*Measuring the effects that human disturbance has on plant density in relation from the distance of the Tambopata Refugio Amazonas Lodge and trail*

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We are constantly impacting the Rainforest in various ways. The effects that are caused base on our decisions and critical judgments as humans are altering the way plants adapt to their new and disturbed environment. Moreover, the relationship between plant density and human disturbance was measured based on the quadrat measures from the lodge and trails towards the inside of the Tambopata Rainforest.

**Data Collection & Processing**

**Research Question:** How is plant density affected by human interference from the distance of the ‘Refugio de Amazona lodge and trail?

**Hypothesis:** If the distance from the ‘Refugio de Amazona lodge/trail increases, then plant density will increase as well because human disturbance of the natural area is reduced causing less plant species to be affected by the adaptations aroused from the lodge’s build.

**Scientific Justification:**

Human disturbance caused by the construction of the lodge and the trail to get there has caused several impacts on the environment in which plants from the Tambopata rainforest live in. As the canopy trees where taken down to make space for the lodge to be built in, the availability of light increased due to the direct radiation of sun falling into the soil that was once covered by shades of leaves. Moreover, this causes competition to occur through the requirement of light as an abiotic factor that allows photosynthesis to occur and the production of essential nutrients to be made and consumed by all plant. Nevertheless, competition causes the fundamental niche of the plants to become realized, causing the potential plant density to be reduced immensely.

Human disturbance have other impacts as well. As eco tourists come and go from the lodge, stepping on and outside the trail will be done unconditionally. This will then affect the plant density that can be found from the lodge to the inside of the rainforest because of the disturbance and killing of plants that occurs on a daily basis. Moreover, the Tambopata lodge has also tried to expose their clients to the real nature, thus artificially planted grass along the lodge in order to re-create the effect of nature.

**Table 1: Variables**

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| --- | --- | --- | --- |
| **Variable Type** | **Variable** | **Unit**  | **How are variables manipulated?** |
| **IV** | Distance from the lodge/trail | m | A line transect was done to compare the plant density from the lodge towards the inside of the rainforest |
| **DV** | Plant Density | Plant/0.25m2 | Plant density was measured by the quadrat sampling done. This will then allow variations to be seen |
| **CV** | -Quadrat Size-Time of the day study was conducted |  | -The same qudrat was used for all samples-Lab was done all within a period of an hour  |

Other variables that affected by lab but could not kept in control due to the study being made in the field where: soil moisture, soil pH, humidity, temperature.

**Materials:**

* 2 Winchas
* 1 Quadrat

**Procedure:**

1. The first wincha was placed on the Refugio Amazonas edge of its floor looking towards the inside of the rainforest
2. A quadrat was placed on the beginning of the wincha
3. A second wincha was placed looking towards the left of the rainforest.
4. A quadrat was placed two meters away from the beginning of the Wincha
5. Step 4 was repeated 4, 6, 8 and 10 meters away from the beginning of the second wincha
6. Steps 2-8 was repeated 10, 20, 30, 40 and 50 meters away from the beginning of the first Wincha

**Diagram**

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A visual representation of how I set up my lab. The yellow lines with a dash in the middle represent the quadrats tested from the lodge towards the inside of the rainforest. The red lines, which where repeated for every distance away from the lodge, represent the trails from the trail towards the inside of the rainforest.

**Data Collection**

*Qualitative:*

Through out this lab I realized that it is very difficult to keep all variables controlled in order to obtain precise data. This means that, for example, when measuring the 5 trails 40 meters away from the lodge, a secondary succession was occurring. This outlier caused my data to be disturbed allowing it the results to be based on the surroundings and the inevitable events that occur in the rainforest. Additionally, counting every plant from the quadrat may be challenging, yet studies for the rainforest revolve around hard word and dedication towards achieving success.

*Quantitative:*

**Raw Data Table**

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| Table 2: The number of plants in relation to the distance from the lodge 'Refugio Amazona' |
| Distance away from the lodge (m) | # of plants per quadrat |
| Trials |
| Trial 1 | Trial 2 | Trial 3 | Trial 4 | Trial 5 |
| 0 | 261 | 334 | 298 | 278 | 254 |
| 10 | 324 | 275 | 375 | 278 | 265 |
| 20 | 265 | 278 | 301 | 298 | 198 |
| 30 | 7 | 4 | 15 | 27 | 35 |
| 40 | 4 | 7 | 18 | 13 | 26 |
| 50 | 6 | 9 | 13 | 19 | 16 |
| All data was collected at temperature 24 C by Carla Frias by May 22. Two line transects where performed to calculate the distance from the Refugio Amazona lodge towards the inside of the Rainforest as well as from the trail made by the lodge towards the left of the rainforest. A quadrat was the used to count the number of plants in each. |
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**Processed Data Table**

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| Table 3: The effects that human disturbance has on the plant density at Tambopata |
| Distance away from the lodge (m) | # of plants per quadrat | Plant Density (# of Plants/.25m2) |
| Trials | Average |
| Trial 1 | Trial 2 | Trial 3 | Trial 4 | Trial 5 |
| 0 | 261 | 334 | 298 | 278 | 254 | 285 | 57 |
| 10 | 324 | 275 | 375 | 278 | 265 | 303.4 | 60.68 |
| 20 | 265 | 278 | 301 | 298 | 198 | 268 | 53.6 |
| 30 | 7 | 4 | 15 | 27 | 35 | 17.6 | 3.52 |
| 40 | 4 | 7 | 18 | 13 | 26 | 13.6 | 2.72 |
| 50 | 6 | 9 | 13 | 19 | 16 | 12.6 | 2.52 |
| All data was collected at temperature 24 C by Carla Frias by May 22. Line transects and quadrats where used to measure the distance from the Refugio towards the inside of the Rainforest and the number of plants in each quadrat. Other variables, such as pH of soil, soil moisture, temperature, where not controlled and may have had an effect on the data recorded. Each trial represent 2 meters from the trail towards the inside of the Rainforest (left side). |
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*Calculations*

Avg. # of plants from distance of the lodge:

 Trial 1+2+3+4+5 from distance x Example:

 5 (261\*334+298+278+254)/5=285

Avg. # of plants from distance of the lodge:

 Distance 0+10+20+30+40+50 from trial x Example:

 5 (261+324+265+7+2+4)/5 =522

 *Example:*

Plant Density: Avg # of plants per quadrat Distance away (0): 285 = 57

 # of sample plots 5

**Graphs**

R value= -0.93

R value= -0.93

**Discussion, Evaluation, Conclusion**

*Trends*

The trend line reveals a tendency of plant density decreasing as the distance from the lodge and trail increases.

Both graphs also portray similar allowing the plant density to be studied on both fields without contrasting each other but using the results as an explanation of why things occurred the way they did.

**Discussion**

Plants, as a biotic factor, depend on other abiotic factors that affect their environmental habitat and the way they interact with it such as the pH or moisture of the soil, light intensity or the temperature. This defines the environment in which they have to adapt to and survive.

Nevertheless, as the relationship between human disturbance and plant density were being study, a major issue came into role; the artificial plants. Because the lodge had required a big amount of space for it to be constructed in a natural area, major loss of plants where involved through the process. With this, because it was a lodge located in the rainforest, plants and diversity had to be conserved thus the ‘Refugio Amazona’ decide to plant a certain specie on its surrounding for physical attractions. This might explain why the distance from the trail seems to show higher plant density than values from the distance of the lodge at a much greater scale, reaching 303.5 plant/0.25m2 as the plant density 20 meters away from the lodge and only 10.8 plant/0.25m2 50 meters away from the lodge. This may also explain why, by taking a look at graph 1, the trend line reveals a tendency of plant density decreasing as the distance from the lodge and trail increases; meaning that the artificially planted plants would be at a greater abundance than those occurring naturally. Nevertheless, better results would have been obtained if the lab would have been performed on a second lodge at Tambopata Research Center lodge on different trails and spots allowing comparison of data to a deeper extent.

Another error that may have affected our data is the trail built by the lodge. This is because, by taking a look at Table 2, we noticed that the average # of plant’s 40 meters away from the lodge increases from 4.0 plant/0.25m2 at trail 4 (meaning 8 meters from the trail towards the inside of the rainforest) to 8.0 at trail 5 (meaning 10 meters from the trails towards the inside of the rainforest). This then altered the way we measured data since human disturbance was tracked along all data collected. Moreover, a solution to this would have been to collect data at a further distance from the trail to avoid externalities as such which impact the reliability of data and concrete information of the actual plant density that can be found in the rainforest without human interference. Furthermore, by adding more samples to this study then the amount of data being used to support my hypothesis would have been greater.

Additionally, eco-tourisms is widely promoted by the construction of the lodge. From the artificial plants and the minimal space used to create a lodge in the wilderness, a minimal impact was implied to the rainforest.

**Evaluation**

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| **Weakness** | **Impact on Results** | **Improvement** |
| Different environments where not compared | By doing so, the relationship between plant density and distance from the lodge at different levels would have been explores since you can then compare how it changes from the human disturbance to complete nature wilderness. | Background research and greater thought put behind the planning. Always exceed on what I am trying to reach in order to exploit the opportunity of collecting data in a place where I will most probably not come back. |
| Number of plants per quadrat was not accurate | Our lab explored plant density, thus it relied on the amount of plants that where on each quadrat. Based on the amount of plants that where recorded by each quadrat, counting each and ever plant was hard to reach. | Try to create models in which a close estimate can be done. This may be by either making small quadrats in the bigger quadrat, counting how many they are and then multiplying by the amount of small quadrats that fit in the bigger quadrat. |
| Controlled variables where not fully measured and thought before the collection of data | Keeping track of controlled variables allows data to be more reliable because of its focus on two elements in which the lab is based. Moreover variables, such as mentioned before (soil pH, moisture, temp, etc) may also have a direct impact on the plant density | Keep track of externalities which may or may not have an impact on data when performing lab in order to be precocious and sure that you have not missed anything |
| Inclusion of the grass | The grass from the lodge has been artificially planted, causing the data to be biased and manipulated by humans even so. This impacted the contrast between plants away and close from the lodge since they had not occurred naturally. | Use different locations when conducting a lab in order to contrast information and see how they vary or are similar. |

**Conclusion**

The research question I explored in this lab was: “How is plant density affected by human interference from the distance of the ‘Refugio de Amazona lodge?” The hypothesis in which my study was based on was: If the distance from the ‘Refugio de Amazona lodge increases, then plant density will increase as well because human disturbance of the natural area is reduced causing less plant species to be affected by the adaptations aroused from the lodge’s build. Based on my data, the plant density decreased as the distance from the lodge decreased, thus the results supporting my hypothesis overall.

By taking a look at graph 1 and 2, the r-values for both data are -0.93. This means that the regression line indicated on both graphs have a negative correlation between the information and the trend line. This reveals that, when comparing scientific data to the trend line (based the further away from the lodge, the lower the plant density is), it proves that the data does not have full reliability.

Human disturbance, identified as a stress factor for plants, has a huge impact on the environment in which the plants grow, modifying the way they interact with their species and their community overall. When the Refugio Amazonas was built, the process to get a proper area in which the lodge could be made consisted of logging and taking down biotic factors which interacted with there desired space. Furthermore, by doing so, they exposed the soil to canopy openness and herb cover, which played a major role in the distribution of plant composition. This is because logging allowed light to reach the soil, causing the fundamental niche in which plants interact to become modified by such factors. Light intensity was then fundamental because it gave energy contained from the light to be absorbed by the plants chloroplast and transformed into glucose or sugar molecules, nutrients that are essential for their growth. Thereby, plants found near the lodge adapted to their new environment in which they found themselves based on human interactions with the environment, causing some to survive and others not to. The shade tolerance, known as the minimal light in which the plants could survive, of the plants which where once under a thick canopy where altered and increased by the removal of trees to open space. Additionally, by exposing the plants to light intensity, it increased competition between native species, which where already there, and invasive species because of the desire to obtain their basic energy to live and survive. This also caused their fundamental niche to become realized through the competition of plants from their same and different plant specie, causing plant density to increase based on the high demand of light intensity to be given to the plants.

Furthermore, Refugio Amazona has artificially planted their own plants in order to keep the wilderness close to the ‘eco-tourism’, causing plant density to be biased because of its unnatural way of developing in the rainforest.

Additionally, by constructing both the trail and the lodge, hiking and walking on the plants are performed. This then causes reduction in the plants potential to live and reproduce, causing plant cover and biomass to be low overall. Plants may then also be limited to their competition because of the photosynthetic area of plants reducing to such level where plant density is no longer able to increase. This may then explain why, the further away the quadrats where measured from the trail rather than from the lodge (represented as ‘trails’ in the data table), the greater the plant density. This could be seen by looking at table 2, where the avg. # of plants of the quadrats measured 0 meters away from the trail where 4 while when it was 10 meters away from the trail it increased to 8. Although there was not a significant increase, it did show an increase on number of plants as the distance from the trail increase. This refers to plants undergoing the process of adaptation of their surroundings and meeting their fundamental needs on their realized niche based of competition from other plants and human disturbance.

The way plants adapt to their local conditions in a short-term response is know as ‘Phenotypic plasticity’. This relates to the way they adapt morphologically (genetically), physiologically or behaviorally to there the environmental fluctuations caused by human disturbance. Plants are on the constant search of resources for their roots, thus as the lodge and the trail may have impacted the low concentrations of nutrients, major impacts on the amount of plants which are ‘fit’ enough to survive are reduced.

The rainforest is an environment where there is so much to discover and learn. This research, for example, could be continued to discover the positive and negative effects that human disturbance has on plant density. On one side, human disturbance allows light intensity to contribute to the plant’s photosynthetic process and its fundamental nutrients to be received; yet on the other, the disturbance can cause a lack of adaptation and limitations on plants that survive. A study could then be conducted to discover such relationships and learn more about the Rainforest and its richness.

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