

A Comparison of Canopy Cover and Shrub Diversity in Old Growth and Plantation Forests.

Research at H.J. Andrews Experimental Forest
June 23rd to July 3rd 2008
Teaching Ecological Complexity Program
Kirk W. Soule' Sunset High School

ABSTRACT:

Vegetation measurements were taken in an Old Growth and Plantation forests in the HJ Andrews Experimental Forest during the summer of 2008. It was hypothesized that differences seen in the shrub layer could be attributed to the amount of canopy cover provided in each area. Line intersects and quadrat methods were utilized, measuring frequency, % cover, and plant volume. It was predicted that the shrub layer in the Old Growth would have greater species richness and diversity. There was no support for this hypothesis, even though the rank abundance profile for the 2 areas were different. The representative shrubs studied may occupy different strata (Parker, 2000) and could be a determining factor in the results of our analyses.

INTRODUCTION:

The HJ Andrews Forest is long term ecological research station (LTER) located in the Willamette National Forest of Oregon. Nestled on the western slope of the Oregon Cascade Mountains, it provides researchers access to a variety of habitats. Research projects include studies on water quality, vegetative succession, plant and animal populations, and stream flows. Long term research projects at Andrews allow for predictions to be made on the “effects of natural disturbance, land use, and climate change on ecosystem structure, function, and species composition.”(1)

This paper is the result of an education outreach program, Teaching Ecological Complexity . The participants were all educators in middle and high schools in Oregon. During the 2 week field experience, the teachers were engaged in a variety of field experiences: collecting information on vegetation, soil arthropods, and leaf litter decomposition. Comparative studies were performed at educator programs at other LTER sites in Puerto Rico, Colorado, New Mexico, and Arizona. The data that was collected at all sites is available for further discussion and analysis on the Ecoplexity website (www.ecoplexity.org)

BACKGROUND:

The forests located on HJ Andrews are examples of a temperate rainforest biome and have many distinguishing characteristics. They are dominated by evergreen trees, fire is a rarity, and they have a more complex structure than other temperate forests. Their “structure is complex because of many canopy layers, a wide variety of tree sizes and ages within a patch of forest, the abundance of epiphytes (plants that live on the surface of other plants, here often represented by hanging lichens, mosses, and ferns), and a dense shrubby understory.” (2) The upper altitude areas of the Willamette National Forest could be included in the Sub alpine forest Biome, but this usually occurs above elevations of 1000 meters. Dominant trees in the Sub alpine biome are

typically Mountain Hemlock, Sub alpine Fir and Noble fir. None of these species were identified on our research sites.

We selected two sites to perform our studies at Andrews; one that represented an old growth forest and the 2nd representing a “plantation” site. The plantation site was clear cut approximately 35 years ago, and managed by accepted methods of that time. Typically a clear cut removes all trees above a specific (marketable) diameter and the remaining smaller trees are cut, and then “skidded” into a the large slash pile and subsequently burned. Heavy equipment is utilized during the logging process, and the impact of bulldozers and rubber-tire skidders on the soil is significant. Young Douglas fir seedlings were planted on this site and now are the dominant large trees species present. The old growth plot in our study was located adjacent to the plantation area and was characterized by larger diameter tree and snags, and a wider range of tree sizes and ages. The oldest trees here are possibly 500 years old, and create an impressive light-blocking canopy at their tops; between 200 and 260 feet above the forest floor. Shade tolerant species of evergreen trees such as Western Hemlock and Western Red Cedar are found growing under the massive canopy created by giant Douglass fir trees. Both plots contained an abundance of dead woody material. This organic material is in varying stages of decomposition, and contains a large amount of biomass. The great abundance of this material “ has led to the development of complex communities of organisms that depend on decomposing materials in various forms for habitat or sustenance” (3) A catastrophic windstorm in the winter of 2008 felled many trees and snags throughout Oregon forests, and evidence of that event is obvious on our plots as well.

HYPOTHESIS:

This investigation is focusing on several key questions:

1. Is there greater % of canopy cover in an Old growth forest as opposed to a managed forest which was cut and planted approximately 35 years ago?
2. Is there a difference in the richness, evenness and diversity of woody shrubs found in the Old growth and Plantation plots?
3. Does the difference in canopy cover correlate to the differences in the shrub layer?
4. Is there a difference in soil moisture content between the Old growth and Plantation sites?

METHODOLOGY:

During our study of the vegetation in our 2 plots we employed a number of sampling techniques.

Transects: Five parallel lines were established through each plot and measurements were taken along each of these 20 meter (m) “transects”.

Frequency and Volume counts were done along each transect line

Plant Frequency: The identity of each species of plant that touched the transect line was recorded at 20 centimeters (cm) intervals.

Plant Volume: The height, greatest length and smallest width was recorded of each species that touched the transect line at each 1 m interval

Quadrats: A 1 square meter area was analyzed for plant cover data along the transects. Measurements were taken at 4 m intervals, and each plant species found within the quadrat had its % cover value estimated and recorded.

Canopy Cover: Measurements of the % of canopy cover was taken at 3 random locations in each plot (Old Growth vs. Plantation). A spherical densitometer was utilized, and 4 measurements were taken at each location (facing N, S, E, and W).

Tree Diameter and height: Tree diameters were measured at breast height, in 2 different areas within each plot. One area was 20 m by 20 m, and the other was 10m by 10m in size. Tree height was measured using an inclinometer.

Soil Moisture Content: The soil moisture can be measured in 2 ways:

Soil Bulk Density: Soil samples are weighed, dried overnight in an oven and reweighed after the water has evaporated.

PR2 Multi Depth Soil Moisture Probe

RESULTS:

Hypothesis #1: Is there greater % of canopy cover in an Old growth forest as opposed to a managed forest which was cut and planted approximately 35 years ago?

Anova: Single Factor

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
og 10x10	6	567	94.5	27.5
og 20x20	3	277	92.33333333	44.333333
plan 10x10	4	320	80	16.66667
plan 20x20	3	247	82.33333333	4.333333

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	661.604167	3	220.534722	9.291106	0.001876	3.490295
Within Groups	284.833333	12	23.7361111			
Total	946.4375	15				

It appears that there is a significant difference between the % canopy cover in the 2 areas.

Hypothesis #2: Is there a difference in the richness, evenness and diversity of woody shrubs found in the Old growth and Plantation plots?

A comparison between the abundance of shrubs in the 2 sites produced the following:

Anova: Single Factor

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
Plantation	15	197	13.13333333	598.4095238
OG	15	217	14.46666667	542.4095238

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	13.33	1	13.3333333	0.023375019	0.87958235	4.19597171
Within Groups	15971	28	570.409524			
Total	15985	29				

It appears that there is no difference between the populations of shrubs (in abundance along transects) in these 2 areas.

When comparing the amount of cover provided by shrubs in each area I found

Site	% cover by shrubs
Plantation	24.92
Old Growth	34.08

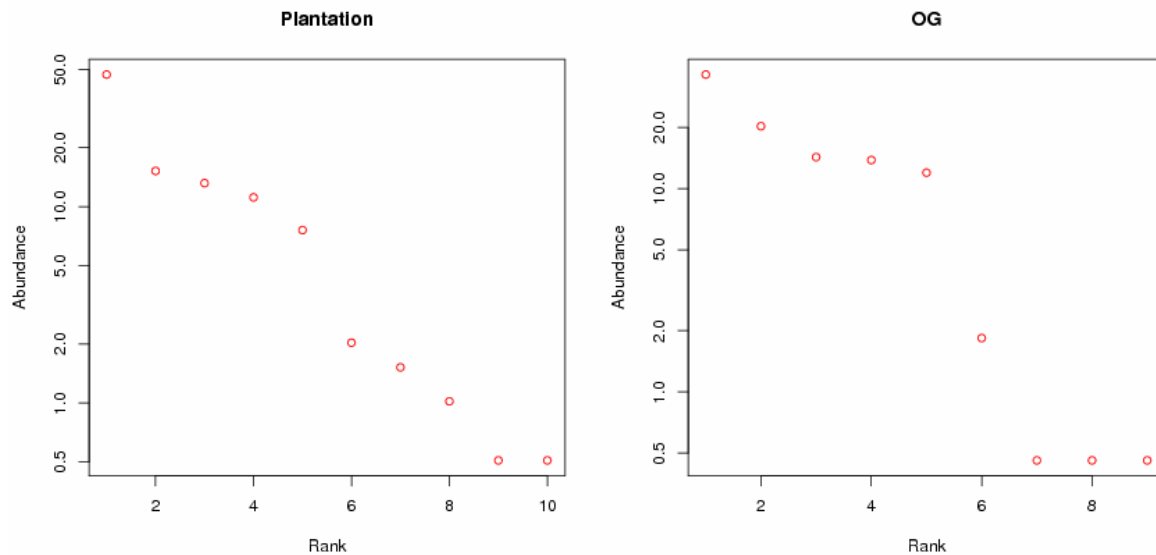
Here is the analysis of the shrub % abundance data (courtesy of Ecoplexity website)

Location	Richness	Shannon Index	Simpson Index
Plantation	10	1.6	0.72
Old Growth	9	1.6	0.77

Sorensen Index = 0.56

It appears that there is no difference in the Shannon index and only very slight difference in the Simpson Index.

Here is the rank abundance plot for the 2 sites (the values shown are % abundance)



The dominant species are not the same for the 2 sites (P = twinflower and OG = Salal)

Rank	Plantation Species		Old growth species	
1	Twinflower	93	Salal	79

2	Oregon Grape	30	Twinflower	44
3	Salal	26	Red Huckleberry	31
4	Red Huckleberry	22	Vine maple	30
5	Raspberry	15	Oregon grape	26
6	Na. Blackberry	4	Dogwood	4
7	Service berry	3	Pipsissewa	1
8	Vine maple	2	Cascara	1
9	Pipsissewa	1	Na. Blackberry	1
10	Snowberry	1		

The differences in the rank abundance plot of the 2 sites led me to believe that there were significant differences in the make up of the shrubs.

The % cover by Salal (*Gaultheria shallon*) is different between the 2 sites

	%cover T1	%cover T2	%cover T3	%cover T4	%cover T5
GASH og	4.861	2	0.2	0	0.2
GASH pl	6	3.2	19	16	5

Anova: Single Factor

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
GASH og	5	7.261111	1.452222	4.2914
GASH pl	5	49.2	9.84	51.028

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	175.9	1	175.88704	6.359	0.036	5.3177
Within Groups	221.3	8	27.659707			
Total	397.2	9				

The % cover by Twin Flower (*Linnaea borealis*) is different between the 2 sites

	%cover T1	%cover T2	%cover T3	%cover T4	%cover T5
LOBO og	14.75	9	18	17.2	6
LOBO	2.4	0.4	2.8	9	9

Anova: Single Factor

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
LOBO og	5	64.95	12.99	27.675
LOBO	5	23.6	4.72	16.092

ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	171	1	170.9822	7.8132	0.02	5.317
Within Groups	175.1	8	21.88375		3	7
Total	346.1	9				

The % of cover by Red Huckleberry (*Vaccinium parvifolium*) is not very different between the sites

	%cover T1	%cover T2	%cover T3	%cover T4	%cover T5
VAPA og	1.16666667	6	1	0	0
VAPA	14	22	4	0	8

Anova: Single Factor

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
VAPA og	5	8.16666667	1.63333333	6.25555556
VAPA	5	48	9.6	74.8

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	158.669444	1	158.669444	3.91507882	0.08322166	5.31765506
Within Groups	324.222222	8	40.5277778			
Total	482.891667	9				

And comparisons of Serviceberry , Oregon Grape(*Mahonia nervosa*), and Vine Maple(*Acer circinatum*) were found to be mostly the same(p values of 0.347, 0.857 and 0.239 respectively).

DISCUSSION:

There are obvious differences between the amount of canopy layer in the 2 sites we studied, but the effect of that difference upon the make-up of the shrub layer in each area is not so distinct. The shrubs present in each of the sites are similar, but the vine maples frequency in the old growth site gave me the impression of a much more developed understory/shrub layer in the more ancient forest. The frequency, richness and diversity indices of most of the shrubs are the same, except for Twin flower and Salal. They seem to be very few differences in the shrub layers of the 2 sites. The nearly inconspicuous Twin Flower dominates the plantation shrub layer make-up. The twin flower is considered a shrub because of its “semi-woody” stem(5), but they grow very low to the substrate and are much less obvious to the casual observer than the taller Vine Maple. The Simpson diversity index is a mathematical measure of species diversity in a community. It provides more information about community composition than simply species richness. It also takes the relative abundances of different species into account. The Old Growth forest had a slightly larger index (0.77) to the Plantation (0.72)

The Shannon diversity index is another index that is commonly used to characterize species diversity in a community. Like [Simpson's](#) index, Shannon's index accounts for both abundance and evenness of the species present. The 2 sites had identical Shannon values (1.6).

I would like to discover how plant volume data would hold up to analysis when considering the Vine Maple's role in the shrub layer. I was hoping that the differences in the shrubs would be more obvious between the areas and to include an additional investigation as to why these differences existed.

LITERATURE CITED

1. HJ Andrews Experimental Forest website , <http://www.fslorst.edu/lter/>
2. Pojar, Jim and MacKinnon, Andy, Plants of the Pacific Northwest Coast, Lone Pine Press, 1994, p17
3. Pojar, Jim and MacKinnon, Andy, Plants of the Pacific Northwest Coast, Lone Pine Press, 1994, p15
4. Parker , Geoffry and Brown, Martin Forest Canopy Stratification Is It Useful?
The American Naturalist , vol 155, No.4 April 2000