildlife in the area.
- Once the area has been designated, the first camera is installed and labeled as Camera 1.
- The GPS location of Station 1 will be recorded, along with the GPS locations of all cameras placed in the array.
- A total of 24 cameras will be deployed within a 3-mile (4.82 kilometers) radius from Station 1, which represents the maximum distance from this station.
- Most of the cameras will be positioned facing north, with a few directed toward the south in areas where viable wildcat signs are detected.

This primarily northerly placement reduces the impact of sunlight on the images. The southern-facing cameras, placed in known travel corridors, will capture photographs from the opposite angle, providing better views of the animals. This approach is essential for examining pelage patterns that can help in identifying individual animals. By comparing these images, we can ensure that individuals are not duplicated in the population census.

Great care is taken to ensure that all variables are recorded accurately, including the date, time, and temperature. At the beginning of the camera setup, the researcher waits for 10 seconds for the camera to trigger. The first photo taken by each camera features a whiteboard displaying

the time, date, GPS location, and the names of the researchers present. This initial picture for each camera aids in organizing the cameras and SD cards effectively.

Journaling (Description and Setup)

Field journals will be maintained 2 to 3 times a day according to the guidelines provided in the "*Field Training Manual for Field Biologists in Papua New Guinea" by Andrew L. Mack and Debra D. Wright.*

This manual is designed to establish a baseline methodology for proper procedures in collecting field data in tropical environments. It serves as the training resource for the high school technicians involved in this project. The journals will include the following information:

- **Your name**
- **Date: day/month/year**
- **Location: GPS fix**
- **Collaborators:**
- **Habitat description (this includes landscape forest fragmentation, forest age, agriculture, wetlands and human activity**
- **Weather: Temperature(Min/Max), Rainfall, Cloud cover**
- **Description of activities: i.e. checking cameras with whom**
- **Important biological observations:**
- **Cross references to data:**

Results/Data/Photos:

During our time in Costa Rica, we collected over 257 photos and videos of 30 different mammal species in both Cuerici and San Gerardo. On average, there were 8.56 photos and videos of each mammal species. The most prominently found animal species was the White-Nosed Coati, with the least spotted animals (Found 1 time) being the Tinamou, Jaguarundi, Coues Rice Rat, Rice Rat Spp., Guan, Tayra, and the Brown Four-Eyed Opossum.

Other unidentifiable species were found, however, they most likely are other animals we previously found before. All of the information we gathered on animals found on our 30 trail cameras was put into a Google sheet. Using Google Sheets, we were able to create graphs to chart our data.

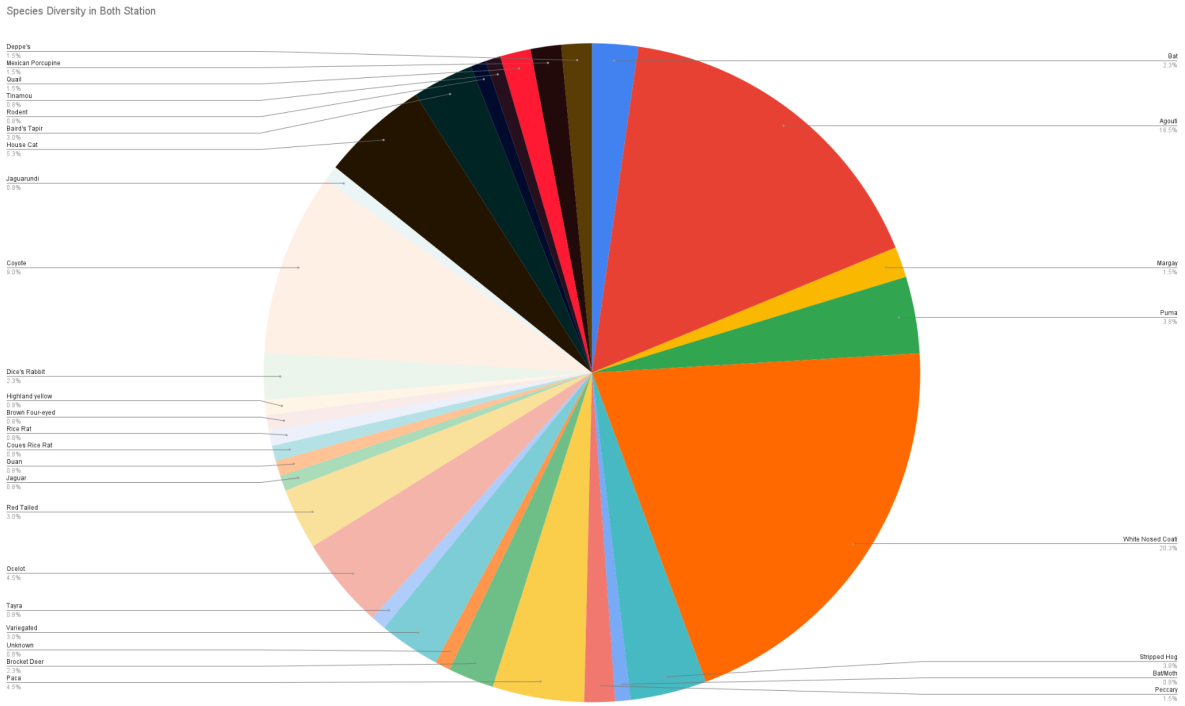

Chart 1-Species Diversity in Both Stations

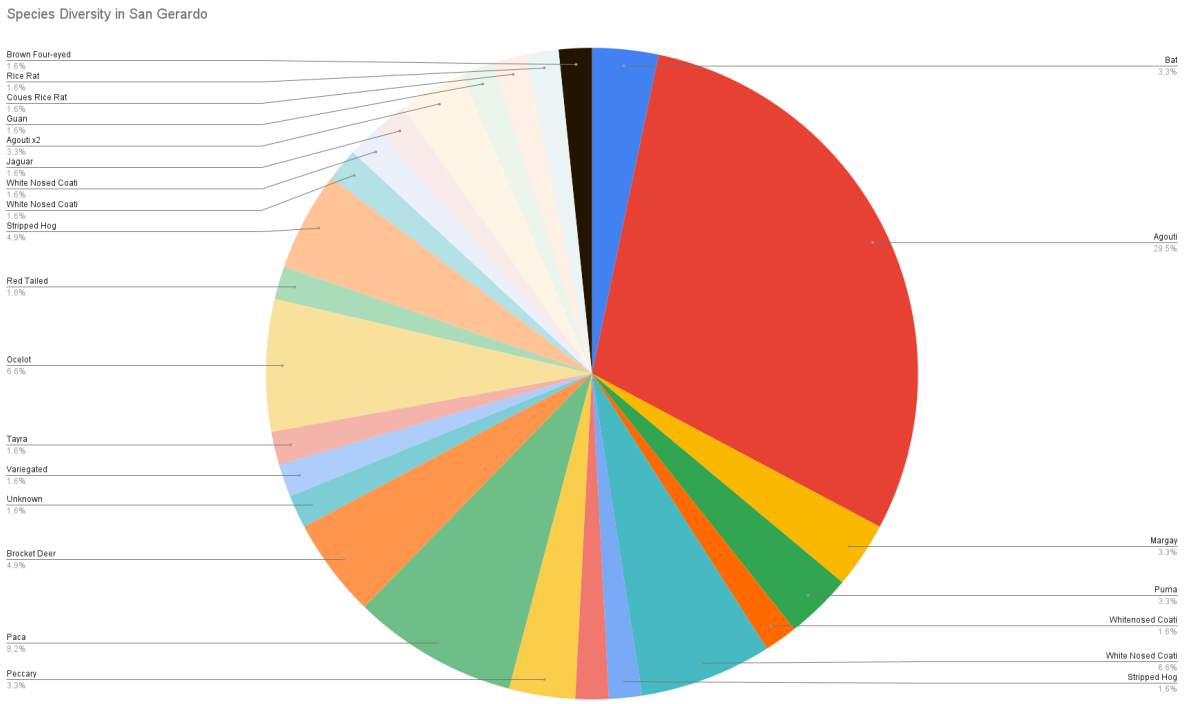

Chart 2-Species Diversity in San Gerardo

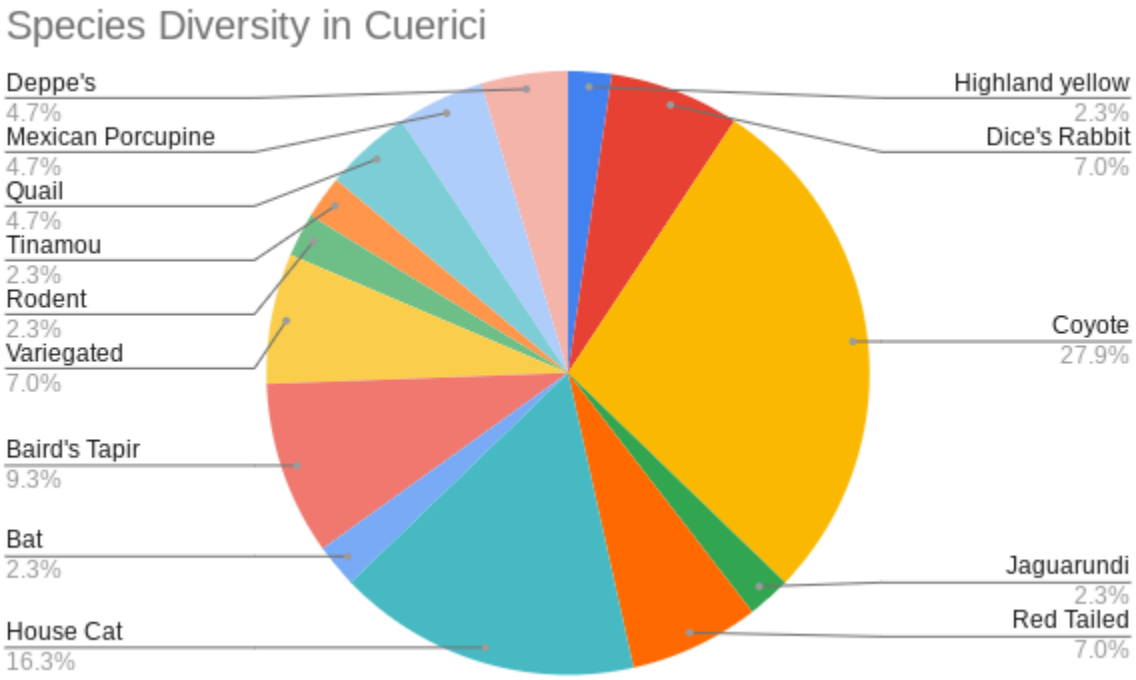

Chart 3-Species Diversity in Cuerici

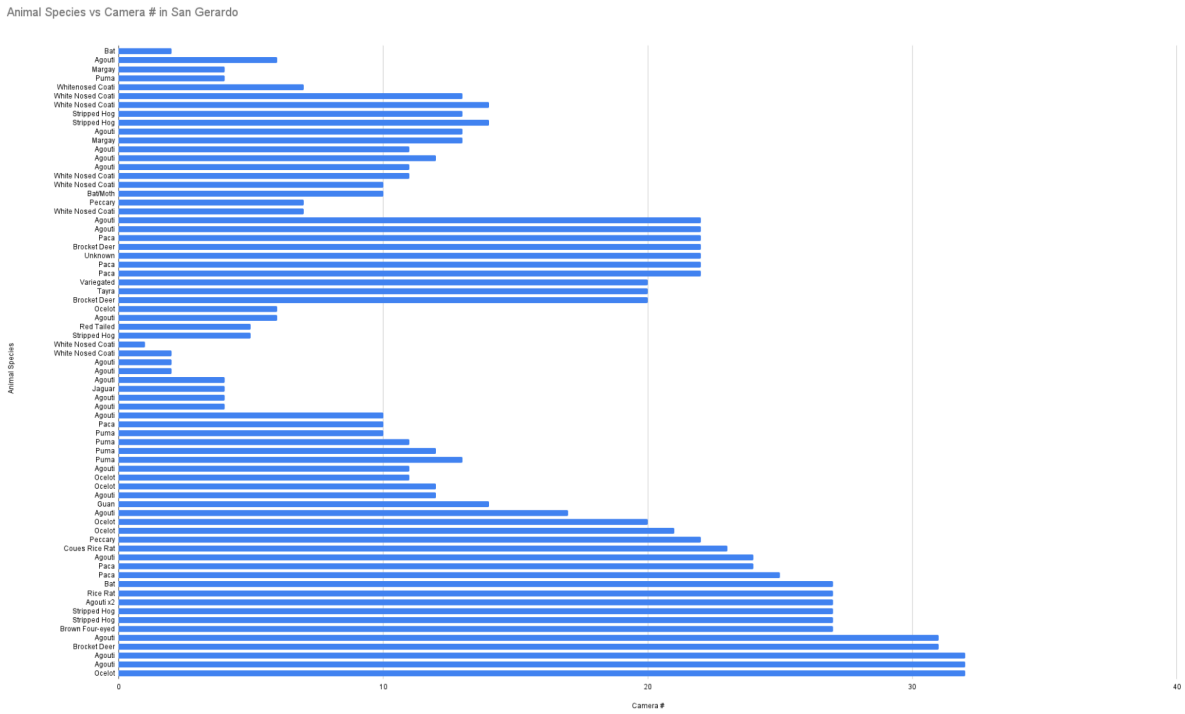

Chart 4-Animal Species Encountered in relation to Camera#

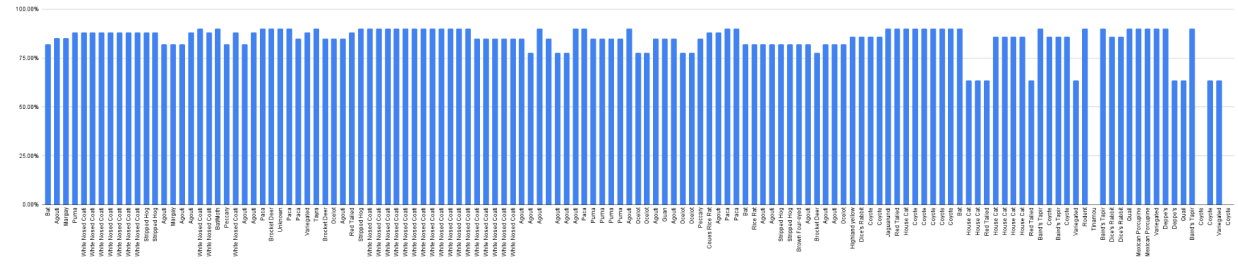

Chart 5-Species found in relation to Humidity%

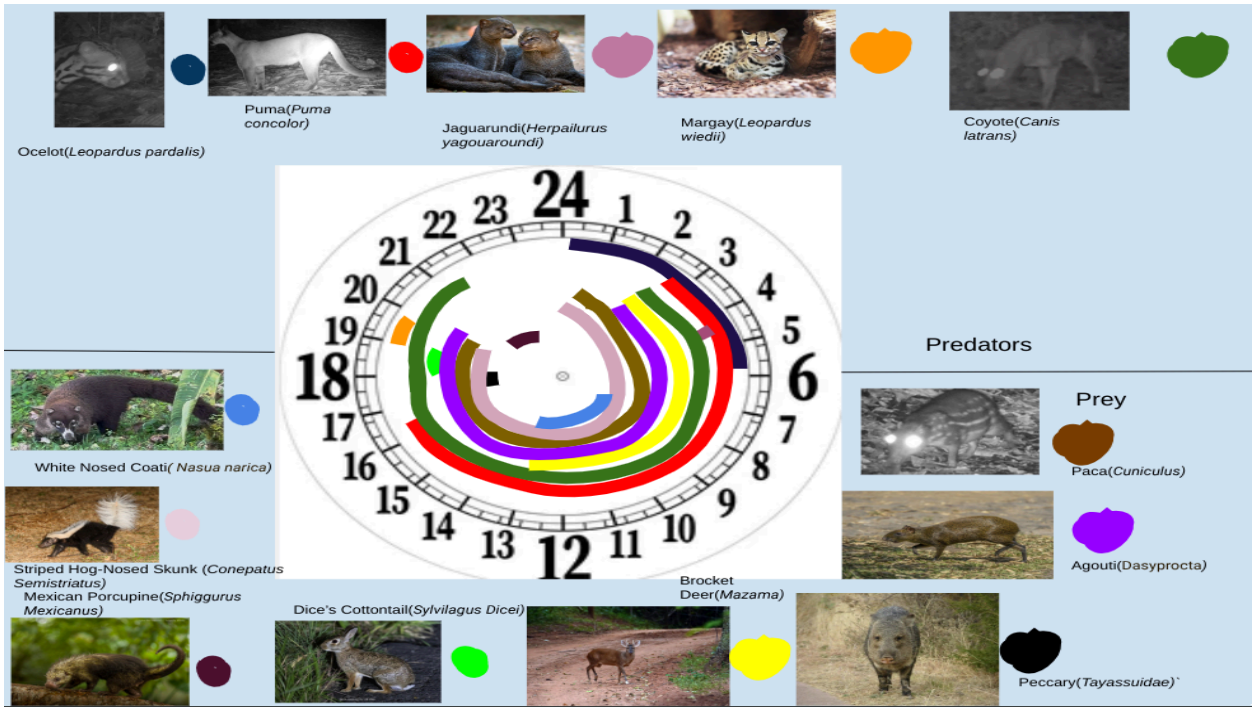

Chart 6

4 : 15

Ratio of Predator to Prey in Both Stations

The Wildcat Team Clock

The Wildcat Clock is an original concept the Wildcat team developed this year. Data was compiled from all of the time ranges different mammals were spotted on our trail cameras into a 24-hour clock system. The circular lines represent the intervals of time each animal was seen. So an overlap between predator and prey species can help us better understand exactly which mammals wildcats(and other prey species) consume. The ultimate goal is to put up an interactive version of a more refined Wildcat Clock in both the San Gerardo and Cuerici biological stations for guests and researchers alike to enjoy.

Images:

Photo 1, Nala the Puma, encountered in San Gerardo at Camera #4

Photo 2, Ocelot, encountered in San Gerardo at Camera #11

Photo 3, Mexican Porcupine, encountered in Cuerici at Camera #11

Photo 4, Tapir, encountered at Camera #22 in Cuerici.

Photo 5, Agouti encountered in San Gerardo at Camera#17

Photo 6, Quail encountered in Cuerici at Camera #15

Photo 7, Brocket Deer encountered in San Gerardo at Camera#31

Photo 8, Highland Yellow Shouldered-Bat encountered in San Gerardo

Photo 9,(DATE WRONG) Paca encountered in San Gerardo at Camera#22


Photo 10, two Coyotes encountered in Cuerici at Camera #27

Photo 11, Jaguarundi- First ever encounter by the Forman Rainforest Project, encountered on Camera #27 in Cuerici.

Photo 12, Two Skunks encountered in San Gerardo at Camera#13-14

Photo 13, Jaguar encountered in San Gerardo at Camera#27

Discussion:

The data shows a surprisingly minimal overlap in species and diversity between the two altitudes. The differences in the prey spotted were astounding, with 150% more animals found in San Gerardo than in Cuereci. A more significant difference is that out of the 32 species found at both stations, only three overlapped: bats, red-tailed squirrels, and variegated squirrels. A probable cause for this phenomenon is directly related to the habitat of these two environments. The higher you go, the less water, less air, fewer plant diversity **[1] [2],** all resources that prey flock to. Resources that, in their absence, drive prey away. Fewer prey in an area brings in fewer predators, limiting the mammal populations and diversity entirely. An important factor to consider is the limited data that can be collected via camera trapping. Just because we don't capture an animal doesn't mean it isn't present within an area. And an animal found in an area could very well be an anomaly. However, the versatility of our cameras and remote locations gives us the best possible chance of collecting inventories, providing a reasonably high level of confidence in our findings.

Animal behavior is perhaps one of the most difficult topics to study. Particularly in cases where we have virtually no species overlap at different altitudes. What we can discuss, though, is noticeable behavior patterns in animals we did see. And the fact that we didn't see certain animals. Noticeable behaviors shown from our photos in Cuereci include the following. In photo 12**,** the striped hog-nosed skunks were traveling in a pair, which is highly irregular for the species. A possible explanation could be the timing of our study, late February, which aligns with their mating season, possibly causing temporary couples to form **[3]**. The coyotes we observed also seemed to favor duos, with one noticeable pair in photo 10, showcasing an adult and an adolescent female. The differing ages suggest a mother-daughter relationship, rather than a sibling or other family bond. Coyotes, unlike skunks, are often found in small family units, similar to their larger relatives, the grey wolves **[4]**. The older wolf, being an adult female, further solidifies this idea, with most packs comprising an alpha female and her relatives. Another animal seen traveling in pairs was the hairy dwarf porcupine. Two adults of an unidentifiable sex passed by a camera, both with noticeably eaten-off tails. While porcupines aren't commonly seen traveling with other members, it is not impossible, since they are known to share dens occasionally. This could be due to the colder temperatures at high altitudes, since in

non-tropical climates, they shelter together in winter months. In San Gerardo, there were far fewer behaviors that stood out, save for one: the Puma and an endangered cat not to be mentioned in a public forum for their own protection. Both species boast some of the largest recorded ranges for big cats. Our findings strongly suggest an overlap of these territories, which is virtually unheard of for animals occupying the same niche. This phenomenon could be a result of human activity, restricting the available terrain, or a consequence of poaching, which drives endangered animals like the Jaguar into smaller and smaller areas.

Understanding the behavior of prey species in relation to the numerical predator population is another challenging task due to the lack of overlap between prey species. What we can understand is the size of prey-to-predator ratios in different areas. In San Gerardo, the predator-to-prey ratio was **1:6.9**, and in Cuereci it was **1:3**. We know through our data that San Gerardo has more predator encounters and species. While both have far more prey animals than predators, and San Gerardo has more animal encounters overall, we can see that there are more prey animals for each predator in San Gerardo. This could be due to several factors, and unrelated or related events. The fewer prey animals in Cuereci might be a reason behind more predator animals. Just as the smaller numeric size in Cuereci could be causing stress on the prey populations, leading to a smaller ratio. However, with the ratios as close as they are, it's entirely possible that the predator and prey populations are both being influenced by external factors, such as human activity or climate, within the two elevations. The likely answer is that both of these situations hold merit. It would be ignorant to suggest a large prey population won't bring in predators, just as it would be foolish to think outside variables don’t cause behavioral changes in all animals within an environment.

Conclusion:

Wildcats across the planet face the threat of extinction constantly, with factors such as deforestation, poaching, and human overreach all playing massive roles in their declining populations. Thankfully, conservation efforts such as this team are working to stop these beautiful animals from disappearing off the face of the planet. This year's research focused on the ecological differences of wildcat activity in high and mid-land elevations. San Gerardo, near the

city of Santa Elena, is a location our teams haven't been to in two years. It is a midland rainforest with the biological station having direct access to 10km (6 mi) of trails. San Gerardo is more of a touristy, scenic area, while Cuerici is quite the opposite. Cuerici is bordered by agriculture but is more directly connected to a much larger, highland rainforest. This location is extremely remote so the only human activity other than our teams are the people who live on the farm itself. More time was spent at San Gerardo, with it also being the more biologically active and diverse station. A total of 4224 trapping hours was spent at San Gerardo, and 2688 trapping hours were spent at Cuerici. Trapping effort represents the total number of hours x total number of cameras were deployed and functional in the field. This could go to show a linkage between species and the terrain they reside in.

In previous samplings, the CR or capture rate success grossly underestimated success. This year, the sampling will include another equation as well as the equation listed below. The new equation will represent all photos taken by the camera as animals may be moving too quickly to trigger the camera's shutter effectively. Cameras were deployed for a total of 6,480 hours in these two locations. The traditional capture rate success was calculated by using this formula;

CR= $ni/\sum tn$ x100.

Efforts were made to not count the same individuals at the same or adjacent stations by coordinating times, dates and camera numbers in analysis. In the former equation *ni* is total captures, which was 152, of individuals and *tn* is total trapping hours, which was 6,480. CR= 152 / 6480 x 100 = 2.3 %. If the CR calculated for Las Cruces Biological Station was CR= 2.05 % as opposed to Cuerici which the CR= 2.7 %. This CR rate did not factor in all photos with people, vegetation movement from wind and animal's moving too quickly for the 0.5 camera reset. Range of the camera sensor is a factor as well, if an animal is moving just on the edge of the sensor, the camera may be triggered, but the animal will not be in the frame. This makes the 1.6% an underestimate of the true success rate of our camera trap plots and transects. This would be much higher in future monitoring. Let's redesign the equation to more accurately show the success rate of a camera with the intent of giving credence to fast moving animals who are too quick for the camera's shutter.

In this equation; CR= $ni/\sum tn$ x 100

Where *ni* is the total # of pictures taken with or without wildlife in frame.

CR for 2024/2025 research is still being calculated and will be updated soon.

Acknowledgements:

Big thank you to the student team: Simon Strazza, Gabriel Hadad-Larrieu, and Kaia Artemas Kasdin.

As well as the Project leaders: Wendy Welshans and Carter Brochu.

Thank you to the other Biologists and adult staff who contributed so much to our program: Dr. Alex Shepack, Maddie Vanderboom, and Ms. Lily Chen.

Thank you to the Staff at San Gerardo and Cuerici for supporting us. We couldn't do what we do without your help.

Literature Cited:

https://lawnlove.com/blog/how-high-altitude-affects-plants/#:~:text=Nutrient%20availability%20Low%20temperature%20at%20high%20altitudes,tends%20to%20significantly%20decrease%20with%20increasing%20elevation. [1]

https://www.jandslandscape.com/challenges-landscape-designing-high-altitude-country/#:~:text=Due%20to%20the%20high%20elevation,or%20reach%20their%20full%20potential. [2]

https://animaldiversity.org/accounts/Conepatus_chinga/#:~:text=Reproduction,of%20age%20(Walker%201991).&text=Females%20are%20the%20sole%20caretakers,own%20territories%20(Walker%201991). [3]

https://urbancoyoteresearch.com/coyote-info/general-information-about-coyotes#:~:text=Coyote%20Social%20Life&text=Packs%20are%20usually%20composed%20of,except%20for%20the%20alpha%20pair. [4]

https://animals.sandiegozoo.org/animals/porcupine [5]