Name _____Group Members (list other members of your group)

_____

LAB #3: FOREST SUCCESSION: EXAMINING FOREST STRUCTURE AND COMPOSITION THROUGH TIME

Purpose:
To examine changes in community structure and composition over time so you will be better prepared to evaluate and project the past, present, and future development of an ecosystem.

Introduction:
Forests have *vertical structure* (layers of vegetation - overstory, mid-story, shrub, and herb strata), but there may be variability in how well the vertical structure is developed in different communities. In this lab, we'll use basal area to sample plant communities. Recall from last lab that basal area is the horizontal area of stems (usually with the diameter recorded at dbh – diameter at breast height = 1.37 m above ground).

Succession is the progressive, somewhat orderly, and somewhat predictable series of replacements of one community by another. Not only does species composition change, but structure becomes more complex, habitats for animals change, and abiotic factors are altered. Often there is an increase in soil organic matter, reduction in fluctuations of temperature and humidity, and a reduction in wind and light penetration within the canopy.

A *sere* is a sequence of communities that develops by the process of ecological succession. Individual communities in a sere are called *seral stages*. We'll visit 3 seral stages in a sere and describe the community in each. The seral stages that we'll visit are: (1) **early seral stage**, (2) **early-mid-seral stage**, and (3) a **mid-seral stage**.

On-Site Activity:
We'll visit 3 sites in the Capitol State Forest: (1) **early seral stage**, (2) **early-mid-seral stage**, and (3) a **mid-seral stage**. None of these sites are totally "natural" - all have been manipulated by humans over time. Ideally we would visit a **late-seral** stage site as well, but these are hard to come by in close proximity to Olympia! At each site we'll break into groups of 4 and examine the plant community. We will spend approximately **1 hour** at each site.

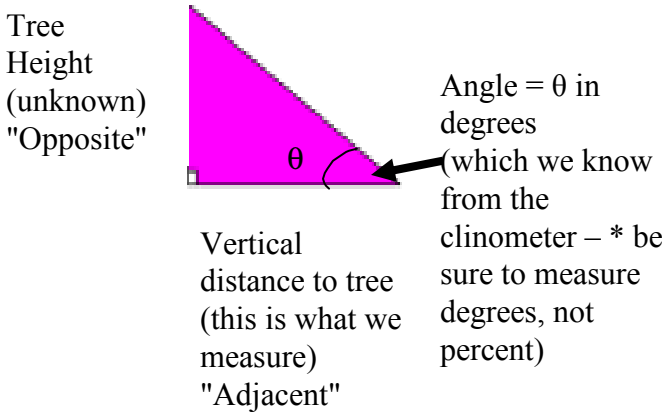
At each site we will do the following:

1. Answer the Ecosystem Analysis Questions, although you'll want to wait to sketch a diagram of the vertical structure (basal area by vertical height layer) until after you've done the calculations of basal area after the lab.
2. Core a dominant overstory tree to try and determine the age of the stand. Alternatively for the early seral stage stand you can calculate the age of the stand by counting the number of whorls (doable because of the growthing habit of Douglas-fir, can't use this approach with all species):

Counting whorls of branches to determine the age of the tree only works for SOME species that have this growth habit, i.e. species that form one distinct layer (whorl) of branches each year such as pines, true firs, and Douglas-fir. It does not work on cedars, hemlocks, and alder because they do not have this kind of branching habit.

Obviously, gets harder to measure as the tree gets older, taller, and you get crown die-back.

3. Measure the approximate height of each layer of vegetation in the forest. You can use a clinometer and a tape measure to indirectly calculate heights of the tree. Yes, geometry class actually has real-world uses ☺ :



Assuming that you take your clinometer reading on a surface that isn't sloped:

Tanθ = Opposite/Adjacent

Tanθ = Tree Height/Vertical Distance

So solving for Tree Height we get:

Tree Height = Tanθ * Vertical Distance

e.g. If you measure a tree with angle of 40 degrees 45 m vertical distance then you get:

Tree height = Tan40*45

=37.759438 Therefore the tree height is approximately 38 m.

* Note that you can't use the tangent function directly in MS Excel because it gives you values in radians rather than degrees,
SO to use Excel to get tan you have to use: TAN((45*Pi)/180) in place of TAN!

4. Select a plot that is representative of the forest around you (do not use exceptionally dense or sparsely vegetated sites unless this truly represents your forest site). **Sample overstory and midstory trees using a 500 m^2 circle plot** [12.6 m (41 ft) radius] and **sample shrubs (including saplings) using a 50 m^2 plot** [4 m (*ca.* 18 ft) radius]. Measure and mark your plots, identify each tree or shrub within your 12.6-m/4-m radius plot by species and record the dbh of each tree and shrub. For shrubs you can just measure a few dbh values for each species and then record the total number of stems and use this information to estimate the basal area for the shrubs (you would spend all afternoon measuring dbh if you measured each shrub woody stem!). After the lab you will use the dbh values to estimate basal area for each species in each vertical layer of the forest. (see more detailed calculation instructions below)

Post-Field Lab Assignment:

Write up a technical laboratory report summarizing the activities, sampling, and results of this laboratory exercise. Please write so that someone who was not along on the laboratory would understand where you went, what you did, why you were there, and what you learned or found. Your report should be typed, double-spaced (12 point font), and 3-5 pages in length. **The report is due at the beginning of the field trip on August 16**.

Introduction:
Describe the purpose of this laboratory and why we visited the sites that we did.

Site Description:
Describe the sites that we visited and sampled. Address the following questions adding additional information as appropriate: Where is the study site? What is the dominant vegetation form? What types of over and understory vegetation did you observe? What are the major topographic characteristics of the sample sites?

Methods:
Succinctly state the objectives of the lab. Describe what information you collected and how you collected it. Identify and briefly explain the indices used to compare the different sites. Attach your spreadsheet calculations to the back of the report to show how you calculated the indices.

Results/Discussion:
What were your results? Be sure and answer the following questions within the body of your summary:

1. Which site(s) has the greatest number of species (combine species from all layers)? For each site, which layer has the most species?

2. Which species were common to all seral stages? Were there any species unique to one seral stage?

3. Based on the height and age of a dominant overstory trees on the site, what do you estimate the site index for each of the sites is (Compare your height and age with the attached site index curve)? Note that for the youngest stand you won't be able to get a good estimate of site index because it is still too young to discern.

4. Use the Shannon Diversity Index to calculate foliage height diversity (FHD) for each site (You will only use data from your group this time). Each layer will be considered a "species". (Consider basal area equivalent to number of individuals – see sample calculation below).

5. Compare vegetation profiles for each site (this is the diagram of vertical structure you create in #3 Ecosystem Analysis). Which site has the most structurally complex plant community? Why? (Hint: use data from Shannon Diversity Index and vegetation profile plots.)

6. What evidence of wildlife use did you observe at each site? Which site would you expect to have the most niches? Why?

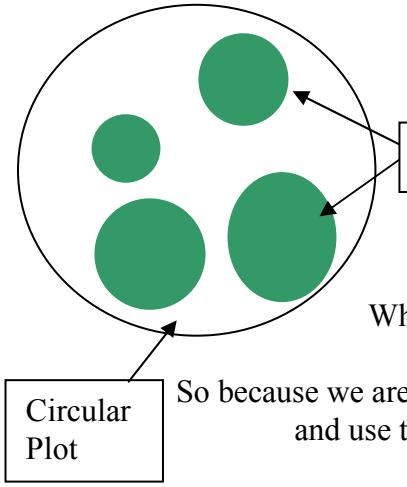
7. Predict successional change after 50 years in each of the 3 sites (consider dominant plant species, horizontal patchiness, vertical structure, dead wood). How easy was this to do? Why or why not?

Conclusion: What do you think is the overall take-home message(s) from this lab?

Refresher on Calculations Required for this Lab

1. Calculating basal area - a different approach to calculate it whereby conversions from dbh to radius and cm to meters are done for you :)

Recall that basal area is the horizontal area of all of the stems in a stand at dbh height (1.37 m/ 4.5 ft). Think of it as if all of the stems were sliced off 1.37 m above the ground and you could measure their radius to calculate their area. Recall that the area for a circle is: Area=πr^2 where π is pi=3.14159 and r is the radius of a circle (and the radius is ½ of the diameter).



A shortcut for calculating basal area in m^2/ha of a stand (G) from a given sized circular plot is the following formula:

$$G = \frac{\pi}{40000} * \frac{\sum dbh^2}{a} = 0.0000785398 * \frac{\sum dbh^2}{a}$$

Where a is the area of the plot that you are measuring in (in hectares) and dbh is the diameter in cm .

So because we are using 0.05 and 0.005 hectare plots we would plug these values in and use the following equation to calculate basal area in each of the layers:

Basal Area (m^2/ha)=G=$\frac{0.0000785398}{0.05 \text{ or } 0.005}$*$\sum$ (dbh – in cm)^2 (the size of our trees/shrub plot in ha)

BA (m2/ha –tree plot)=G=0.001570796*$\sum$ (dbh)^2

BA (m2/ha –shrub plot)=G=0.0001570796*$\sum$ (dbh)^2

E.g. If in the above diagram the 4 trees were of dbh 30, 50, 60, and 70 cm dbh, and the circular plot was 0.05 ha, then you would get the following estimate of basal area per hectare:

BA= 0.001570796*[(30*30)+(50*50)+(60*60)+(70*70)] = 18.7 m^2/ha

If we want to calculate basal area within height intervals, then we would use the same formula, but we would only include the dbh values for trees within a given height interval when calculating basal area. For example, if the 30 cm dbh tree was in one layer and the remaining 50,60, and 70 cm dbh trees were in a second layer, then we would calculate the basal area as:

BA= 0.001570796*[(30*30)] = 1.41372 m^2/ha for the layer with the 30 cm dbh tree, and

BA= 0.001570796*[(50*50)+(60*60)+(70*70)] = 17.2788 m^2/ha for the other layer.

(Note that the total basal area of the stand is the same, it's just that we're breaking it out by vertical height layer (17.3+1.4=18.7 m^2/ha))

2. Calculating Shannon Index/ Foliage Height Diversity

Also, recall the calculations that are used to measure Shannon diversity:

Shannon Diversity Index (H') used to calculate Foliage Height Diversity (FHD)

$$H' = -\sum p_i \ln p_i ,$$

This procedure uses the same formula as for species diversity in Lab 1. However, instead of calculating diversity of species we are calculating vertical diversity of the forest using basal area. Therefore the proportion of basal area (p_i) for layer i is calculated by dividing the basal area for that layer (b_i) by the total basal area for all layers in the community. The proportions are then summed for the total number of layers in the community. It is up to you how you want to assign your trees to layers: you can make distinctions between overstory, midstory, and shrubs (probably the most straightforward approach), or alternatively you can divide heights into fixed vertical intervals such as 0-10 m, 10-20 m, 20-30 m, etc.

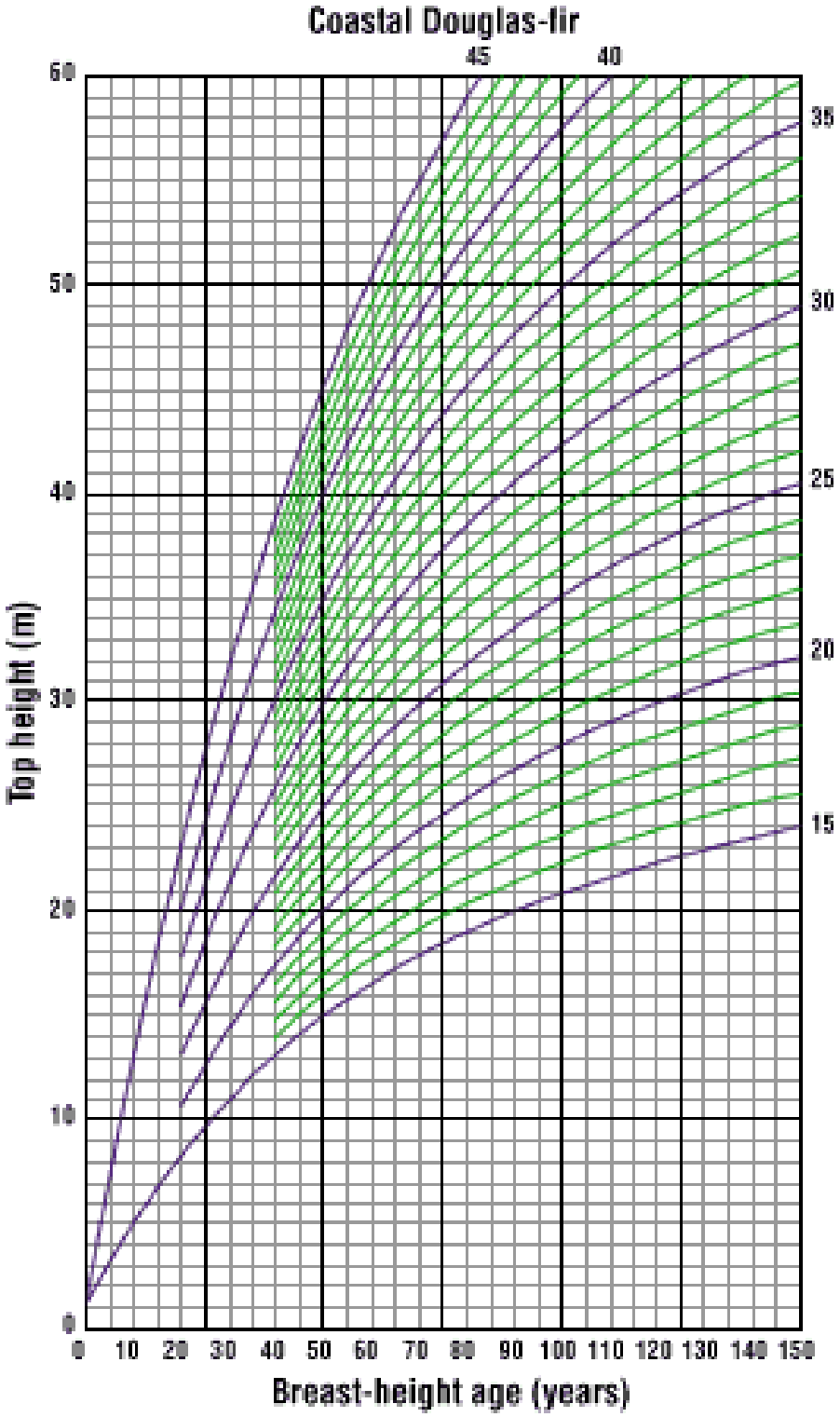
Remember that the units of H' are unimportant; the values of H' are used in a relative fashion, to determine which communities are more or less structurally diverse than others. **Note, we are using the natural log (ln) NOT $\log_{10}$.

EXAMPLE:

	Community A	
"Species"	basal area(m^2/ha)	proportion (p_i)
Overstory Tree	11	11/20 = 0.55
Midstory Tree	6	6/20 = 0.3
Shrub/Sapling	3	3/20 = 0.15
Total	20	

for Community A:

H' = -[(0.55 ln 0.55) + (0.3 ln 0.3) + (0.15 ln 0.15)
H' = -[0.55(-0.60) + 0.3(-1.20) + 0.15(-1.90)
H' = -[-0.33-0.36-0.29] ……**H'= 0.98 = FHD**



Site Index Curve for Coastal Douglas-fir. Site Index is a measure of the height the stand will be at a set age, as a function of the site quality. In this graph the site index is the height of the trees at age 50 (breast height age). Site index is based on the height of dominant overstory trees.

To use curve: Find the breast height age for the tree you have aged (on the x-axis) and then locate the height of the aged tree (on the LEFT y-axis). Now follow the **curve** associated with your x,y value over to the RIGHT axis to see what site index your site is.

Example : 30 yr (breast height tree), 22 m tall, corresponds to a site index of 30 (meters).

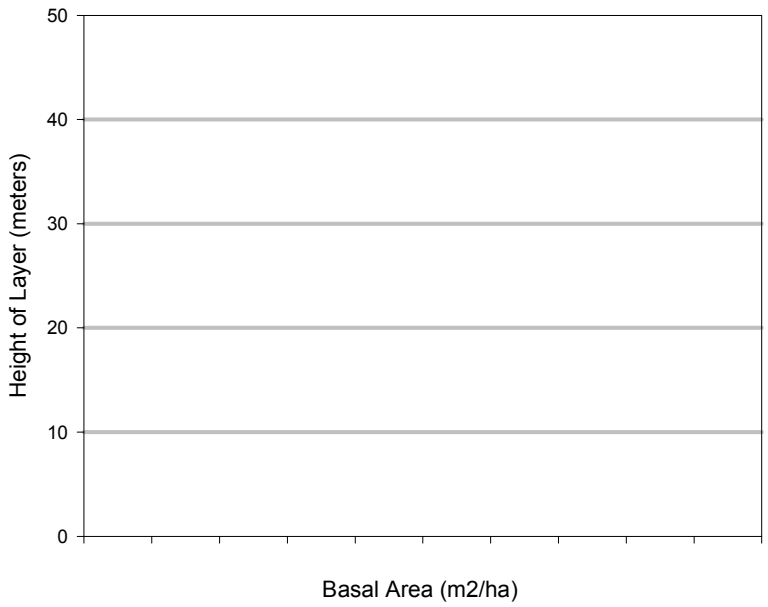
ECOSYSTEM ANALYSIS QUESTIONS

SITE: _____ NAME: _____

1.. List all (a) Symbiotic (even if you do not observe these, what relationships would you EXPECT to exist) and (b) Antagonistic Interactions

2. What is the successional/developmental stage of the site (stand initiation, stem exclusion, understory reinitiation, old-growth)? What evidence do you see that supports this successional stage?

3. Vertical Structure



Use Data p8

Community Description

4. Community structure and composition

12.6-m radius 4-m radius

Tree Species	DBH (cm)	Approximate Height (m)	**Shrub Species**	Mean DBH (cm)	Number of stems

5. What is the age (at breast height when coring) of the dominant overstory trees (either core a tree or count whorls for youngest stand) ?

6. Do you see any evidence of wildlife habitat components ?

7. Total number of tree species = _____(tally number of species for all layers).

ECOSYSTEM ANALYSIS QUESTIONS

SITE: _____ NAME: _____

1.. List all (a) Symbiotic (even if you do not observe these, what relationships would you EXPECT to exist) and (b) Antagonistic Interactions

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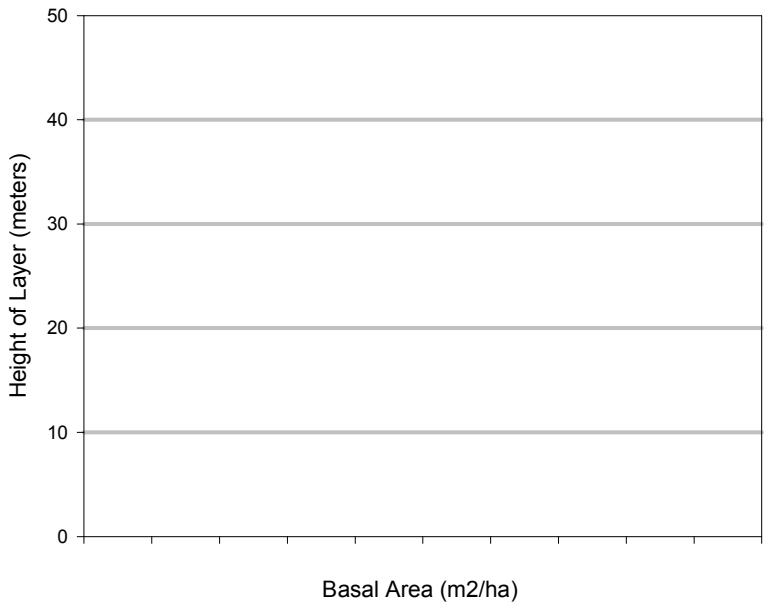

Use Data p10

Community Description

4. Community structure and composition

12.6-m radius 4-m radius

Tree Species	DBH (cm)	Approximate Height (m)	**Shrub Species**	Mean DBH (cm)	Number of stems

5. What is the age (at breast height when coring) of the dominant overstory trees (either core a tree or count whorls for youngest stand) ?

6. Do you see any evidence of wildlife habitat components ?

7. Total number of tree species = _____(tally number of species for all layers).

ECOSYSTEM ANALYSIS QUESTIONS

SITE: _____ NAME: _____

1.. List all (a) Symbiotic (even if you do not observe these, what relationships would you EXPECT to exist) and (b) Antagonistic Interactions

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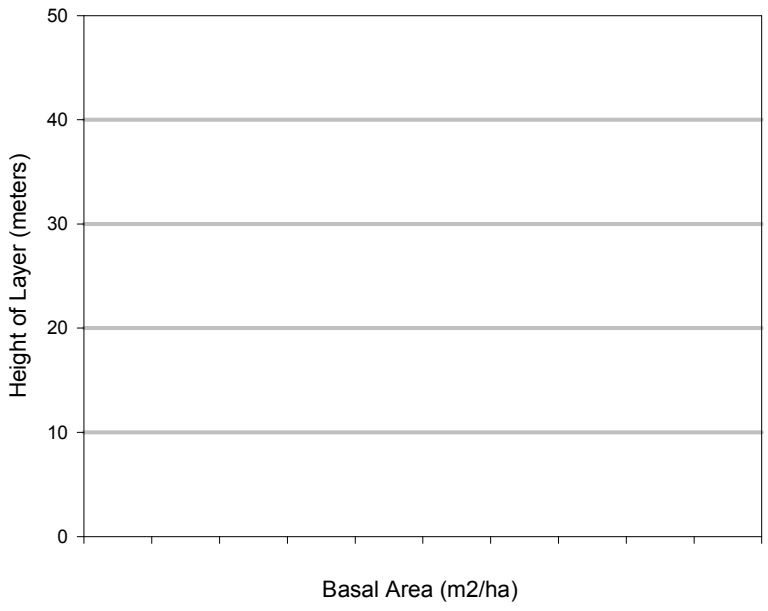

Use Data p12

Community Description

4. Community structure and composition

12.6-m radius 4-m radius

Tree Species	DBH (cm)	Approximate Height (m)	**Shrub Species**	Mean DBH (cm)	Number of stems

5. What is the age (at breast height when coring) of the dominant overstory trees (either core a tree or count whorls for youngest stand) ?

6. Do you see any evidence of wildlife habitat components ?

7. Total number of tree species = _____(tally number of species for all layers).