

**Learning Objective:** Following this lab students will manipulate PTAEDA 4.0 and project plantation growth of new and previously established stands to aid in making silvicultural decisions.

## Introduction

Before using models, it is helpful to first understand some generalities about what models are, how they work, and how they are developed. **A model is nothing more than a simplified version of a system.** The purpose of a model is to predict current or future behavior of the system under a range of realistic or hypothetical conditions. We use models because they are easier to work with than the real system we would like to study or predict. For example, it is much easier to model the growth of a forest than it is to wait for the many years it would take to grow a real forest. A mathematical model uses equations to represent a system. Mathematical models are made up of several primary components that are either implicitly or explicitly defined. The definition of these components dictates the utility of a model, including what conditions it may be used under and how accurately it reflects the system (Voinov 1999).

Boundaries define the limits of the system being modeled.

*Example:* PTAEDA only models the growth of a homogenous site spanning an area of 25 rows each containing 25 trees. Considering an SMZ would be beyond the boundary of this model.

Variables are quantities that change. Their values describe the behavior of a system.

*Example:* PTAEDA outputs stand and stock tables that can include the tons of pulpwood per acre at any given time. Tons of pulpwood per acre is a variable that describes the system of a stand.

Parameters are similar to variables, but they do not change. They often represent specific conditions.

*Example:* PTAEDA allows you to select the site index of your site. The site index is a parameter that does not change, but defines how fast the modeled stand grows.

Forcing Functions impose constraints from outside the boundaries of the system.

*Example:* PTAEDA is only designed to work for loblolly pine plantations in the southeastern US. Growth rates of loblolly pine in this region are controlled by precipitation, light, and temperature. These are all forcing functions implicit to the growth curves used in PTAEDA.

Developing a model involves several key steps:

1. Creation: A model is first developed to represent a particular system. Boundaries are defined, model structure is generated, and forcing functions are specified either implicitly or explicitly.
2. Calibration: Parameter values must be set using real-world data from within the boundaries of the system.
3. Validation: A model must be checked for accuracy by using different data from those used in calibration that are still within the boundaries of the system. This ensures that the model will adequately predict what it is intended to predict.

When working with models it is important to remember several caveats:

- Models are only as good as the data used to create them. If you use a model to predict the behavior of a system for which it was not designed or for part of the system beyond the boundaries of the model, it will likely produce results that diverge from actual system behavior.
- Models reflect the assumptions that are used to create them. If a model is built on a flawed assumption, it will produce flawed results. It is important to understand the assumptions of a model you are using to make decisions.
- Model development requires a balance between simplicity and complexity. Simple models may behave reliably, but may not adequately predict system behavior under all conditions. Complex models may be able to handle a wider range of conditions, but may be difficult or laborious to parameterize and run.
- Models produce output. It is up to the expertise of the user to determine the validity of that output. A consistently skeptical approach to interpreting model output will help a user to identify mistakes in parameterizing models and avoid making poor decisions based upon flawed model results. Remember: ALL MODELS ARE WRONG; SOME MODELS ARE USEFUL.

PTAEDA is a distance dependent individual tree model that projects the growth of existing or new stands of loblolly pine plantations in the southeastern United States. It generates stand and stock tables and thinning reports based on per acre values. All data output from PTAEDA will be on a per acre basis. The user can specify many different parameters, including spacing, stand density, diameter distribution, hardwood competition, site index, physiographic province, site preparation, fertilizer application, herbaceous competition control, and thinning. PTAEDA allows the user to 'grow' an existing or new stand under a wide range of conditions using different stand prescriptions to see how productivity will be affected. This model and its predecessors are widely used by forest industry, and are affordable and practical for forestry consultants who operate at much smaller scales.

## **Procedure**

### *Equipment for Each Individual*

All computers in any forestry computer lab have an installed copy of PTAEDA 4.0. You may access this software whenever the lab is open. If now or in the future you wish to acquire this software, it is available from the Virginia Tech Forest Modeling Research Cooperative at a current cost of \$295. Further information is available at: <https://fmrc.frec.vt.edu/Models/ptaeda4.html>

The full software manual is available at:

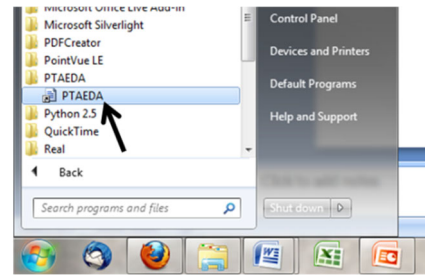
[https://fmrc.frec.vt.edu/content/dam/fmrc\\_frec\\_vt\\_edu/documents/ptaeda4.0%20manual.pdf](https://fmrc.frec.vt.edu/content/dam/fmrc_frec_vt_edu/documents/ptaeda4.0%20manual.pdf)

### *Methods*

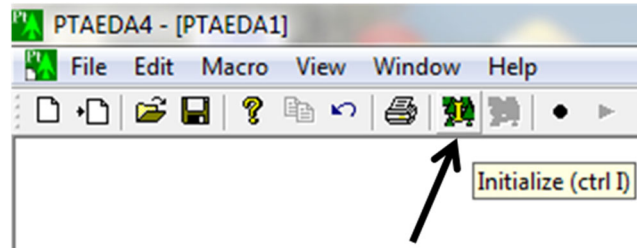
You will explore the capabilities of PTAEDA 4.0 by two different methodologies. First, we will input the data collected from the plantation prescription. Second, you will generate several hypothetical stands from establishment. Begin both methods by opening PTAEDA, accessing the INITIALIZE STAND DIALOG, then filling in information on several different tabs.

## Modeling a Stand Growth in PTAEDA

1. Open PTAEDA 4.0 from the PTAEDA folder in the start menu.

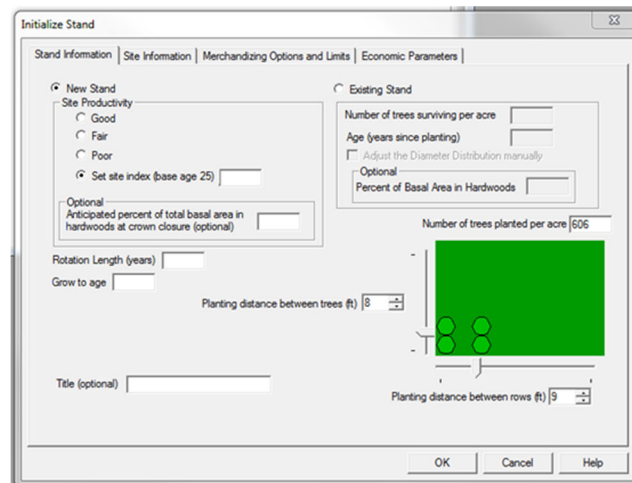


2. Click the INITIALIZE icon.

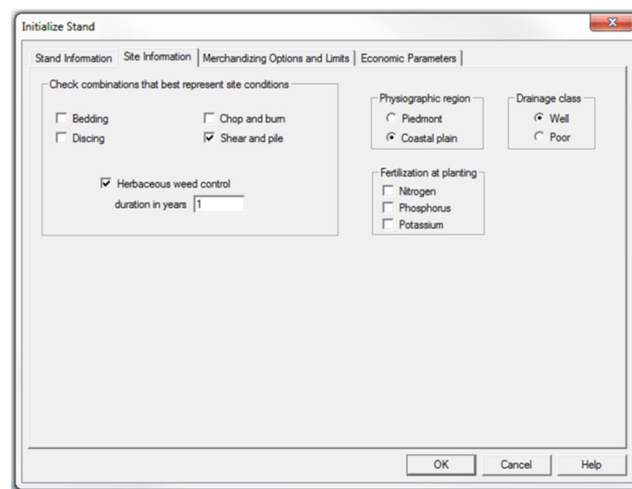


3. This opens the INITIALIZE STAND DIALOG. You will always use this dialog to begin a model run.

If you attempt to begin a model run without inputting all required parameters, the software will prompt you with an error message instructing you to enter the required value. When you exit the error message, the cursor will be blinking in the appropriate field.



4. On the SITE INFORMATION TAB enter the appropriate values for your site.

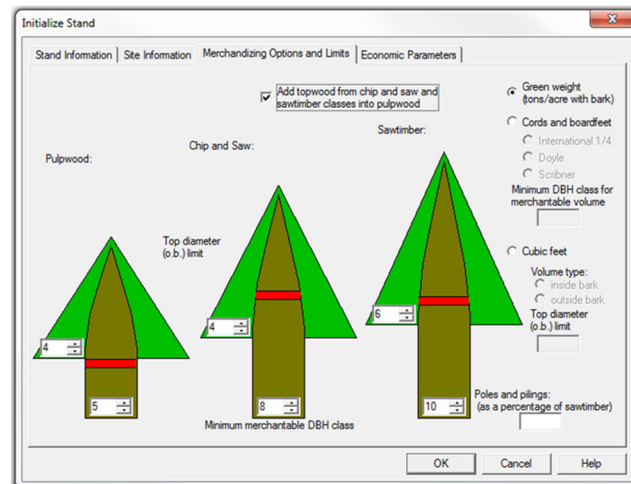


5. On the MERCHANDIZING OPTIONS AND LIMITS TAB check the TOPWOOD BOX and adjust the LIMIT and CLASS VALUES accordingly.

We'll use the following values in this class:

|      | Top Dia | Min Merch |
|------|---------|-----------|
| Pulp | 4       | 5         |
| CNS  | 4       | 8         |
| Saw  | 6       | 10        |

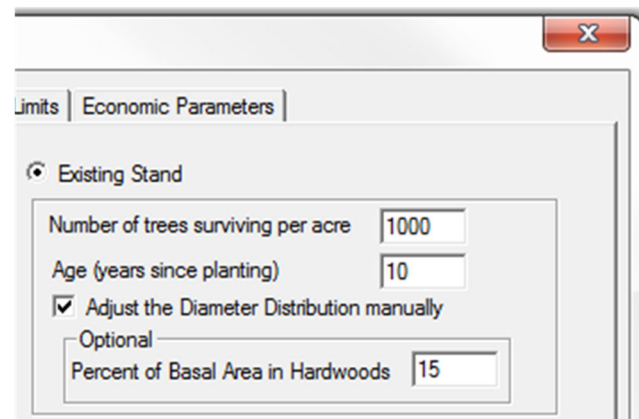
Leave the ECONOMIC PARAMETERS TAB blank.



### Existing Stand Exercise:

1. Select the EXISTING STAND RADIO TOGGLE on the STAND INFORMATION TAB in the INITIALIZE STAND DIALOG. Fill in the boxes below with your data from the pine plantation lab.

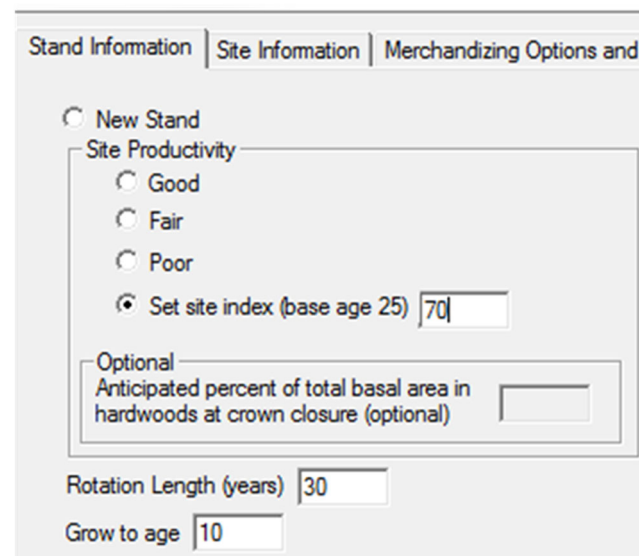
By selecting the ADJUST DIAMETER DISTRIBUTION MANUALLY BOX, PTAEDA will adjust the default diameter distribution parameters to match your stand.



2. Enter site index (base age 25 years), rotation length (years), and the age to which you want to grow the stand.

You cannot project a stand past the rotation length. You can output data prior to completion of the rotation, so it is best to select a longer rotation length if you are uncertain.

You will be unable to apply midrotation treatments except at ages to which you grow the stand. If you want to examine how the stand grows over time, you can do so incrementally and apply midrotation treatments as desired.



- Enter the number of trees in each 1-inch center-point diameter class on the DIAMETER DISTRIBUTION DIALOG.

The number of trees you enter must sum to the stand density of surviving trees. The three boxes at the top will help you ensure that your distribution is accurate.

Diameter Distribution

Number of Trees Surviving: 1000  
Trees Assigned to Diameter Classes: 0  
Trees Remaining to be Assigned: 1000

|                   | 1" | 2" | 3" | 4" | 5" | 6" | 7" | 8" | 9" | 10" |
|-------------------|----|----|----|----|----|----|----|----|----|-----|
| Trees             | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   |
| Percent Defective | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   |

|                   | 11" | 12" | 13" | 14" | 15" | 16" | 17" | 18" | 19" | 20" |
|-------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Trees             | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| Percent Defective | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |

OK

- After clicking OK, you will see the model output at the age to which you chose to grow the stand.

Model output consists of two parts: 1) a description of all the parameters you input, and 2) a stand and stock table with some associated stand structural metrics at the specified age.

PTAEDA3

Simulation length=30  
Distance between rows=9.0000  
Grow to=10  
Trees surviving=600.0000  
Manual Distribution=no  
Pulp top diameter=4.0000  
Saw top diameter=6.0000  
Chip min DBH=8  
Add topwood=yes  
Bedding=no  
Discing=no  
Herbaceous weed control=yes  
Phosphorus=no  
Duration=1  
Physiographic region=coastal plain  
Stand exists=yes

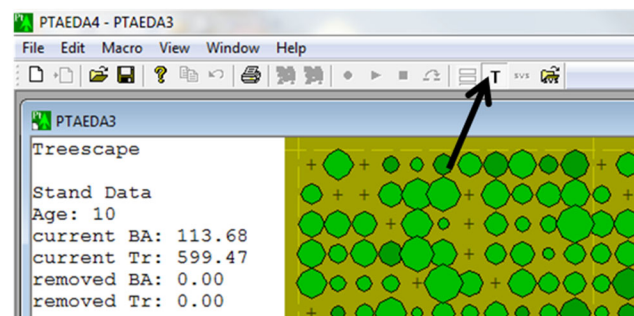
Site index=75.0000  
Distance between trees=8.0000  
Hardwood competition=5.0000  
Existing age=10.0000  
Volume type=green weight  
Chip top diameter=4.0000  
Pulp min DBH=5  
Saw min DBH=10  
Poles and Piling %Saw=0  
Chop and Burn=no  
Shear and Pile=yes  
Nitrogen=no  
Potassium=no  
Drainage=well  
Clonal planting=no

| INPUTS                      |  |      |                       | PREDICTED |      |  |  |
|-----------------------------|--|------|-----------------------|-----------|------|--|--|
| Site Index =                |  | 75.0 | Dominant Height =     |           | 38.5 |  |  |
| Growing Seasons Completed = |  | 10.0 | Average DBH =         |           | 5.67 |  |  |
|                             |  |      | Average Height =      |           | 36.2 |  |  |
| Percent Hardwood =          |  | 5.0  | Average Crown Ratio = |           | 53.1 |  |  |

| DBH Class | Number Trees | Average Height | Basal Area | Green Weight with Bark (tons) |          |              |           |
|-----------|--------------|----------------|------------|-------------------------------|----------|--------------|-----------|
|           |              |                |            | Total                         | Pulpwood | Chip and Saw | Sawtimber |
| 2         | 12.1         | 21.1           | 0.3        | 0.1                           | 0.0      | 0.0          | 0.0       |
| 3         | 55.6         | 27.8           | 2.9        | 0.9                           | 0.0      | 0.0          | 0.0       |
| 4         | 73.7         | 32.4           | 6.6        | 2.6                           | 0.0      | 0.0          | 0.0       |
| 5         | 123.3        | 35.4           | 16.7       | 7.3                           | 4.5      | 0.0          | 0.0       |
| 6         | 141.4        | 37.9           | 27.8       | 13.2                          | 10.6     | 0.0          | 0.0       |
| 7         | 105.1        | 39.6           | 27.7       | 13.8                          | 12.3     | 0.0          | 0.0       |
| 8         | 70.1         | 41.0           | 24.1       | 12.5                          | 3.1      | 8.6          | 0.0       |
| 9         | 18.1         | 41.9           | 7.7        | 4.1                           | 0.0      | 3.9          | 0.0       |
| Total     | 599.5        |                | 113.7      | 54.5                          | 30.5     | 12.5         | 0.0       |

- Click the TREESCAPE BUTTON to view an overhead map of the stand.

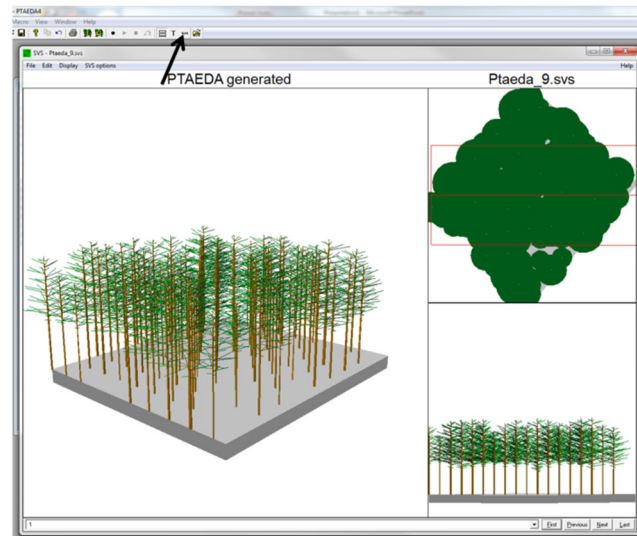
Place the cursor over individual trees in this mode to see individual tree data.



- Click the SVS BUTTON to enable the USDA Forest Service's Stand Visualization System.

SVS will allow you to see computer generated images of a stand over time, and will include the effects of any midrotation treatments you apply to your stand.

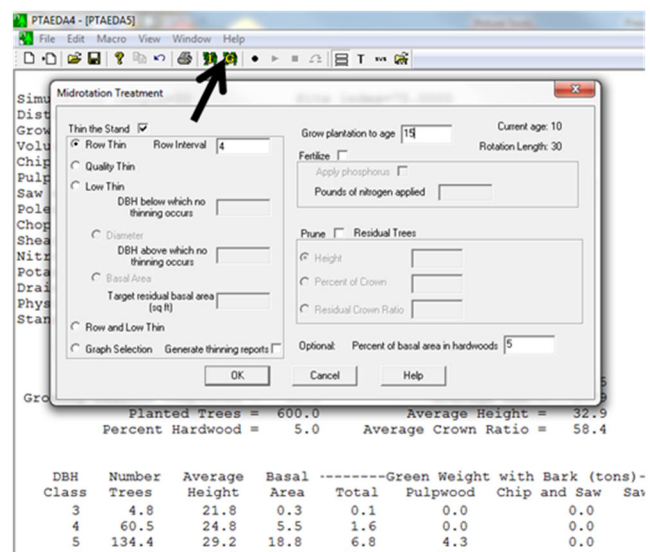
This tool may be useful in helping you interpret data from the stand and stock table by illustrating what the stand may look like. Please do not include imagery from SVS in any reports.



- Click the MIDROTATION TREATMENT AND PROJECT (G) BUTTON to open the MIDROTATION TREATMENT DIALOG. Use this dialog as many times as necessary during a rotation to apply intermediate treatments to your stand.

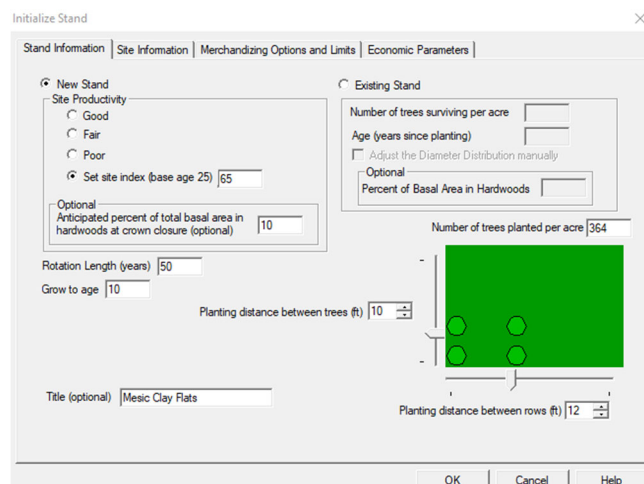
Fill in parameters as you did in the other dialog boxes, choose an age to which you wish to grow the plantation, and click the OK BUTTON.

Remember, if you grow the stand to the rotation age you will be unable to apply any further midrotation treatments.



### Optimizing Growth on a Hypothetical Tract Exercise

- For this exercise we'll generate data for new stands using default diameter distributions built into PTAEDA 4.0. The procedures are very similar to what we have done except for how the stand is initialized on the STAND INFORMATION tab of the INITIALIZE STAND dialog. See the example to the right.
- We will test two typical scenarios for pine plantations growing in east Texas.



Mesic Clay Flats: Average productivity (SI 65), Coastal Plain, Poorly Drained

Mesic 'Ridge' in Bottomlands: High productivity site (SI 90), Coastal Plain, Well Drained

For each assume 10% hardwood basal area at crown closure, and use 10-by-12 foot spacing. Use the same merchandizing options and limits as in the previous exercise.

Here are some general guidelines you may wish to consider relevant to this exercise:

- Poorly-drained sites are often bedded at stand establishment to achieve adequate survival rates; moderately or well drained sites are almost never bedded.
- Herbaceous weed control is most often only maintained for 1 year after stand establishment.
- Chopping and burning or shearing and piling are used to manage slash from the previous harvest, but only if there is so much slash that the site cannot be planted without mitigating it. Most research shows that moving slash around has little effect on growth or survival. However, these treatments do sometimes benefit growth if they result in increased competition control, but herbicide application is a much cheaper and more effective alternative to achieve this goal.
- Disking along with subsoiling is used to break up impermeable soil layers, such as plow pans. Unless the stand is being planted on a recently cultivated field or heavy clay site with pan layers, most studies show little benefit to growth and survival.
- Wet clay flats are often phosphorous and sometimes potassium deficient sites. Phosphorus growth response on these sites can last for longer than a rotation. Phosphorous is not usually a limiting nutrient to growth early in the rotation on most moderately to well drained sites.
- A stand with an average live crown ratio (the percentage of total height with live branches) approaching 30% or less following crown closure often responds to midrotation fertilization.
- Most stands are not nitrogen deficient until around age 5.
- Most midrotation nitrogen applications will only improve growth rates for 6-8 years.
- Typical midrotation fertilizer application rates are 150 lbs. N per acre and 25 lbs. P per acre.

### **Literature Cited**

Voinov, Alexey. 1999. Online Simulation Modeling Course. <http://www.likbez.com/AV/Simmod.html>  
Last accessed 08/10/11.

## Assignment

You will work in pairs to complete the assignment for this lab. The lab may be submitted to me via email in a word document. The word document must contain your names, and four correctly formatted stand and stock tables. Those stand and stock tables are:

- 1) The tract we previously measured at its current age.
- 2) The tract we previously measured at the end of your best simulated rotation.
- 3) The mesic clay flats hypothetical tract at the end of your best simulated rotation.
- 4) The mesic 'ridge' in bottomlands hypothetical tract at the end of your best simulated rotation.

Remember your constraints for each scenario:

- 1) You may only use a 0, 1, or 2 thin scenario for the tract we previously measured.
- 2) You may not prune or fertilize the tract we previously measured.
- 3) You may not thin either of the hypothetical tracts, and must use a 10 x 12 foot spacing.
- 4) Keep the rotation lengths economically reasonable (i.e.  $\leq 35$  years in all cases).

These constraints are intended to allow you to work efficiently within a reasonable number of possibilities for each scenario.

For each table you submit, it must follow the lab style manual for proper formatting. Specific things I'll be evaluating include:

- 1) Correct lines on the table.
- 2) Correctly labeled columns.
- 3) Correct units for each column.
- 4) That the table is correctly captioned at the top.

The caption of each table must contain the following information:

- 1) A brief description of the prescription applied.
- 2) The age of the stand reflected in the table (i.e. the rotation length for all but your first table).
- 3) The mean annual increment, with correct units.

Mean annual increment (MAI) is calculated by summing all the pulpwood, chip-n-saw, and sawtimber harvested over the whole rotation, and then dividing by the rotation length. For the first table this will be standing pulpwood, chip-n-saw, and sawtimber divided by current age. Units are tons per acre per year. A small portion of your grade will be based on how your MAIs compare to your peers. Higher is better.

$$MAI = \frac{Pulpwood + Chip\&Saw + Sawtimber}{Rotation\ Length}$$

You will need one row at the bottom of each table for each harvest, and one row for totals. So, if you thin a stand twice and then clearcut, there will be four rows at the bottom of the table:

- 1) First Thin
- 2) Second Thin
- 3) Clearcut
- 4) Total (first thin + second thin + clearcut)

Do not include totals for variables that do not make sense (i.e. height). Since you cannot thin the hypothetical tracts, it means you only need one row at the bottom for the clearcut, as this is also the overall total.