

# **Biodiversity in Relation to Human Settlement in Different Ecosystems around ITEC field station in Boca del Drago, Panama**

ITEC Research Station, Boca del Drago, Isla Colón, Bocas del Toro, Panama

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## **Abstract**

This study relates the biodiversity of different ecosystems depending on their relation to human habitation. Observations and population counts were made of observable species in three distinct ecosystems (ITEC Station, a pasture, and the rainforest) in order to determine if human habitation in these areas had an effect on biodiversity and what that effect might be. It was found that the area with the highest observable biodiversity was the area surrounding the ITEC buildings, however all three areas had similar results. This directly opposed the working hypothesis that assumed there would be a noticeable difference between the biodiversity of human-settled areas and non-human settled areas. It is clear that the ITEC research station was able to maintain a certain level of biodiversity through their intentional practices to maintain the pre-existing ecosystem.

## **Introduction**

Biodiversity is an integral part of all of Earth's ecosystems. The word itself derives as a contraction from "biological diversity" or "biotic diversity", both of which refer to the concept of living variation (Faith, 2021). The planet as a whole maintains an incredible amount of biodiversity, however, some ecosystems are significantly more biodiverse than others. Tropical rainforests are the most biodiverse terrestrial ecosystems, as their high temperatures and rainfall rates are able to support many types of flora and fauna. However, these essential ecosystems are disappearing quickly. Since 1947, it has been estimated that the total area of rainforests has decreased by half, mostly due to human development and deforestation. Biologists estimate that rainforests could lose 5-10% of their species every decade (Johnson, 2015). However, many communities and organizations are committed to fighting against these effects and conserving the rainforests.

One such organization is the Institute for Tropical Ecology and Conservation (ITEC). The ITEC facility is located on Isla Colón, within the Bocas del Toro province of Panama. Here, the staff hosts and guides students and professors through research of the surrounding area. Located adjacent to the rainforest, ITEC is committed to preserving the natural state of the rainforest, and conserving it through careful observation as well as educating local communities. However, a small portion of the rainforest was cleared in order to create the space needed for the organization's facilities. Along with these buildings, there is also a nearby pasture that was cleared out to hold the livestock of a local family that lives near the ITEC property. Due to its goal of maintaining the ecosystem ITEC operates as a pseudo ecotone, which serves

as a region of transition between the ecosystem of the rainforest and that of the pasture. This allows for certain species to exist in its surrounding areas that might not be found in both the rainforest and pasture. This unique environment created the question, has the local biodiversity of the rainforest been affected by this human activity? Observations and population counts were made of the observable species in each area (ITEC, the pasture, and the rainforest) in order to determine the validity of the working hypothesis that stated there would be a notable difference in the biodiversity of human settled and non-human settled areas.

### **Materials**

The materials used in this study were two sets of notebooks and pencils; and cameras capable of taking detailed photos of small animals.

### **Methods**

The study was conducted in three different environments, the rainforest, the area surrounding buildings that make up ITEC), and the pasture that exists in the land between the mangroves and the beginning of the ITEC facility. Observations of the different identifiable creatures in each of the ecosystems were taken over a 20 minute period over the course of three days, once in the morning and once in the afternoon, between the hours of 8:30-10:30 AM and the hours of 2:00-5:00 PM respectively. The creatures were separated into categories: Insect, Reptile/Amphibian, Bird, and Mammal, along with distinct calls. Additionally, instead of counting the number of individual ants and termites, these insects were counted by the number of observed nests, as millions of these organisms are capable of existing in each structure. The time of day, temperature, and weather conditions were also noted at

the beginning of each 20 minute period. The observed species and the number of each species were recorded on tables that separated them into the four pre-decided categories mentioned above. Immediately after the 20 minute period ended species were no longer recorded.



*Left: The rainforest surrounding the ITEC Station  
Top Right: Two out of the Three ITEC facilities  
Bottom Right: The Pasture outside of the ITEC Station*



# Results

## Data Collection #1 - Pasture

### Total Observed Individuals in Pasture

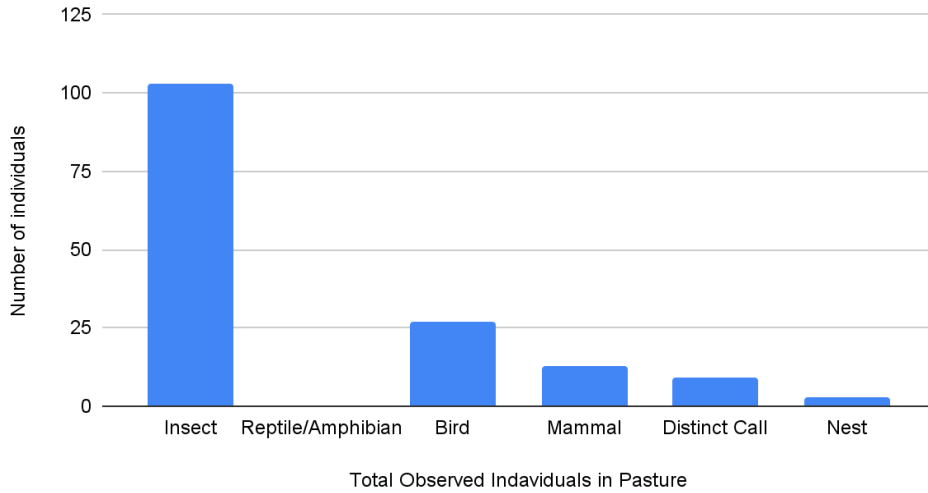


Figure 1: Table of observed individuals in Pasture, Isla Colón, Bocas del Toro, from 9:32-9:52 AM, 3/28/2022 and from 2:41-3:01 on 3/29/22  
Weather: 27°C, cloudy, humid, light rain and 26°C, sunny respectively

### Pasture - Total Distinct Species

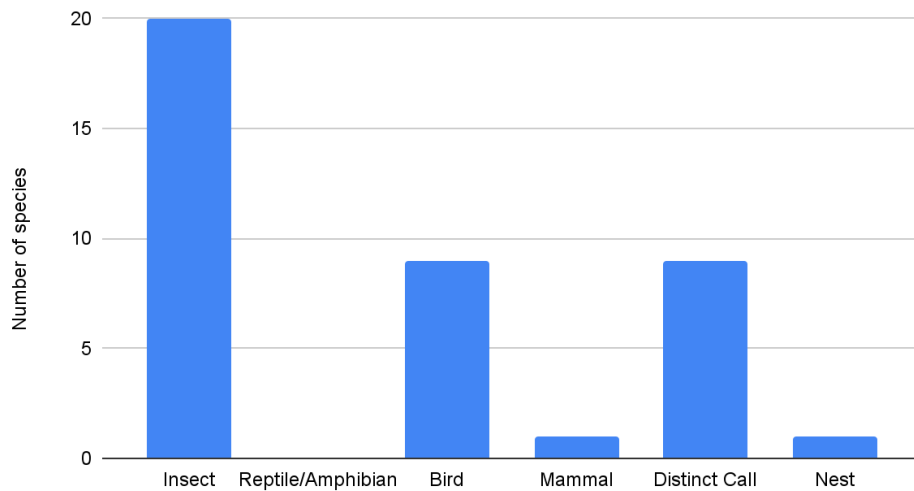


Figure 2: Table of observed distinct species in Pasture, Isla Colón, Bocas del Toro, from 9:32-9:52 AM, 3/28/2022 and from 2:41-3:01 on 3/29/22  
Weather: 27°C, cloudy, humid, light rain and 26°C, sunny respectively

## Data Collection #2 - Rainforest

### Total Observed Individuals in Rainforest

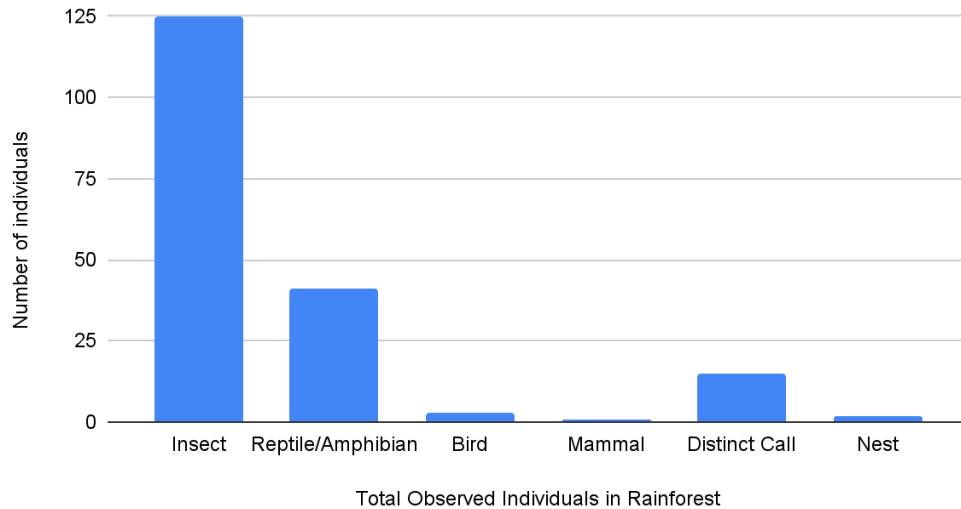


Figure 3: Table of observed individuals in Rainforest, Isla Colón, Bocas del Toro, from 1:11-1:31 PM, 3/28/2022 and from 1:11-1:31 PM, 3/28/2022  
Weather: 28°C, cloudy, humid, light rain, shortly after heavy rain (equivalent for both)

### Rainforest - Total Distinct Species

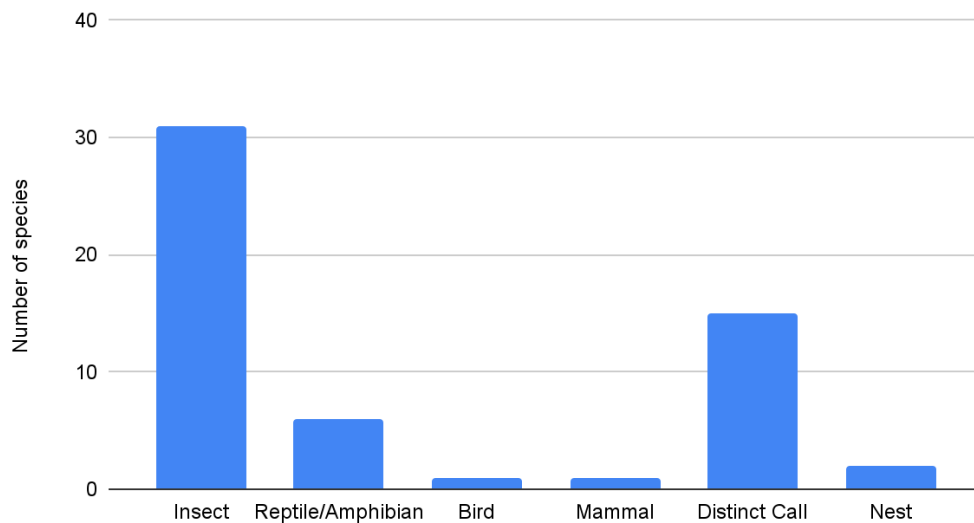


Figure 4: Table of observed distinct species in Rainforest, Isla Colón, Bocas del Toro, from 1:11-1:31 PM, 3/28/2022 and from 1:11-1:31 PM, 3/28/2022  
Weather: 28°C, cloudy, humid, light rain, shortly after heavy rain (equivalent for both)

### Data Collection #3 - ITEC

#### Total Observed Individuals around ITEC

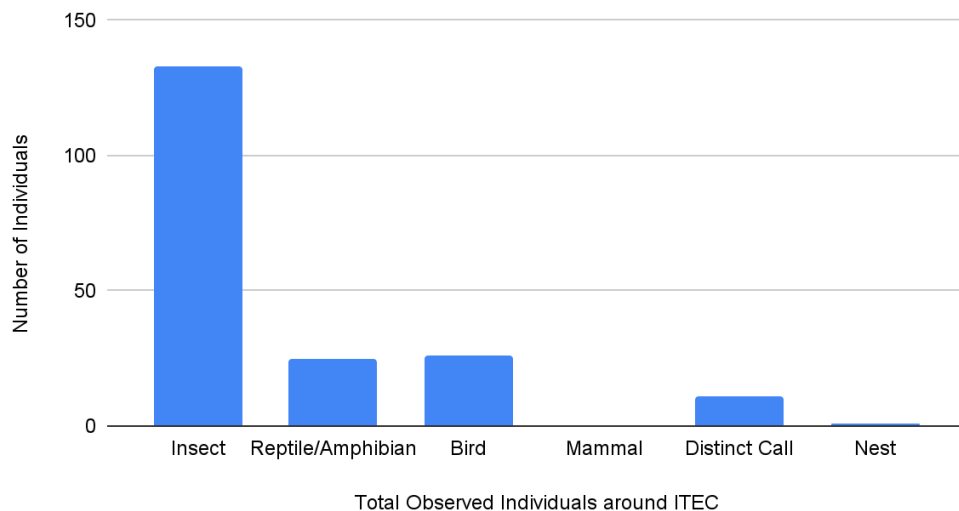


Figure 5: Table of observed individuals in the area around ITEC buildings, Isla Colón, Bocas del Toro, from 9:24-9:44 AM and from 2:07-2:27 PM, 3/29/2022  
Weather: 27°C, cloudy, humid, shortly after heavy rain

#### ITEC - Total Distinct Species

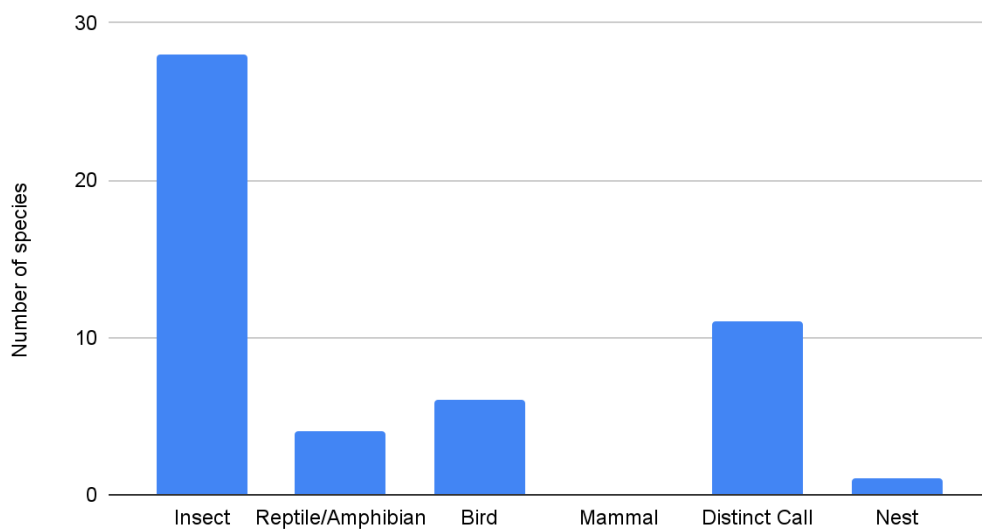


Figure 6: Table of observed distinct species in area around ITEC buildings, Isla Colón, Bocas del Toro, from 9:24-9:44 AM and from 2:07-2:27 PM, 3/29/2022  
Weather: 27°C, cloudy, humid, shortly after heavy rain

Using a calculator called Shannon's Diversity Index (or the Shannon-Wiener diversity index) one is able to estimate species diversity of an ecosystem. More specifically, it takes into account species richness as well as species evenness to ensure a better measure of diversity. This is a popular metric used in ecology, based on Claude Shannon's formula to estimate species diversity. Mathematically, the equation for the Shannon's Diversity Index reads as follows:

$$H = - \sum [(p_i) \cdot \log(p_i)]$$

Where:

- H = Shannon's Diversity Index
- $p_i$  = the proportion of individuals of i-th species in a whole community

The minimum value of Shannon's Diversity index is 0, meaning that there is no species diversity, and only one species was recorded in the environment. Although there is no upper limit for the Diversity Index, in the real world indexes usually range from 1.5 - 3.5. Using this calculator we were able to compare the three different ecosystems we observed in a concise manner that accurately took into account both the number of species and the overall observed individuals.

	Pasture	Rainforest	ITEC
Shannon's Diversity Index	3.02	3.03	3.12
Total Number of Individuals	143	171	184
Average Population Size	4.77	4.28	4.97

Table 1: Table of estimated species diversity using Shannon's Diversity Index and its related figures

Another way to analyze biodiversity is by comparing the similarity of species between different ecosystems. Sorenen's coefficient of community similarity index is a value that was designed to determine the similarity between two ecological populations. The equation for this index is as follows:

$$CC = \frac{2C}{S1 + S2}$$

Where:

- C = species common to both communities
- S1 = number of species in area 1
- S2 = Number of species in area 2

Sorensen's index can range from 0 to 1. 0 indicates that the samples share the same species composition and 1 shows that the samples share no species in common. In this circumstance there were three samples that all had to be compared to each other individually, and were put into a table to be compared.

	Pasture	Rainforest	ITEC
Pasture	0	0.25	0.29
Rainforest	0.25	0	0.20
ITEC	0.29	0.20	0

Table 2: Table of Sorensen's Indexes comparing the three ecosystems



## Discussion

The area with the most observable biodiversity was the area surrounding the ITEC buildings, however, this was a very slight difference compared to the rainforest and pasture areas (See *Table 1*). This directly opposes the working hypothesis that assumed there would be a noticeable difference between the biodiversity of human-settled areas and non-human settled areas. These results also suggest that the area surrounding ITEC is more biodiverse than the rainforest which is not possible as tropical rainforests are considered to be the most biodiverse terrestrial ecosystems in the world (Johnson, 2015).

One possible explanation for this result is the ITEC buildings provide open spaces for creatures such as spiders, lizards, and birds to call home. Another factor is the many decorative flowers and plants that have been placed around the buildings, which attract pollinators such as bugs and hummingbirds with their bright colors. This was likely an intentional choice to attempt to maintain the biodiversity of the area. One of APEC's goals is to study and live amongst nature but not to disrupt it. So, despite removing the rainforest to form the clearing needed for the station, it has maintained similar biodiversity in comparison to non-human settled areas.

Along with these factors, it is also important to take into account the disparity between the weather conditions during each outing. For example, one of the studies of the rainforest was performed after heavy rain, likely reducing the number of observable bugs. As well as weather conditions, the rainforest is a considerably more three-dimensional space than the ITEC station and pasture. There were likely many species in the canopy of the rainforest, such as birds, monkeys, and sloths, which we were not able to see due to our positioning on the ground. Oppositely, ITEC

occupies a much smaller area of land compared to the surrounding forests and pastures, so more animals were able to be seen in the same amount of time.

Finally, human error must be taken into account when addressing factors that might have affected the results. Inherently, there was no possible way to observe and count every living creature within each respective space. There is a high probability that the same individual might have been counted multiple times, or certain species that were too small to see might have been overlooked. Similarly, since we were only out in each area for a total of 40 minutes, we only caught a glimpse of all the possible creatures that occupy each space.

While the data suggests that ITEC was the most biodiverse out of the three spaces, there were still differences between the types of animals found in each one. For example, no reptiles or amphibians were counted in the pasture, as there were not many hiding spaces and it was likely too dry for amphibians. The pasture also contained species purposefully put there by humans, such as cows and chickens, which could have altered the success rate of native species. Finally, since most bird species prefer open spaces (Lahanas, 2022 pers, comm.), this may explain why we were able to observe them more in the ITEC and pasture area.

To definitively compare the similarities in species between three areas, we used Sorenen's coefficient of community similarity index to analyze the similarities and differences between the three ecosystems. Interestingly, the two areas that had the highest amount of species difference was the ITEC stations and the pasture (See *Table 2*). Although these two areas are closer in proximity to each other than the pasture and the rainforest, they still shared less species in common. This could be a result of the drastic differences between the flat landscape of the pasture versus the

tree-filled environments of ITEC and the rainforest. Along with these differences, the pasture was calculated by the Shannon's diversity index to be the least diverse, and ITEC was calculated to be the most (although these values varied very minimally). This could be another reason attributed to the difference in species similarity.

### **Conclusion**

Although these results go against what is known about the biodiversity of rainforests, it is clear the ITEC research station was able to maintain a high level of biodiversity. Strategies such as maintaining native plant life and minimal disruption of the nearby environments have allowed them to achieve their goals of living in balance with the surrounding ecosystem, changing their man-made ecotone into something that naturally flows with the life of its surrounding ecosystems.

### **Works Cited:**

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