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Effect of Australian pine (*Casuarina equisetifolia*) canopy density on the understory plant community on San Salvador, Bahamas

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Effect of Australian Pine (*Casuarina equisetifolia*) Canopy Density on the Understory Plant Community on San Salvador, Bahamas

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Introduction

Casuarina equisetifolia, or Australian Pine, is an invasive angiosperm species on the island of San Salvador, The Bahamas. It was originally found only in Southeast Asia and Australia. This tree is unique in that its leaves are much reduced and occur in whorls around the photosynthetic branchlets. It has been established that this tree contributes to the increased erosion of sediment on the dunes of San Salvador (Sealey 1998). This study investigated several possible factors contributing to differences in the understory plant community which may contribute to this erosion including leaf litter density, shading, and soil pH. It is hypothesized that dense *Casuarina* stands contribute to decreased understory species richness and diversity.

Methods

For this experiment, two high and low density 100m^2 *Casuarina equisetifolia* plots were identified on San Salvador. These plots were analyzed for:

- *Casuarina equisetifolia* density and diameter at breast height
- Leaf litter density estimate taken by weighing needles in a 1x1 foot section and measuring depth
- Light levels at ground level (Apogee MQ-200 Quantum meter)
- Three visual observations of canopy and understory cover were taken at each site and averaged

The above procedure was done to establish a quantifiable difference between high and low density *Casuarina equisetifolia* plots.

Table 1: Measurements from *C. equisetifolia* plots

	Mature Tree Density (m²)	Leaf Litter Depth (cm)	Leaf Litter (g/cm²)	Light Range (µmol/m²s)	Understory Cover	Canopy Cover
HD	1.01	8.08	0.621	17 – 540	17.50%	50%
LD	0.0883	3.27	0.288	21 – 1614.5	55%	8%

Figure 1: Measuring leaf depth

Figure 2: *Casuarina* leaves

Understory growth and pH were also recorded at these locations. Fresh leaves were collected, ground, and soaked in water for 36 hours. At this time, pH was measured using a Mettler-Toledo SG2 pH meter. The understory growth was counted and identified in the field using *A Field Guide to the Vegetation on San Salvador* and web resources.

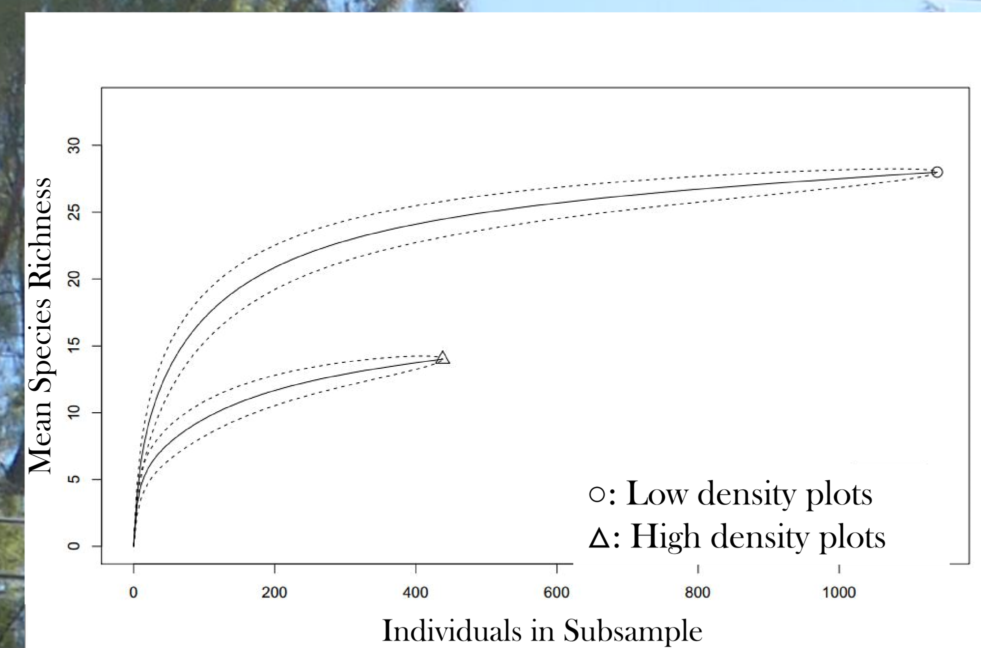


Figure 3: Rarefaction curves of high and low density *Casuarina* plots

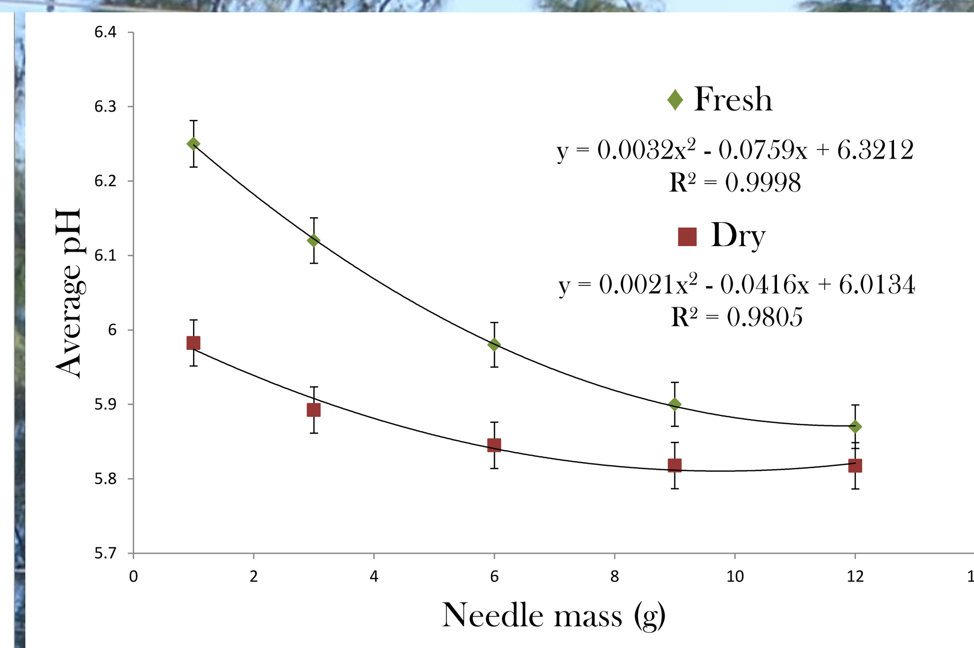


Figure 4: Effect of varying masses of *Casuarina* leaves on water sample pH

Table 2: Understory growth ID
LD -Low Density HD -High Density

Understory Species	LD 1	LD2	HD 1	HD 2
Ambrosia hispidea	215	81	0	0
Euphorbia lecheoides	112	2	0	0
Croton linearis	107	0	1	0
Sporobolus virginicus	91	93	0	148
cf. Scaerola	47	5	0	0
Ernodea littoralis	35	0	0	0
Waltheria indica	31	0	0	0
Phyla nodiflora	29	0	3	40
Dactyloctenium aegyptium	28	0	0	0
Stachytarpheta jamaicensis	18	0	0	0
Smilax havanensis	12	0	0	0
Salvia serotina	11	0	0	138
Gundlachia corymbosa	8	0	5	0
Passiflora pectinata	8	0	3	6
Turhera ulmifolia	8	0	0	0
Antirhea myrtifolia	3	0	0	0
Corchorus hirsutus	3	0	0	0
Cenchrus spinifex	3	8	0	0
Lantana involurata	2	1	0	0
Erithalis diffusa	1	3	1	0
Solanum	1	0	0	0
Casuarina equisetifolia	0	0	5	48
Cocoloba uvifera	0	143	3	0
Leucaena leucocephala	0	0	1	0
Pithecellobium bahamencia	0	0	2	0
Ipomoea pes-caprae	0	1	0	5
Aloe vera	0	0	0	3
Nasturtium officinale	0	0	0	26
Erithalis fruticosa	0	13	0	0
Stylosanthes hamata	0	10	0	0
Thrinax morrisii	0	1	0	0
Chamaecrista lineata	0	4	0	0
Cassytha filiformis	Present	0	0	0
Total	773	365	24	414

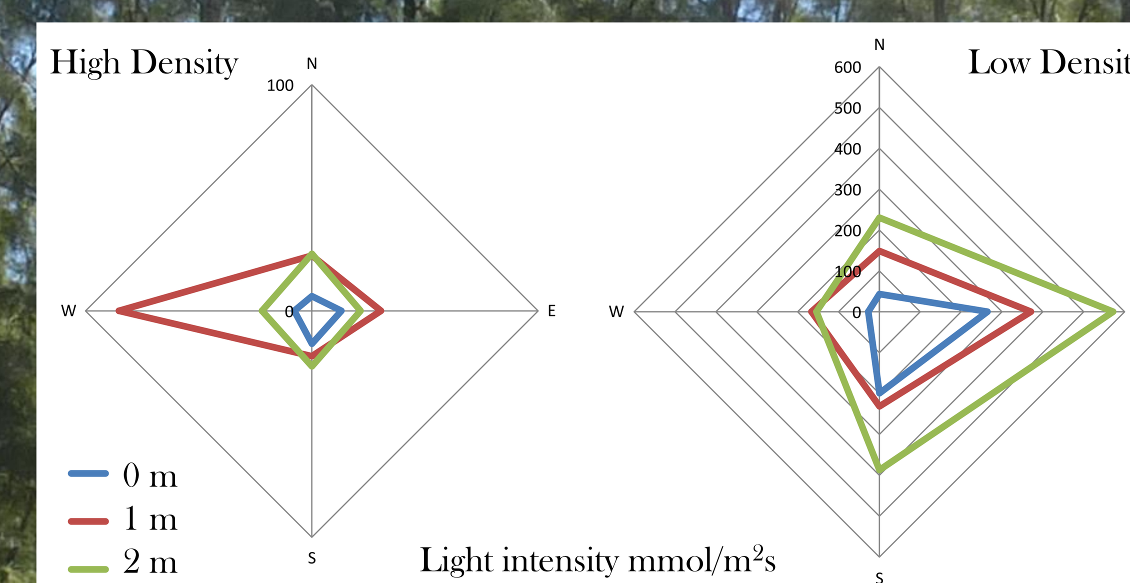


Figure 5: Average morning light intensity of high and low density *Casuarina* plots

Table 3: Diversity indices for understory growth

Casuarina plot	Richness	Evenness	Simpson's Index	Shannon Index	Avg. Num. of Stems
High Density	8.5	0.448	0.794	1.79	219
Low Density	17	0.299	0.784	1.89	569

Results & Discussion

Table 1 shows that the high and low density *Casuarina* plots had different densities of mature *Casuarina* trees. The average percent canopy and understory cover in each location differs by 37.5%, justifying the delineation of the two sites. In Table 3, it can be seen that low density plots have a higher understory species richness (17), are more diverse according to the Simpson's Index (0.784), and are more even by the Shannon and evenness indices (1.89, 0.299) when compared to the high density plots (8.5, 0.794, & 1.79 respectively). These trends are consistent with the hypothesis that a *Casuarina* plot with a higher density of mature trees will hamper understory growth. This correlation is shown in Figure 3 which represents the rarefied species richness of high and low density *Casuarina* plots. The low density plots have a higher species richness than the high density plots, supporting the proposal that high density plots impede understory growth. The leveling out effect shows that the plots were sufficiently large and contained enough species to accurately determine and compare species diversity in these areas.

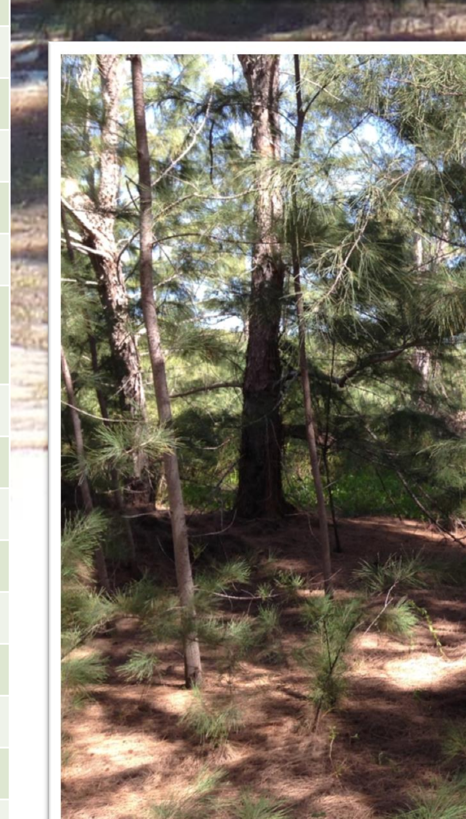
-The difference in understory growth may be attributed to several factors-

Leaf Litter- Table 1 shows that low density *Casuarina* plots have a lower leaf litter density (0.288 g/cm²) than high density plots (0.621 g/cm²). This relates to a more than twofold increase in leaf litter cover in the high density areas. The leaf litter is also thicker (8.08 cm) in the high density location than in the low density (3.27 cm) The thicker and higher density mat of leaves at high density locations may account for the inability of understory growth to take root there.

Shading- Understory growth may be hindered in high density plots because of increased shading. Table 1 displays values for highest and lowest light intensity readings measured at each plot. The low density plots had a higher maximum light intensity (1614.5 µmol/m²s) that was 2.98 times higher than that of the high density plots (540 µmol/m²s). Figure 5 shows the average morning light intensity for each plot with the light intensity for the low density *Casuarina* plots being far higher. This higher light intensity should promote understory growth (Rice and Bazzaz 1989).

pH- Leaf pH and the inferred effects it has on soil pH may contribute to decreased understory growth in high density *Casuarina* plots. Figure 4 shows that an increased leaf mass causes a decreased pH, corresponding to increased acidity. Table 1 shows that high density *Casuarina* plots have a higher leaf litter density (0.621 g/cm²) than low density *Casuarina* plots (0.288 g/cm²). A higher density of leaf litter is predicted to increase the ground acidity. This will in turn cause a decrease in understory growth, because plants are sensitive to pH levels (Giraldez-Ruiz 1997)

Conclusion



This project was undertaken to ascertain the difference between understory plant communities in both high and low density *Casuarina* stands and investigate possible causes of this difference.

- Our results are consistent with the hypothesis that dense *Casuarina equisetifolia* stands contribute to decreased understory species richness and abundance, but the diversity value difference is not statistically significant (more replicates needed).
- Three factors, including higher leaf litter density, increased shading, and increased soil pH may contribute to these difference.

Further research beginning with a multifactorial study is required to determine which factors contribute most to these differences and to investigate the implications of this study on the increased sediment erosion noted by other researchers. We would be interested to see this tree's affect on pH compared to other trees including conifers because we predict a similar effect. While conducting the study, it was posited that increased leaf litter may in fact be beneficial in the alkali high carbonate soils present in the Bahamas. It would be interesting to study this potential effect in addition to current understory conditions.

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Sources:
Giraldez-Ruiz N , Mateo P, Bonilla I, Fernandez-Pinas F. 1997. The Relationship between Intracellular pH, Growth Characteristics, and Calcium in the Cyanobacterium Anabaena sp. Exposed to Low pH. *New Phytologist* [Internet][cited 2014 April 14]; 137(4):599-605. Available from http://www.jstor.org/stable/2558969.
R Foundation for Statistical Computing [Internet]. 2014. R: A Language and Environment for Statistical Computing [cited 2014 April 14]. Available from http://www.R-project.org.
Rice SA, Bazzaz FA. 1989. Quantification of Plasticity of Plant Traits in Response to Light Intensity. *Oecologia* [Internet][cited 2014 April 14]; 75(4):502-507. Available from: http://www.jstor.org/stable/4218898
Sealey, N. Small Hope Bay-The Cycle of Casuarina-Induced Beach Erosion. The 10th Symposium on the Natural History of the Bahamas.
Smith, RR. 1993. Field Guide to the Vegetation of San Salvador Island, The Bahamas . 2nd ed.

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