ECOLOGICAL FIELD METHODS:
CHARACTERIZING VEGETATION STRUCTURE

Background

Vegetation structure has important implications on resource availability, carbon stocks, succession, and community composition. Measurable attributes of the structure of a plant community include the canopy height, the density of trees, the relative proportions of trees of different sizes, the amount of understory, and the species that dominate. As Ceiba works to restore forests and establish "analog forests" with landowners to enhance connectivity among patches of forest like the Lalo Loor reserve, we will monitor changes in vegetation structure through time in restored sites and compare it to the structure of primary forest. This will allow us to evaluate how restored areas develop through time, and how they ultimately compare in structure to original forest habitats.

You will compare the forest structure within a permanent monitoring plot set up within the 250 ha intact forest in the Lalo Loor reserve, to a reforested pasture. The intact forest at is a seasonally dry tropical forest fragment of ~250 hectares. Density of large trees may decrease in forest fragments due to higher mortality; at the same time, sapling density may increase or decrease depending on disturbance, light availability, edge effects, effects on seed dispersers and herbivores, impacts of cattle and other factors (Laurance 2001). The pasture was planted in 2006 with several tree species in approximately a 3x3 m spacing. The recovery of natural forest structure and diversity is being monitored through time as the plot matures.

Learning Objectives

This exercise will teach you standard methods for characterizing forest structure. After completing this exercise you will be able to:

1. Describe the components of vegetation structure and the value of collecting such data.
2. Measure the "diameter at breast height" (DBH) of trees, use a spherical densiometer to measure canopy openness, and implement the point-quarter method to estimate tree density.
3. Calculate and interpret tree density, size class distribution, and basal area for forest characterization and monitoring.
4. Practice two plotless sampling methods: transects and point-centered quarters.
5. Properly use a compass, reel tape, and diameter tapes.
6. Interpret vegetation structure data to assess reforestation outcomes and make predictions about future forest structure.

RESEARCH QUESTION

How does vegetation structure (tree density, basal area, and size class distribution) differ between intact semi-deciduous forest and a reforested area in coastal Ecuador?

HYPOTHESES – enter your expectations in your field notebook

DATA COLLECTION

1. Work in groups. Obtain a reel tape, diameter tape, compass, and stake flag.
2. Your group will be assigned to sample either the forest or the reforestation plot. Set up a 100 m long transect at the starting location indicated by your instructor.

Point-Centered Quarter Method:

3. Establish sampling points at 10, 30, 50 and 70, and 90 meters along your transect (5 points per group). At each point estimate density of trees <10 cm dbh and >10 cm dbh using the Point-Quarter Method (see diagram below):
    - establish the center point
    - using a compass, visually divide the area around the point into four quarters (NE, SE, SW, NW).
    - record the distance in meters to the *center* of the nearest tree <10cm DBH in each quarter.
    - also record the distance in meters to the *center* of the nearest tree >10cm DBH in each quarter
    - measure the diameter at breast height (DBH in cm) of the trees >10 cm using a diameter tape. (Note: DBH is taken at 1.37 m). For trees with multiple trunks, measure the DBH of all trunks. (The *area* of each will be added for basal area calculations).
    - do not include vines, shrubs, dead trees, or trees less than 2 m tall.

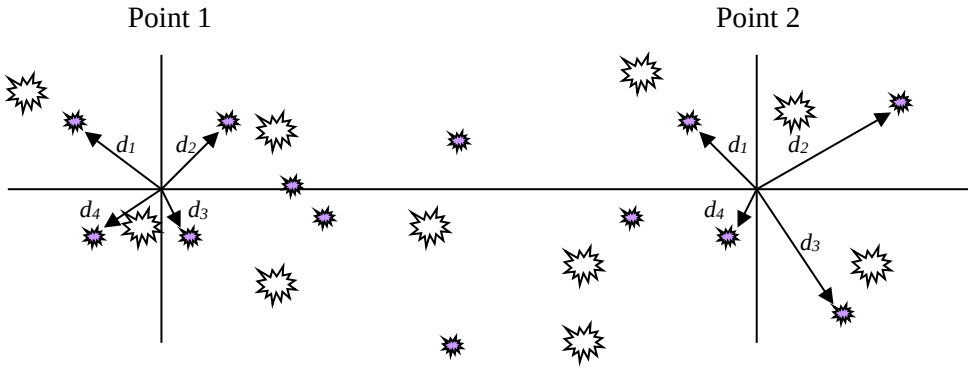

Figure 1: This diagram shows how to measure distance to trees <10cm dbh
You will also measure the distance to the nearest tree >10cm in each quadrant.

DATA ANALYSIS

Share data with the other group that sampled in your forest type (reforestation or intact forest). All analyses below will be based on the 5 points (40 trees) sampled in your forest type.

1. Tree Density estimation from point-quarters (tree density = # trees/ha)

- Calculate the density of trees <10 cm DBH using the equation at below. Repeat with trees >10 cm DBH.

D = density estimate (per m^2)
n = # of points sampled
π = 3.14159
d_{ij} = distance from point i to nearest plant in quadrant j (in meters)

$$D = \frac{4(4n-1)}{\pi \sum_{ij} \left(d_{ij}^{\ 2}\right)}$$

- Convert the densities to # trees/hectare. 1 ha = 10,000 m^2
- You will have **two density estimates** for your forest type: $D_{>10cm}$ and $D_{<10cm}$

2. Size class distribution - a size class distribution is a histogram of the frequency of trees of different sizes in a forest.

- Calculate the percentage of trees in each of the following DBH classes (10-20, 20-30, 30-40, 40-50, >50 cm) out of the total number of trees >10 cm measured.
- Multiply $D_{>10}$ (per ha) by the proportion of trees in each size class to obtain density for that size class.
- Plot size class distribution (density of individuals vs. size class) for each size class including 0-10 cm ($D_{<10}$) and all the size classes listed above.

3. Basal area (BA) estimation - B.A. is the total area in a forest occupied by trees >10cm DBH

- Convert diameters (in cm) of all trees >10 cm into area (cm^2).
- Calculate the mean area of all trees, and multiply by density ($D_{>10}$). This is the estimated basal area per hectare (in cm^2/ha). Divide the numerator by 10,000 to obtain BA in m^2/ha.

4. Share results:

- Share your density, basal area, and size class graph with groups who sampled the other forest type before interpreting the outcomes of the study.

DATA REPORTING & INTERPRETATION:

1. Report all results as described above.
2. Do the results appear to support or refute your hypotheses?
3. How do tree density and basal area differ between intact forest and the reforested area? What factors might explain any differences you observe?
4. Do the size class distributions differ between intact forest and reforested area? Discuss the factors that might account for the patterns you see.
5. What can you predict about the future structure of the forest (in both locations)?

VEGETATION STRUCTURE DATA SHEET

DATE: _____ Group initials: _____

TREATMENT: _____ **LOCATION:** _____

Pt	Quad	Dist. (m) <10 cm	d^2 <10cm	Dist. (m) > 10 cm	d^2 >10 cm	DBH (cm) tree >10cm	B.A. (cm^2) tree >10cm
1	1						
	2						
	3						
	4						
2	1						
	2						
	3						
	4						
3	1						
	2						
	3						
	4						
4	1						
	2						
	3						
	4						
5	1						
	2						
	3						
	4						
6	1						
	2						
	3						
	4						
7	1						
	2						
	3						
	4						
8	1						
	2						
	3						
	4						

$\Sigma(d^2)$ group		**$\Sigma(d^2)$ group**		**Σ(BA) grp**	
$\Sigma(d^2)$ all		**$\Sigma(d^2)$ all**		**Σ(BA) all**	
$D_{<10}$ (trees/m^2):		**$D_{>10}$ (trees/m^2):**		**Mean BA**	
$D_{<10}$ (trees/ha):		**$D_{>10}$ (trees/ha):**		**BA/ha**	