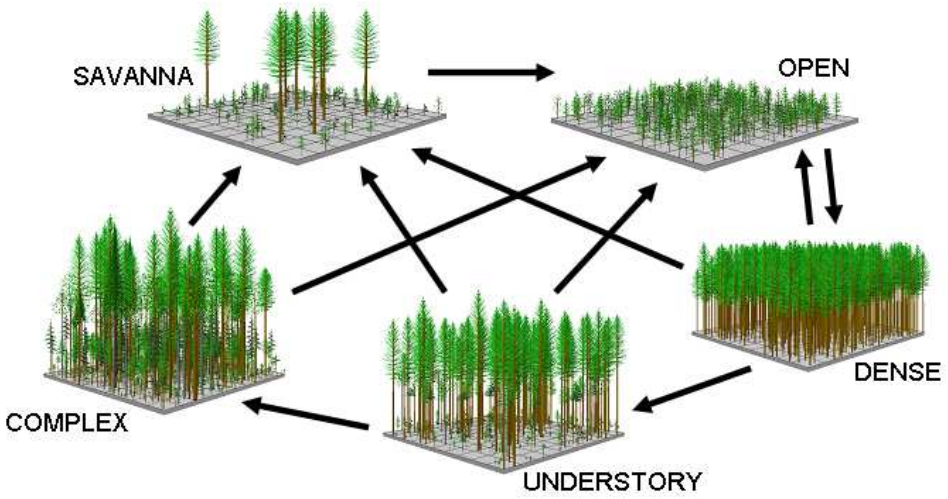
LMS Learn: Forestry Education

Educator's Manual
Lesson Plans for K-12 Instruction



LMS-Lite program developed by James McCarter and Chris Nelson

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- **Global Institute of Sustainable Forestry, School of Forestry and Environmental Studies, Yale University**
- **School of Forest Resources, University of Washington**
- **U.S.D.A. Forest Service**
- **Cradle of Forestry in America**

Table of Contents

Chapter 1, Part I: What is a Forest?

Prep Time: 30 min, plus travel time to field site;
Introduction: 30 min
Field: 2 hours field (3 – 5 minutes/tree)

Location: outside (introduction may be done in classroom)
Indoor Alternative? Yes

Materials needed:
- Dichotomous key (in workbook)
- Tree images, field guide or leaf samples
- Tree tape (or other material to mark trees, such as yarn and index cards or clothespins)
- Paper and pencils

Materials recommended:
- Pocket knife (to examine bark, other tree parts)
- Rulers (for measurement of leaves)

Objectives:
- Be able to identify common tree species
- Be able to use dichotomous key

National Science Standards:
- 5 – 8/A/use appropriate tools to gather and analyze data
- C/structure and function of living systems
- /populations and ecosystems
- /diversity and adaptations of organisms

Preparation:

Go to field site and mark trees for students to identify.

Before beginning the exercise, teachers should mark the trees to be identified with a number (a piece of masking tape around the trunk or a clothing pin on the twig works well to mark the trees) so that the students will know what tree they are working on and can compare answers with other groups and with the teacher (this also helps prevent students getting stuck on trees that are not identified with this key). Teachers are advised to find the answers for all the trees they mark before starting the exercise so that they can help students that are stuck and so that they can provide answers at the end of the exercise.

If indoors, prepare samples/images of trees for classroom identification

Press and laminate leaves from representative trees near your school. If possible, also press a sample of the bark for students to examine. Images of common trees are included in this teacher's manual. Excellent images can also be found online.

Introduction:

Present Lesson 1 PowerPoint to students to introduce the concepts of a forest.

The presentation introduces the concept of a forest to students. The activities in this section will help students gain familiarity with the forest in their local area.

Practice using a dichotomous key.

It is recommended that you use the practice key (lesson 1) with students unfamiliar with dichotomous keys. Online practice with a dichotomous key for trees is possible at http://www.arborday.org/trees/treeID.cfm. Click on Eastern/Central Tree Identification or Western Tree Identification to launch the key. An animated dichotomous key that talks students through the steps, plus a great glossary of tree terms is available at http://www.arborday.org/trees/wtit/. You could use sample leaves or the images included in this lesson (page 4) to practice with the key.

Identify trees!

You will need to either take students to a nearby forest or forested area to practice identifying trees or bring in leaf samples for the students to practice on (one sample of each tree should be sufficient) to do the field version of this exercise (Indoor versions are also possible, but they do not provide the context for the trees that a forest gives. See below for indoor adaptation). Students can work alone, or in small groups. Depending on the age and level of the students, teachers may want to walk the entire group of students through the key together for all the trees, or at least for the first tree.

To do this exercise students will simply find a branch and then work through the key to identify the tree species. The time of this exercise will vary depending on how many trees you ask the students to work through. It should take students approximately 3 to 5 minutes to identify each tree, once they have practiced a few times. It is advisable to give students time to work through at least 5 trees. Teachers may wish to mark the same type of tree multiple times so that students can gain familiarity with trees they have already identified once. At the end of the exercise teachers should give students the answers and, if time allows, encourage them to go back to trees they missed or couldn't identify and 'work backwards' through the key to find out where they went wrong. Students may need rulers or measuring tapes. Teachers may wish to carry a knife to cut the bark on the tree when needed for identification, or they may do this before the exercise.

It is advisable to have some more comprehensive tree guides and/or keys available for students that find trees not included in this key, or for students that would like to continue to more advanced identification. This key is written for trees with their leaves. If you are teaching this module in the winter you may want to use a winter tree guide, bring in pictures of trees and have students identify the trees from these pictures, or have students identify trees from the picture guide included with this packet. Using pictures may make the exercise more difficult. There are also a number of regionally specific field guides available both in print and on line that may be preferable to using this national key.

What if it's winter? (working indoors)

For beginners, it's much easier to use leaves to identify trees. The dichotomous key provided is designed for such use. However, tree silhouettes, winter identification keys and other tools for using non-leaf features to identify trees are available. You can always use the images provided for in-class tree identification. Or collect leaves in the fall or spring for use later in the classroom (laminate on a stiff page for best results).

Chapter 1, Part I: What is a Forest?

What are you doing?
One way to become more familiar with a forest is to learn about the trees in the forest. You can think of species of trees like breeds of dogs; they come in different shapes and sizes. From the tall, straight pine tree that keeps its needles all year long, to the broad, droopy, weeping willow – trees vary enormously. Each species of tree has its own characteristics and its own lifestyle. This exercise is going to help you identify trees and the names of a few common species.

Why is this important?
One of the major ways people understand forests and tell them apart is by knowing the tree species in the forests. Until you can identify the trees you can't understand the forest. Another reason to know your trees is because that will let you predict what is going to happen to your forest in the future. Some trees live for a long time, while some have very short lives; some trees grow in the shade and others in the sun. The more you know about trees, the more you will understand how your forests work, and what is likely to happen to it in the future.

How are you doing it?
With so many trees out there, it can seem overwhelming to try and tell them apart and find out what they're called. One way that people who study plants – called botanists – figure out what plant they're looking at is by using a **dichotomous key**. A key asks a series of yes and no questions about your plants and, depending on how you answer, directs you on to another question. As you go through the key the questions will get more and more specific until eventually, instead of directing you to the next question, the key will give you the name of your tree.

1a: Using a Dichotomous Key

A dichotomous key leads you through a series of questions (generally yes or no) to learn about the object you are trying to identify. It's a little like a choose-your-own-adventure book, but you have to go to the question that matches your object! Before heading out into the field with a dichotomous key to trees, let's practice on something we are familiar with: the alphabet.

On a separate piece of paper, write one of the following letters: A, B, C, D, E.

Pass your paper to a classmate.

Look at the paper you received. Use the dichotomous key below to figure out which letter you have (you already know the answer – that makes it easy to check your work!). Circle the steps you took to come to your answer.

Dichotomous Key to the Start of the Alphabet

Question 1
Does the letter have any curves?

Yes → go to question 2.
No → go to question 4.

Question 2
Does the letter have more than one curve?

Yes → This letter is **B**.
No → Go to question 3.

Question 3
Is the curve on the left side of the letter?

Yes → This letter is **C**.
No → This letter is **D**.

Question 4
Is the letter shaped like a triangle?

Yes → This letter is **A**.
No → This letter is **E**.

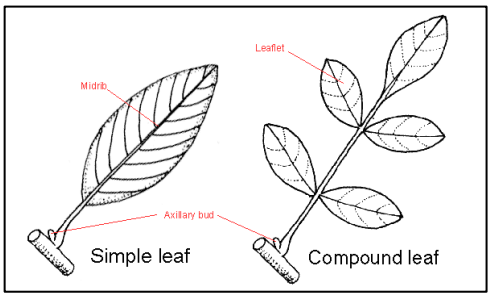
Extension: Make your own dichotomous key
Now that students understand what a dichotomous key is, ask them to make their own key. You might ask students to create a dichotomous key for the trees in the forest using characteristics that are meaningful to them. Or you might suggest the class use something

familiar – the shoes they are all wearing, the students in class, objects in the classroom or any other set of connected objects.

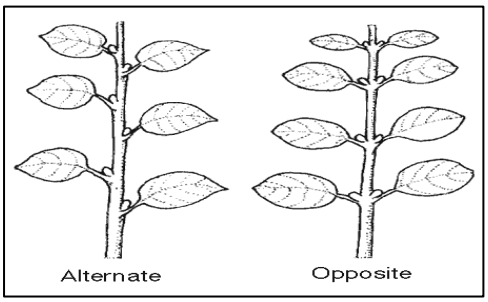
1b: Dichotomous Keys for Trees

Before you head out into the field, familiarize yourself with some of the tree vocabulary below. Dichotomous keys and field guides use these tree terms to describe the trees you see.

Simple vs. compound leaves



Opposite vs. alternate leaves

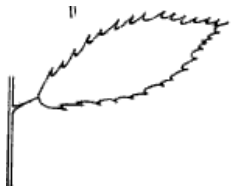


Palmate leaves

Pinnate leaves

Lobed leaves

Toothed leaves



Now you're ready to head into the field! Use the dichotomous key below to key out the trees your teacher has marked for you. Remember that, just as there is great variation among individual humans, there will be a lot of differences among the trees in a given species. Not all lobes are as big as those in the picture, for example! Also, trees in the forest are not as well-preserved as specimens in a museum. You might find a well-chewed (by insects) leaf that you think is toothed. So take your time, look around, and use common sense. Check out more than one leaf on a tree and peek at the leaves on the ground around the tree.

Foresters can often tell the species of a tree just by looking at it, even in the winter. But this knowledge comes from years of keying out trees, being led through fieldwork by experienced foresters and spending time with the trees. There are also clues beyond the visual – smells, the feel of the bark, where the tree is located relative to geographic features. For the sake of ease, we'll start with the dichotomous key today. Have fun!

Dichotomous Key to Common Trees

Question 1
Do the trees have needle-like leaves?

Yes → this tree is probably a "conifer", a tree with cones. The wood of these trees is generally relatively soft and so they are also called "softwoods." To learn what kind of conifer tree this is, go to question 2
No → go to question 9

Question 2
Is the tree "evergreen" – keeping its leaves through the winter? And does it have needles in groups of 2 to 5?

Yes → This is probably a pine tree. Go to question 3 to find out what kind
No → go to question 38

Question 3
How many needles are in each group of needles?

5 → This is an **Eastern White Pine**. It grows throughout much of the United States, but particularly in the Northeast.
3 → go to question 4
2 → This is a **Scrub Pine**
Both 2 & 3 → Go to question 7

Question 4
Are the leaves longer than 8 inches?

Yes → This is a **Longleaf Pine.** It grows in savannahs in the southern United States
No → go to question 5

Question 5
Are the needles shorter than 6 inches and sometimes growing from the trunk?

Yes → This is a **Pitch Pine**
No → go to question 6

Question 6
Are the needles between 6 and 8 inches long?

Yes → This is a **Loblolly Pine.**
No → go to question 7

Question 7

Are the needles less than 5 inches in length?

Yes → This is a **Shortleaf Pine** and is found only in the southern United States.
No → go to question 38

Question 8

Are you located in the southeast of the United States?

Yes → This is a **Slash Pine** and is found only in the southern US, particularly along the coast.
No → This is a **Ponderosa Pine.**

Question 9

Are the leaves simple (only one leaf structure attached to each stem)? See vocabulary at the beginning if you need help understanding this question.

Yes → Go to question 10
No → If the leaves are complex (many leaflets on each stem) go to question 18

Question 10

Are the leaves opposite from one another? See vocabulary at the beginning if you need help understanding this question.

Yes → go to question 11
No → go to question 17

Question 11

Are the leaves palmate – they have a shape with lobes that looks like a hand? See vocabulary at the beginning if you need help understanding this question.

Yes → This tree is a MAPLE. To find out what kind go to question 12
No → go to question 18

Question 12

Are the leaves whitish on the underside, do the edges of the leaves have fine teeth, and is there is a sharp v between the lobes?

Yes → go to question 13
No → go to question 15

Question 13
Is the bark striped?

Yes → This is a **Striped Maple**
No → go to question 14

Question 14
Are the leaves about 4 inches across and some leaves have only 3 lobes?

Yes → This is a **Red Maple.**
No → This is a **Silver Maple**

Question 15
When you break off a leaf does white sap come out of the leaf?

Yes → This is a **Norway Maple,** it grows mainly in cities
No → go to question 14

Question 16
Are the leaves mostly 3 lobed?

Yes → This is a **Sugar Maple.** This is the tree that Maple Syrup comes from. If you cut the bark deeply some sweet syrupy water should come out (especially in the early spring).
No → This is a **Black Maple**

Question 17
Are the leaves smooth (without teeth on the edges) and have veins that run along the edges

Yes → This is a **Flowering Dogwood**
No → This tree with heart shaped leaves is a **Northern Catalpa.**

Question 18
Are the leaves fan shaped?

Yes → This is a **Gingko**
No → go to question 19

Question 19
Are the leaves shaped like a tulip?

Yes → This is a **Tulip Tree.** This large tree has deeply grooved bark and bell shaped seed pods.
No → go to question 20

Question 20

Are the there 3 different shapes of leaves on the same tree (mitten shaped, 3 lobed, and simple teardrop shaped)

Yes → This is a **Sassafras**. If you chew on the green colored twigs they taste good. People used to make tea out of the bark.
No → go to question 21

Question 21
Do some or all of the leaves have lobes? See vocabulary at the beginning if you need help understanding this question.

Yes → Go to question 22
No → go to question 31

Question 22
Are the lobes palmate (similar to the shape of a hand). See vocabulary at the beginning if you need help understanding this question.

Yes → Go to question 23
No → go to question 35

Question 23
Are the leaves star shaped?

Yes → This is a **Sweet Gum**
No → go to question 24

Question 24
Are the leaves less then 4 inches wide and have white hair on the bottom?

Yes → This is a **White Poplar**
No → This is an **American Sycamore.** Its fruit is actually a spiky hairy ball and its bark is a patchwork of colors like an army uniform.

Question 25
Does the branch have thorns?

Yes → This is a **Hawthorn**
No → go to question 24

Question 26
Do the leaves have downy fuzz?

Yes → This is a **Crabapple.** The fruit is a small sour apple.
No → go to question 24

Question 27
Does the tree have one large vein running down the center (a "midvein") or three main veins?

3→ This is a **Mulberry.**
No → This is an OAK, go to question 28 to find out what kind

Question 28
Is there a bristle at the tip of the lobe? See vocabulary at the beginning if you need help understanding this question.

Yes → Go to question 29
No → This is a **White Oak**

Question 29
If you cut into the bark of the tree is it bright yellow?

Yes → This is a **Black Oak.**
No → Go to question 30

Question 30
Are the lobes very deep?

Yes → This is a **Pin Oak** or **Scarlet Oak** (These are quite similar, so don't worry about it. If you're interested, check out a tree guide for particulars. In general, Pin Oaks have a triangular silhouette and Scarlet Oaks have a round silhouette.)
No → This is a **Red Oak** (the bark has a distinctive pattern that looks like ski trails)**.**

Question 31
Does the bark have **lenticels** – small holes – on it? (the tree uses those to breathe)
Yes → Go to Question 32
No → Go to Question 33

Question 32
Is the bark black and peeling? Looks a little like burnt potato chips? When you cut the bark does it smell bad?

Yes → This is a **Black Cherry**
No → This is **Black Birch** (this one should smell like wintergreen when you cut the bark)

Question 33
Is the bark smooth and shiny?

Yes → This is a **Beech.** The leaves have toothed edges. This tree sends up sprouts from its roots.
No → Go to question 34

Question 34
Is the bark shiny, flaky, and peels off in thin sheets?

Yes → This is a **Birch** (the golden colored ones are **Yellow Birch** and the white ones with paper like bark are **White or Paper Birch)**
No → Go to question 35

Question 35
Does the tree have very narrow leaves and drooping branches?

Yes → This is a **Weeping Willow**
No → Go to question 36

Question 36
Does the tree have very shaggy or shredded bark that hangs off the tree?

Yes → Go to question 37
No → Go to question 38

Question 37
Is this a very big tree, probably growing in moist ground?

Yes → This is a **Shagbark Hickory**
No → This is a **Hop Hornbeam**

Question 38
Are the needles flat?

Yes → Go to question 39
No → Go to question 40

Question 39
Are the needles very short, and have a white stripe on the bottom?

Yes → This is an **Eastern Hemlock**
No → This is a **Fir**

Question 40
Do the needles have scales and does the bark, if you cut it smell like cedar?

Yes → This is an **Eastern Red Cedar**
No → This is a **Spruce**

AFTER YOU IDENTIFY SOME TREES WRITE YOUR ANSWERS BELOW:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____

Scientists consider information to be very valuable. Generally they try to collect more data than just the precise details needed for their study. Take a few minutes to describe the general area in which you are identifying trees:

What is today's weather? Is the land flat or sloped?

Which direction does the area seem to be facing? (If you don't have a compass or a map, try to figure this out by observing the location of the sun relative to the time of day.)

Are the trees all about the same size? If not, is one species larger in general than another? Or is it a mix? Describe the relative sizes of the different types of trees.

Are there many plants (not trees – shrubs or herbs or wildflowers) on the ground?

Is the area sunny or relatively shaded?

QUESTIONS: LESSON 1

1. What is a forest?

2. Give 3 reasons forests are important. Another way of saying this might be – what are 3 services that forests provide?

3. What are 2 reasons forests are disappearing?

4. What are the 3 major types of forest and what are they like?

5. What is one way that forests differ from each other?

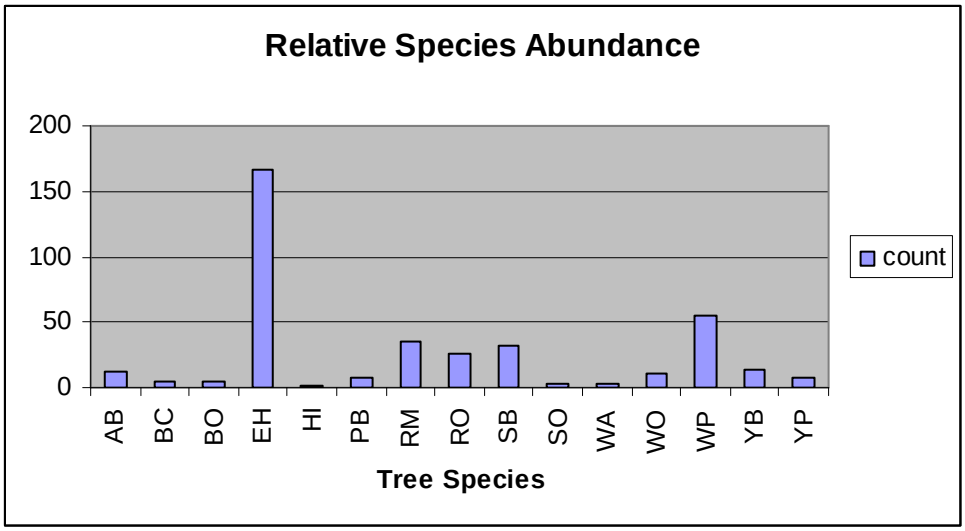
EXTENSION EXERCISES:

1. There are many different types of forests in the world. Pick one forest type and research it. Where is this type of forest located in the world? What is the climate like in this area(s)? How are the trees in this forest adapted to the conditions? What types of wildlife live in your forest? Why is this forest special? If this forest is threatened by human activity, how is it threatened? What can be done to protect this forest? What is being done to protect this forest?

2. Make your own leaf collection. Go outside and gather 10 different leaves. Work through the key you have and identify what type of tree the leaves come from. Look in a book or on the internet and find out one interesting fact about each tree – such as where it grows or how it lives.
   To save the leaves:
   For this activity, get a teacher or other adult to help you: Place each leaf between two sheets of wax paper. Place this between two towels (or one towel folded over). Iron on low heat until the wax paper has melted. Check on it every few seconds to make sure you're not burning it!
   If you have access to a laminator, laminate each leaf to a stiff piece of paper. Wrote the name of the tree and any information you want to remember about it on the paper before you laminate it.

3. Trees are not the only type of plants in a forest. Take a wildflower guide out with you, and one for mosses, fungus and ferns, and go for a walk through the forest. How many different species can you find? Are there any patterns to where they are? Near trees, far from trees, near certain types of trees? In shady or sunny areas?

4. Now that you know what the different types of trees are, count them. How many of each tree type (species) are in the area your class studied? Prepare a graph like the one below to show the relative distribution of trees (this means how many of each tree in comparison to the others). Which are the **dominant** trees in your forest? Forests are often identified by the dominant trees – such as the oak-hickory forests on the east coast or redwoods forest in the Northwest.


Relative Species Abundance
200
150
100
50
0
AB
BC
BO
EH
HI
PB
RM
RO
SB
SO
WA
WO
WP
YB
YP
Tree Species
count

Younger student adaptation for Dichotomous Keys:
Dichotomous keys are based on groupings of objects. Ask students to create categories for the leaves of the trees in the forest, familiar objects such as their bookbags or shoes, or any other set of objects you have available. After one student suggests a set of categories, challenge students to place objects in those categories. A fun extension for active students is to make placement in categories into a relay race. Prepare a basket or clearly defined spot for each category for each group of students. At the starting line, hand students an object. The student must run over to the baskets, then correctly categorize their object before running back to his or her line.

Younger students can also identify trees, but it may be appropriate to stop at the genus or family level, rather than keying out the tree to the species level. For example, determine that a tree is an oak, rather than distinguishing between a white oak and red oak.

AFTER YOU IDENTIFY SOME TREES WRITE YOUR ANSWERS BELOW:
if you mark trees with numbers (note cards hung from yarn or written with marker on clothespins), students can complete the list of trees below, then compare to the master sheet you make when numbering trees.

21. _____
22. _____
23. _____
24. _____
25. _____
26. _____
27. _____
28. _____
29. _____
30. _____
31. _____
32. _____
33. _____
34. _____
35. _____
36. _____
37. _____
38. _____
39. _____
40. _____

QUESTIONS: LESSON 1

6. What is a forest?

A forest is an environment where trees and woody plants are the most common form of plant life.

7. Give 3 reasons forests are important. Another way of saying this might be – what are 3 services that forests provide?
    - Forests provide the oxygen we breathe
    - They keep our water clean
    - They are a valuable source of wood (providing money and wood products)
    - They protect against climate change (providing climate protection)
    - They stop soil erosion (providing good soil for things to grow on)
    - They provide homes for many plants and animals (providing wildlife habitat).

Younger student adaptation

Give students small stickers. Ask them to put a sticker on everything in the classroom that comes from a forest. (pencils, wooden furniture, paper, books and such will be obvious) Leave the stickers on for a few days to remind students of their interdependence with forest products. Ask them if there is anything else (perhaps at home) that they use from forests.

Also point out to students some examples that they might not realize, or bring in photos of some forest-derived products: support beams in the building or at home (but they're behind walls in most cases); tell all students to take a deep breath to represent the oxygen in the air from plants, especially trees in the forest; is your classroom shaded by a tree? This is a great forest resource!; read The Giving Tree, by Shel Silverstein, as a great example of trees as (friendly) resources.

8. What are 2 reasons forests are disappearing?
    - Population growth means that people are cutting down forests to make room for agriculture, animals, and homes
    - Many people cut down forests to sell the valuable wood – if the cutting is too heavy, the forest won't be able to regenerate (grow back) as fast as it is cut
    - Other human activities & impacts – such as mining, climate change, human-caused wildfires.

9. What are the 3 major types of forest and what are they like?

    - Boreal forests are forests in the northern latitudes. These forests are dominated by evergreen coniferous trees such as firs, pines, and spruce. The climate can get very cold and dry.
    - Temperate forests are forests that have distinct seasons. Many trees may lose their leaves in the winter.
    - Tropical forests are forests concentrated around the equator that do not have winters. The only seasons are wet and dry seasons.

    One map of distribution of global forest types can be found at http://www.unep-wcmc.org/forest/global_map.htm

10. What is one way that forests differ from each other?

    Forests vary by the average age of the forest, the species that make up that forest, the climate they live in, how close together the trees are, and many other ways too!

EXTENSION EXERCISES:

5. There are many different types of forests in the world. Pick one forest type and research it. Where is this type of forest located in the world? What is the climate like in this area(s)? How are the trees in this forest adapted to the conditions? What types of wildlife live in your forest? Why is this forest special? If this forest is threatened by human activity, how is it threatened? What can be done to protect this forest? What is being done to protect this forest?
   Good resources for forest research include: U.S.D.A. Forest Service, state forest agencies, U.S.D.I. Bureau of Land Management

6. Make your own leaf collection. Go outside and gather 10 different leaves. Work through the key you have and identify what type of tree the leaves come from. Look in a book or on the internet and find out one interesting fact about each tree – such as where it grows or how it lives.
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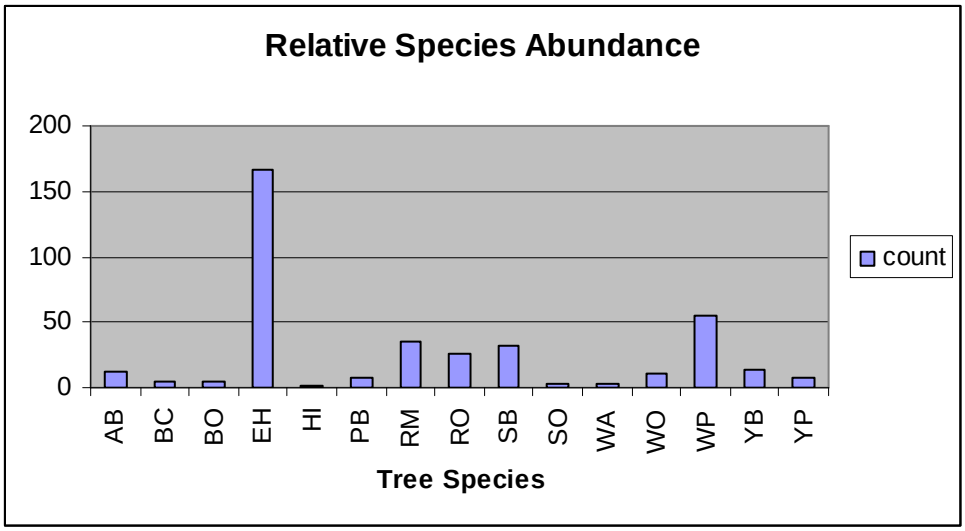

Relative Species Abundance
200
150
100
50
0
AB
BC
BO
EH
HI
PB
RM
RO
SB
SO
WA
WO
WP
YB
YP
Tree Species
count

Chapter 1, Part 2: What's Wild in Your Forest?

Prep Time: minimal
Introduction: 10 min
Field: 30 minutes; longer if desired

Location: outside (introduction may be done in classroom)
Indoor Alternative? No; possible to do research as an alternative

Materials needed:
- If desired, clipboards or notebooks for students to record their observations
- Pens or pencils

Materials recommended:
- Field guide or other source of information about the animals found in the local forest
- List of local wildlife

Objectives:
- Understand that wildlife comes in a variety of sizes and types
- Be able to identify several types of wildlife in the forest and the signs of their presence

National Science Standards:
- Content Standard C: populations and ecosystems; all populations living together and the physical factors with which they interact compose an ecosystem.
- Content Standard C: diversity and adaptation of organisms

In this lesson students learn about the wildlife around them. For this exercise teachers will need to take students to a forest – or at least to an area with trees. Even a small area will do.

Preparation:

Assemble a list of wildlife likely to be found in the local forested area.

Lists of local wildlife can be downloaded from the National Wildlife Federation's eNature local lists program at http://www.enature.com/localguide/localguide_home.asp.

You may wish to have students develop this list. It is recommended that students enter the activity without knowing the various habitat requirements of the specific animals they are likely to observe. This will allow students to enter the search with a wider view of the forest – they are more likely to observe phenomena they would otherwise overlook.

Introduction:

Give students 10 to 20 minutes to look around the forest for all signs of wildlife. Another way to do this is to assign a specific animal to each student or small group of students. Ask them to research the animal in advance, then to look for signs of that animal in the forest.

Some prompts for helping students find signs of wildlife:

Listen for noise – is something moving? Can you hear birds singing or insects chirping?

(Deer and many other animals have adapted large ears to better hear predators or signs of danger. Encourage students to cup their hands behind their ears like deer while everyone is silent to pick up sound cues you might otherwise miss. You can practice using "deer ears" in the classroom before heading out to the field)

What do all animals need to survive? Look for those things to see if animals have been using them.

Basically the same stuff we need – to eat, to drink water, a place to hide stay warm (if it's cold out), to go to the bathroom (scientists refer to this as **scat**), places to raise their young (nests, dens, egg sacs, etc.). Particularly if the animals of the forest have heard you coming, the odds are very low that you will see any actual animals.

If the students were an animal, where would they go?

Remind students that they are more likely to see signs of animals – nibbled branches or leaves, vacant or abandoned nests, footprints (tracks), holes where they've gone underground, holes pecked through tree bark, galls, etc.

Call students back to discuss their findings. Encourage consideration of the animal's adaptations to the forest ecosystem. What other animals might live in the forest?

Chapter 1, Part 2: What's Wild in Your Forest?

What are you doing?
In this lesson you are going to look for signs of wildlife in forests that you may not have noticed before. Your teacher is going to take you to a forest area and give you a period of time to search for signs of wildlife. You and your group are going to explore the area and create a list of everything you found that you think might be a sign of wildlife (or animals you actually see!). You will put together a group list of your observations and then brainstorm about what other wildlife you think lives in that forest. Remember wildlife is more than big animals: it's also insects, worms, lizards and birds. They all count.

Why are you doing this?
We often think of wildlife as big animals and we normally go to the zoo to look at them. But in truth wildlife is all around us and forests are one of the major habitats for wildlife. More than half of all the wildlife species in the world live in forests. This exercise will help you realize how much wildlife lives in the forests around you. Think about why so many animals live in forests.

How are you going to do it?
This exercise is pretty simple. You are going to go off on your own or in groups and look for any evidence of wildlife in the forest and record it. When your time is up, return with your list ready to discuss what you found. Remember that wildlife is wary of people: you will have better results if you move quietly.
For each animal you should also try to understand why it is that this animal lives in the forest:

- How is it adapted to the forest environment?
- What does it need that forests provide that other habitats don't provide?
- Why do you think so many more animals live in forests than in other habitats?

Write below what wildlife you found and why they live in forests. Complete the chart to the best of your ability.

Animal Name	Did you see the animal or evidence of it?	Describe what you observed	What does this animal eat?	Where/how could the animal get water?

Younger Student Adaptation:

Prepare images of local wildlife that you might see in the forest so students can familiarize themselves with the names. Ask students to research the way the animals live in the forest.

Some examples:

- Raccoons – live in hollowed out tree trunks
- Deer – males rub their antlers against tree trunks to remove the 'velvet' – it is possible to see bark rubbed off of trees. If deer are overpopulated in an area, you may observe a 'browse line' marking the level above which the deer can not reach any plants to eat. Below this line will be rather barren.
- Birds – birds tend to be distinctive in where they get their food. For example, cardinals are ground feeders. Some birds can be identified by the materials used for their nests or the way in which the nest is constructed.

When you go to the forest, give each child or group of children (or the whole class, if appropriate) one animal. They will be in charge of looking for clues to that animal, such as tracks, plants they'd eat, nests, dens or other sleeping areas, etc.

Chapter 2: How Does Your Forest Stand Grow?

Prep Time: 30 min, plus travel time to field site;
Introduction: 30 min
Field: 2 hours field (3 – 5 minutes/tree)

Location: outside (introduction may be done in classroom)
Indoor Alternative? No

Materials needed:
- Clipboards
- Paper and pencils

Objectives:
- Be able to identify different stand structures
- Understand the process of stand dynamics
- Understand the difference between a stand, landscape and forest

National Science Standards:
- Content standard C: structure and function in living systems; diversity and adaptations of organisms
- Content standard F: populations, resources and environments; natural hazards; and risks and benefits
- Content standard G: science as a human endeavor
- Content standard A: develop descriptions and explanation; use mathematics in all aspects of science inquiry.

In this lesson students learn about the different levels of forest organization: stand, management unit, landscape and forest. The relationship between stand structures will also be explained, such as how a forest stand would change from being in one structure to the next.

Preparation:
Locate a field site and identify stand structures to be visited.
If desired, ask a forestry professional to accompany your class on its trip. Contact your state department of forestry to determine if a forester is available to show your class a nearby state forest. Many cooperative extension offices (http://www.csrees.usda.gov/Extension/) have foresters and forest educators who may also be able to guide a trip. If a local university has a forestry department, a student or faculty member may be able to assist or direct you. Ask the forester to help students identify stand structures and to point out the disturbances that have occurred in the area. You may also want the forester to explain how the forest is currently managed.

Introduction:
Present Chapter 2 PowerPoint to students introducing the concepts of forest stand structures.
Some prompts for helping students recognize stand structures:
- Take a piece of white paper to place on the ground or use a student's white shirt to make comparisons of the amount of sunlight reaching the ground. This will help students estimate how open or closed the canopy is.
- Compare the trees in the stand: are the trees of the same species about the same size? If so, they are probably the same age. If possible, use a corer to measure tree age or count the rings on an exposed stump.
- Are there many young trees?
- Is there a layer of herbs or shrubs on the ground (also called the understory)?
- Wildlife can also be a clue for stand structure. For example, many species of woodpeckers prefer savanna structures.

If possible, visit at least one example of each stand structure. If you are unable to visit a stand for each structure, ask students what would be different if the stand you are currently in were a different structure.

Chapter 2: How Does Your Forest Stand Grow?

What are you doing?
In this lesson you are going to learn how a forest is divided into smaller sections by managers. These groupings are: forest, landscape, management unit and stand. You will also learn to recognize the different stand structures.

Why are you doing this?
Stand structures are good clues about forest age, health and diversity. To manage appropriately for a variety of values, a forest should have a mix of stand structures.

How are you going to do it?

You will visit a forest to see examples of each of the stand structures. For each one, identify the stand with its official name. (Forest managers like to name stands. Some get boring names, like West Forest 12. Others have funny names that foresters pick based on people who managed the area or silly things that happened there. For example, at one of Yale University's forests, a stand has been named "Juicy Bits.".) Draw a sketch (keep it very simple) that shows the structure of the stand. Write down which type of stand structure best fits this area.

Stand Name:

Stand Structure:

Sketch:

Stand Name:

Stand Structure:

Sketch:

Stand Name:

Stand Structure:

Sketch:

Stand Name:

Stand Structure:

Sketch:

Stand Name:

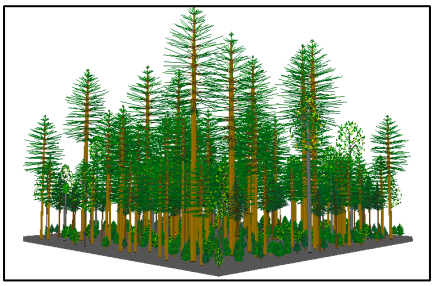
Stand Structure:

Sketch:

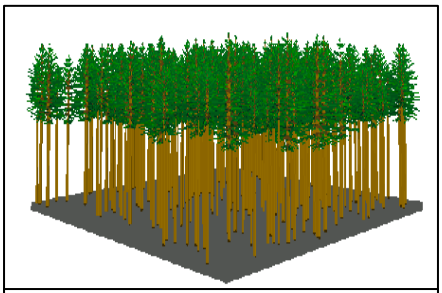
QUESTIONS: LESSON 2

1. Can you match each of the following pictures of a forest with the correct name of the forest structure? Draw a line connecting each picture with its proper name. Underneath the name write a brief description of that forest structure

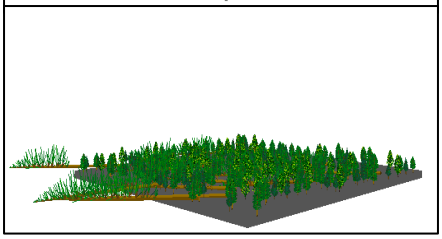
SAVANNAH FOREST



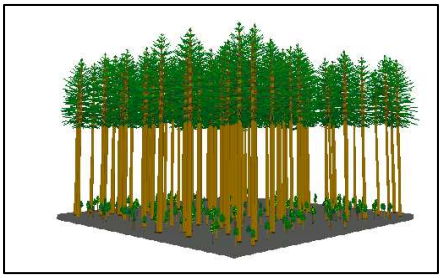
UNDERSTORY FOREST



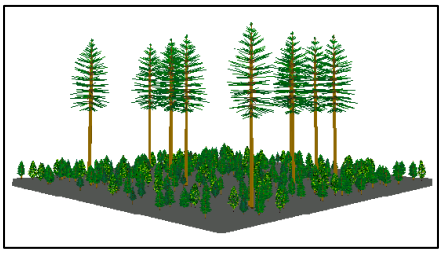
OLD GROWTH/ COMPLEX FOREST



OPEN FOREST



DENSE FOREST



2. If there were no major disturbances, how would these forests age? Put the forest structures in order. (Do not include Savannah structure in this list, as savannah forests would not occur without fire disturbances)

    1. ----------
    2. ----------
    3. ----------
    4. ----------

2b. (extension) Write a story describing the changes in the forest over time. Start with the stand that you decided would come first in the question above.

3. What are some types of disturbance that cause a forest structure to change? List 5 types.

    1. ----------
    2. ----------
    3. ----------
    4. ----------
    5. ----------

4. What is a forest "STAND"? Describe one stand and its structure that you observed during the class's visit to the forest.

5. What is a forest "LANDSCAPE"? What would the landscape boundaries be for the forest the class visited?

EXTENSION EXERCISES:

1. Show students images of various forests. Ask them to identify the type of structure. A good source of photos are http://www.forestryimages.org/ or http://www.ruraltech.org/projects/image_archive/.

2. Different types of forest stands are good for different kinds of wildlife. Pick a type of forest structure and find 2 different animals that like this forest structure. What is this animal's life like? Why does it need this type of forest to live? (Some potential choices include deer, woodpeckers, elk, moose, turkeys, grouse, tree frogs, parrots, howler

monkeys, giant pandas, koalas, grizzly bears, and almost any forest animal you can think of). Some animals can live in many forest types. If you pick an animal that can live in many forest types, what is it about the lifestyle of this animal that allows for it to be so flexible about his habitat? Some animals need multiple kinds of habitat. Why is that?

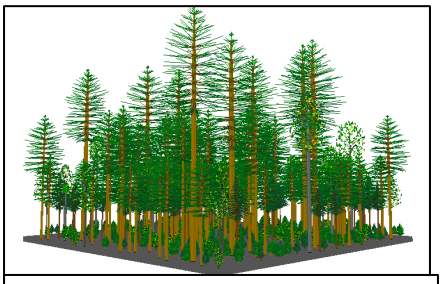
3. Forests do many things. Providing homes for wildlife is just one of the many examples. Pick one of the other services forests provide – such as cleaning our water, helping slow global warming, producing oxygen, and providing timber. Why is this so important? How do forests do it? What would happen if we didn't have forests doing this job?
   .

4. Ask groups of students to each create a diorama of one of the stand structures. If you wanted to be more realistic, have each group use a map of the site you visited and create their stand on a topographical model of the actual landscape.

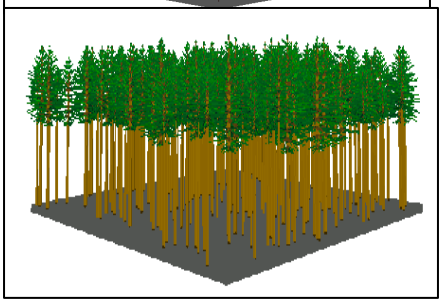
QUESTIONS: LESSON 2

1. Can you match each of the following pictures of a forest with the correct name of the forest structure? Draw a line connecting each picture with its proper name. Underneath the name write a brief description of that forest structure

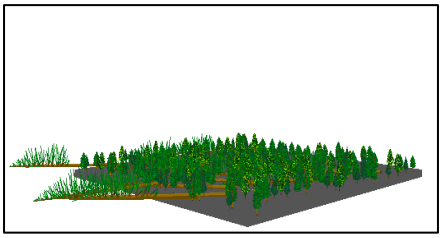
SAVANNAH FOREST
When a mature forest burns regularly small trees are not able to survive the fires. Only the large and established trees remain and they are fairly spread apart.



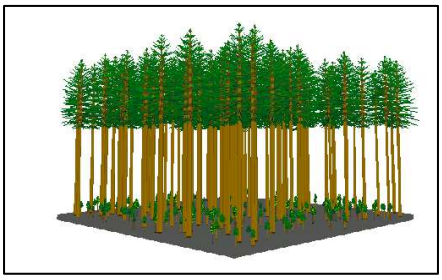
UNDERSTORY FOREST
As a dense forest grows, some of the trees do not get enough light and water and die. The forest thins out and enough light now gets through allowing an understory to grow again.



OLD GROWTH/ COMPLEX FOREST
This is an old forest with all different ages and sizes of trees. There is some understory vegetation and some standing dead trees as well as fallen logs.

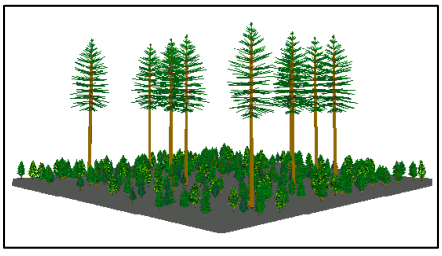


OPEN FOREST
This is the first stage of a forest, right when all the trees begin to grow up in a meadow or old field. There are lots of young trees and plenty of open space. As the young trees grow up the forest will likely become a dense forest.



DENSE FOREST

This is still a young forest, but all the very small trees have now grown up to be very dense. They are competing with each other for light and water. Very little light reaches the forest floor and so there is no understory vegetation



In order from top to bottom, the pictures depict a complex forest, a dense forest, an open forest, an understory forest and a savannah forest.

2. If there were no major disturbances, how would these forests age? Put the forest structures in order. (Do not include Savannah structure in this list, as savannah forests would not occur without fire disturbances)

    1. ---------- Open Forest
    2. ---------- Dense Forest
    3. ---------- Understory Forest
    4. ---------- Complex Forest

2b. (extension) Write a story describing the changes in the forest over time. Start with the stand that you decided would come first in the question above.

3. What are some types of disturbance that cause a forest structure to change? List 5 types.

    1. ----------
    2. ----------
    3. ----------
    4. ----------
    5. ----------

    Wildfire cutting/logging, disease, windstorm, ice storm, prescribed burns, fire fighting.

4. What is a forest "STAND"? Describe one stand and its structure that you observed during the class's visit to the forest.

    A stand is an area that contains a number of trees that are relatively similar and have a common set of characteristics. Normally a stand will be studied or managed as a single unit. Sometimes multiple stands with similar characteristics are grouped into management units.

5. What is a forest "LANDSCAPE"? What would the landscape boundaries be for the forest the class visited?

    A forest landscape is the big picture view of a forested area. A forest landscape may contain different types of forest within it and is often divided up into many different smaller units, called management units or stands. The landscape, for our uses, is the area of land being managed. So it is often the land owned by one landowner or, say, a state forest.

EXTENSION EXERCISES:

1. Show students images of various forests. Ask them to identify the type of structure. A good source of photos are http://www.forestryimages.org/ or http://www.ruraltech.org/projects/image_archive/.

2. Different types of forest stands are good for different kinds of wildlife. Pick a type of forest structure and find 2 different animals that like this forest structure. What is this animal's life like? Why does it need this type of forest to live? (Some potential choices include deer, woodpeckers, elk, moose, turkeys, grouse, tree frogs, parrots, howler monkeys, giant pandas, koalas, grizzly bears, and almost any forest animal you can think of). Some animals can live in many forest types. If you pick an animal that can live in many forest types, what is it about the lifestyle of this animal that allows for it to be so flexible about his habitat? Some animals need multiple kinds of habitat. Why is that?
   You can find information about the habitat requirements for various species online:
   http://www.nwrc.usgs.gov/wdb/pub/hsi/hsiintro.htm
   http://el.erdc.usace.army.mil/emrrp/emris/emrishelp3/list_of_habitat_suitability_index_hsi_models_pac.htm
   Models for other species' habitat requirements may be found by doing an internet keyword search for the species and "habitat suitability index." These documents are written in rather technical language. It may be more appropriate for some students, who are not as focused on the precise details (such as minimum necessary tree diameter for a species's foraging needs, for example) to do more basic research about the organism. The National Wildlife Federation's eNature online field guides are an excellent source of general information about animals (and plants): www.enature.com.

3. Forests do many things. Providing homes for wildlife is just one of the many examples. Pick one of the other services forests provide – such as cleaning our water, helping slow global warming, producing oxygen, and providing timber. Why is this so important? How do forests do it? What would happen if we didn't have forests doing this job?
   http://www.esa.org/ecoservices/ is an excellent resource for information about ecosystem services. Without forests or other ecosystems to perform these functions, humans would have to engineer solutions in order to remediate environments that were disturbed. A classic example of an ecosystem service provided by human constructions is the water treatment plant, which can filter water to drinkable levels.

4. Ask groups of students to each create a diorama of one of the stand structures. If you wanted to be more realistic, have each group use a map of the site you visited and create their stand on a topographical model of the actual landscape.
   Use the visualization function in LMS to compare the 'stands' created by students to the actual stand.

Younger student adaptation:
Show students a map of the area your class visited, with the stands delineated on it (the foresters who manage the site may be able to provide you with this, or you can estimate stand locations on a regular map). Ask students to identify the landscape and a stand, to demonstrate the difference in scale.
Ask students to name each stand you visited. Or assign one stand to each student, or a group of students. Ask them to name their stand with a descriptive term and to write a short report describing the stand using some of the forestry terms they have learned.
Show students images of each of the stand structures and ask them to identify them with their name.

Chapter 3, Part 1: Exploring LMS-Lite

Time: 2-4 hours
Location: inside
Indoor alternative? Not applicable

Materials needed:

- PC computer with LMS loaded

Objectives:

- Be able to use basic features of LMS
- Understand and apply basic silvicultural practices

National Science Standards:

- Content Standard A: recognize and analyze alternative explanations and predictions; understandings about science and technology

Students can now see how forest stand dynamics development is likely to occur in their forest over the next 50 years. They can also practice "managing" their forest by implementing a variety of silvicultural practices they have learned about in this lesson – including prescribed burns, clearcuts, thinnings, and several other treatments. They can see both the immediate and long-term effects of these management tools. This lesson will make the theoretical understanding of forest management much more practical by showing students how these practices would actually affect a forest that they have seen and inventoried themselves.

You will use one or more versions of LMS depending on which exercises you want to complete for this chapter. Chapter 3 consists of introductions to LMS-Lite (Part 1), LMS 2.x (Part 2), and conducting forest inventory (Part 3) which can be used with LMS 2.x. If you will not doing Part 3, or will only be doing the inventory so that students better understand how to do an inventory then use LMS-Lite for introducing students to the software.

If you plan to do the complete exercise of collecting forest inventory information and want to use the information the students collect, then use LMS 2.x.

Introduction:

Present the PowerPoint for this chapter to students.
Ask students to work through the questions at the end of this chapter before experimenting with LMS.
Give students 30 to 60 minutes to explore LMS-Lite, simply to look at the different functions provided, visualize their stands and play a bit.

Preparation:

Install LMS-Lite on each computer students will be using. The program is on the CD provided.

Chapter 3, Part 1: Exploring LMS-Lite

What are you doing?
In this lesson, you will learn how to use the LMS-Lite version of the Landscape Management Systems (LMS), a computer **decision support tool** that models forest landscapes, to predict the effects of forest management on your landscape. You will be able to see what the forest will probably look like in 50 years. You can then see how this would change if a natural disaster, such as a wildfire, were to hit it. You can also see how it would change if you were to manage it by performing one of the basic cuts on that forest.

Why are you doing this?
This will teach you a little bit about how LMS and similar modeling tools work and why they are helpful to forest managers in making decisions about how to manage their forest. You will also gain a better understanding of how forest management impacts ecosystems.

What will you need?
A sample inventory provided by your teacher (included on the course CD), access to a computer, and the LMS program provided as a CD with this course.

What is LMS?
LMS stands for Landscape Management System. LMS is a computer program developed by a team of foresters and computer programmers. It is a decision support tool. This means it is a program that helps manage and analyze information and make decisions. This makes LMS quite flexible, so it can be used by foresters with different objectives (say, one who is focused on making money from timber sales and another who is focused on providing habitat for pileated woodpeckers).

How are you going to do it?
You use an example dataset selected by your teacher. Start Lms-Lite using the desktop icon (Figure 1) or Landscape Management System program group (Figure 2). Select File/Open… and select one of the data sets provided: Mountain, NewEngland, Pacific, or SouthAtlantic.

Figure 1. Lms-Lite desktop icon.

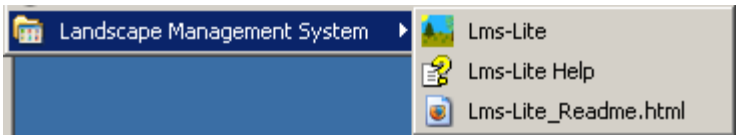


Figure 2. Landscape Management System program group showing Lms-Lite icons.

1. **First, project a stand:**
Once a data set is open you can **right click on a stand and click "Grow…**". A new window will open up that says stand projection. Confirm the stand you want to grow is selected and then hit OK.

2. Now, show a picture of the stand:
On the main window you will see a list of stands and years. **Right click on any stand and year that is white and select "Picture…".** You will get a visual image of what your stand looks like, such as the one below (Figure 1). You can repeat this for any year you are interested in looking at. Close each

image after you are done viewing it and do not adjust any of the options at the top of the image screen as this may affect your ability to continue viewing your stand.

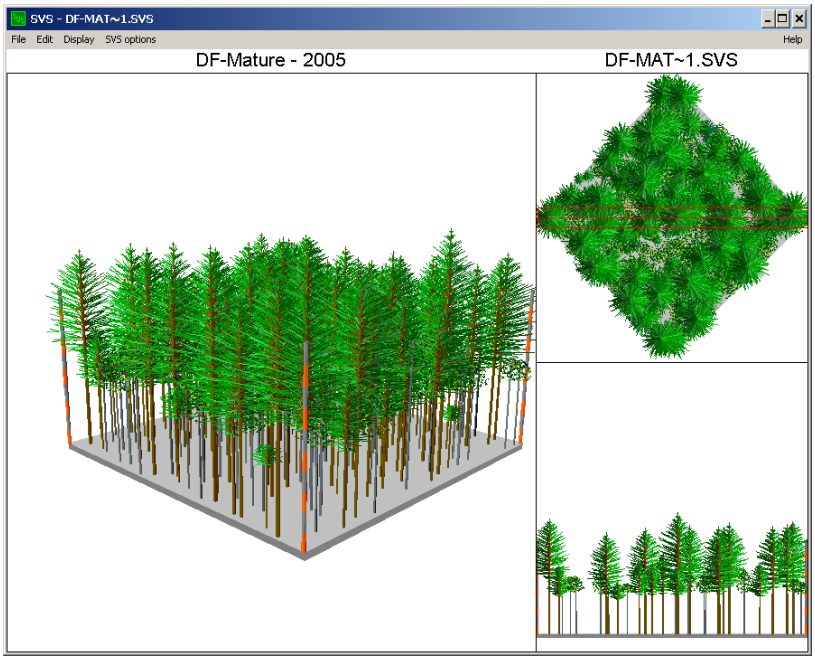


Figure 3. Picture of DF-Mature stand in 2005.

3. Treat the stand:
From the LMS-Lite main window any stand can be treated a number of possible ways. R**ight click on a stand and year, then select Regenerate…, Thin…, or Disturb…** For each of these you will be prompted to select the type and intensity of the management or disturbance. **Click OK when ready.** See the LMS-Lite Users Manual or Using LMS-Lite on the CD for more information.

4. View Tables and Charts about your stand:
For any stand and year you don't only get a picture, you also can get more detailed information about the stand using tables and charts. Right **click on a stand and year**, then select Table… or Chart… to see more information about your stand.

5. Try a different treatment:
If you want to start from scratch and try new treatments on your stand, **click Change Stand/Reset Stands on the window**. This will erase all treatments and let you start again. Follow the directions above to try another treatment.

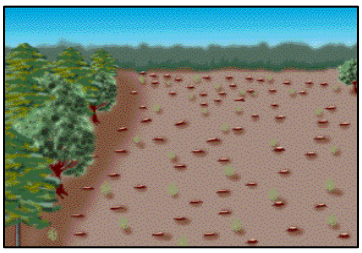
How did your forest change over 50 years? How did your treatments change your forest?

QUESTIONS: LESSON 3

1. Can you match each of the following pictures of a type of silvicultural treatment with its proper name? Draw a line connecting each picture with its proper name. Underneath the name write a brief description of that type of forest treatment

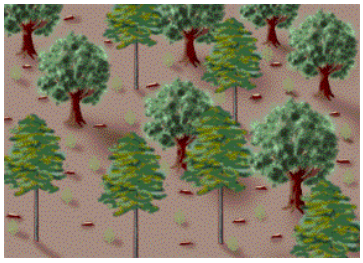
SEED TREE

A Seed Tree Cut is when you cut down most of the trees in a stand but you leave a few of the largest behind to provide the seeds to make new young trees, but not so many as to create much shade. You may later return and cut the remaining seed trees after young trees have sprouted



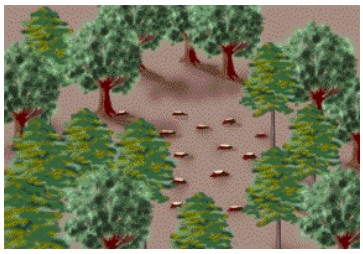
SINGLE TREE SELECTION

In Single Tree Selection you remove scattered trees throughout a forest. This allows species of all ages to survive in a stand. It favors shade tolerant species.



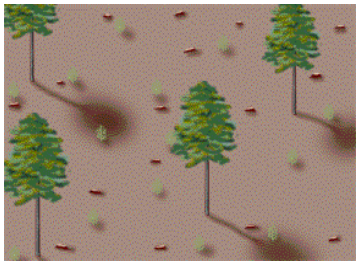
GROUP TREE SELECTION

In Group Tree Selection you remove a small group of trees in a forest stand. Like a single tree selection, this allows trees of all ages to exist in a stand, but it does not favor shade tolerant species as much.



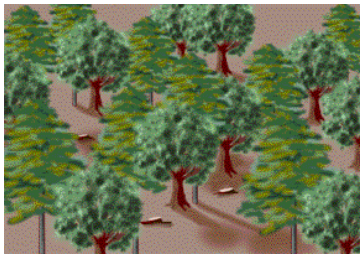
SHELTERWOOD

A shelterwood cut is actually a series of cuts. In the first cut you remove the smaller trees, leaving enough to provide shade. This helps shade-loving species of trees grow. Once these young trees have grown up a bit you come back and cut off the trees you left behind before to give the young trees more light so that they will grow straight and quickly.



CLEARCUT

Clearcutting is when you cut down all the trees in a stand or large area.



The images, from top to bottom depict

- *clearcut*
- *shetlerwood*
- *group tree selection*
- *seed tree cut*
- *single tree selection cut.*

2. What is "silviculture"?
   Silviculture is the science and practice of managing a forest.

3. What is "ecology"?
   Ecology is the study of living organisms and the way they interact with their environment

4. What is a "prescribed burn" and what is its purpose?
   A prescribed burn is a fire set intentionally by foresters; these burns are designed to burn understory vegetation both to prevent wildfires and to maintain fire adapted forest structures such as savannahs.

5. Describe another silvicultural treatment not mentioned above.
   Pruning – removing lower limbs from a tree to keep it growing straight, quickly, and without knots;
   cleaning – removing understory vegetation to keep it from competing with the trees; planting – planting new trees after a cut to help the forest regrow with a good species mixture.

6. What is a forest inventory?
   A forest inventory is a collection of data gathered from a forest, including basic information on the height, species, and volume of all or some of the trees. Inventories are covered in depth in the first part of this chapter, but are critical during the management of the forest.

Younger student adaptation:
The entry of data into a computer program may be a good way for students to learn mastery of keyboarding. However, the computer modeling process will not likely make sense to younger students, as it involves numerous abstractions. Additionally, younger students will not have enough data to create their own inventory. However, if you have a robust enough dataset, enter the data for students to use in the next section.

Chapter 3, Part 2: Exploring LMS 2.x

Time: 2-4 hours
Location: inside
Indoor alternative? Not applicable

Materials needed:

- PC computer with LMS loaded

Objectives:

- Be able to use basic features of LMS
- Understand and apply basic silvicultural practices

National Science Standards:

- Content Standard A: recognize and analyze alternative explanations and predictions; understandings about science and technology

Students can now see how forest stand dynamics development is likely to occur in their forest over the next 50 years. They can also practice "managing" their forest by implementing a variety of silvicultural practices they have learned about in this lesson – including prescribed burns, clearcuts, thinnings, and several other treatments. They can see both the immediate and long-term effects of these management tools. This lesson will make the theoretical understanding of forest management much more practical by showing students how these practices would actually affect a forest that they have seen and inventoried themselves.

You will use one or more versions of LMS depending on which exercises you want to complete for this chapter. Chapter 3 consists of introductions to LMS-Lite (Part 1), LMS 2.x (Part 2), and conducting forest inventory (Part 3) which can be used with LMS 2.x. If you will not doing Part 3, or will only be doing the inventory so that students better understand how to do an inventory then use LMS-Lite for introducing students to the software.

If you plan to do the complete exercise of collecting forest inventory information and want to use the information the students collect, then use LMS 2.x.

Introduction:

Present the PowerPoint for this chapter to students.
Ask students to work through the questions at the end of this chapter before experimenting with LMS.
Give students 30 to 60 minutes to explore LMS, simply to look at the different functions provided, visualize their stands and play a bit.

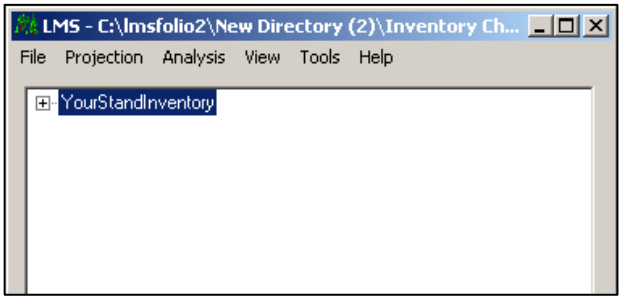
Preparation:

Install LMS on each computer students will be using. The program is on the CD provided.

Chapter 3, Part 2: Exploring LMS 2.x

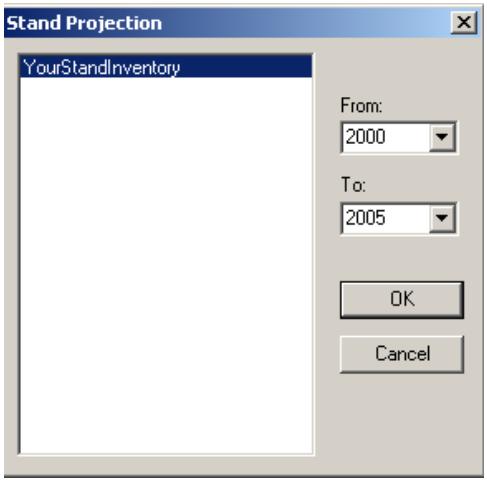
What are you doing?
In this lesson, you will learn how to use Landscape Management Systems (LMS), a computer **decision support tool** that models forest landscapes, to predict the effects of forest management on your landscape. You will be able to see what the forest will probably look like in 50 years. You can then see how this would change if a natural disaster, such as a wildfire, were to hit it. You can also see how it would change if you were to manage it by performing one of the basic cuts on that forest.

Figure 4



Why are you doing this?
This will teach you a little bit about how LMS and similar modeling tools work and why they are helpful to forest managers in making decisions about how to manage their forest. You will also gain a better understanding of how forest management impacts ecosystems.

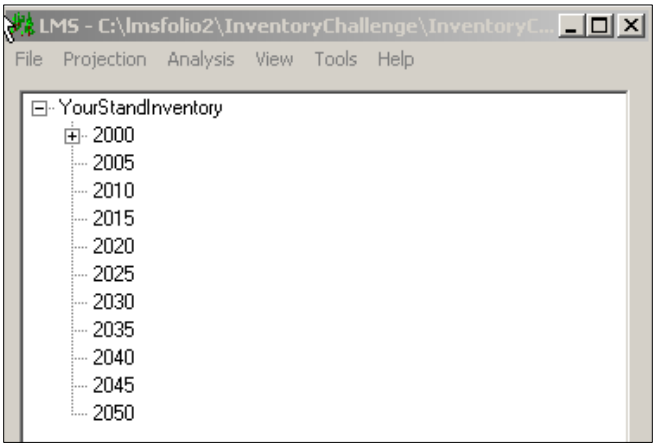
What will you need?
A sample inventory provided by your teacher (included on the course CD) or the inventory data you collected in the field, access to a computer, and the LMS program provided as a CD with this course.



What is LMS?
LMS stands for Landscape Management System. LMS is a computer program developed by a team of foresters and computer programmers. It is a decision support tool. This means it is a program that helps manage and analyze information and make decisions. This makes LMS quite flexible, so it can be used by foresters with different objectives (say, one who is focused on making money from timber sales and another who is focused on providing habitat for pileated woodpeckers).

How are you going to do it?
You will take the inventory data you gathered in the field and enter it into the LMS Portfolio Wizard on the LMS CD, saving it after you are done. In the "Portfolio Wizard" you should first open the Getting Started option. Then select "Growth Model Selection Guide." Select your state. It will tell you what growth model you are using. Write this down. Return to the main menu and click "Enter/ Edit Portfolio Data." You will first need to name your portfolio (anything you like) and select the growth model (this is the information you just wrote down). Hit "Select" and you will get a worksheet where you can enter data. Enter all your data from the field. The only data you *must* enter is the stand acreage, the year you took the inventory, the species of all the trees, and the DBH of all the trees. If you collected more data you can also enter this.

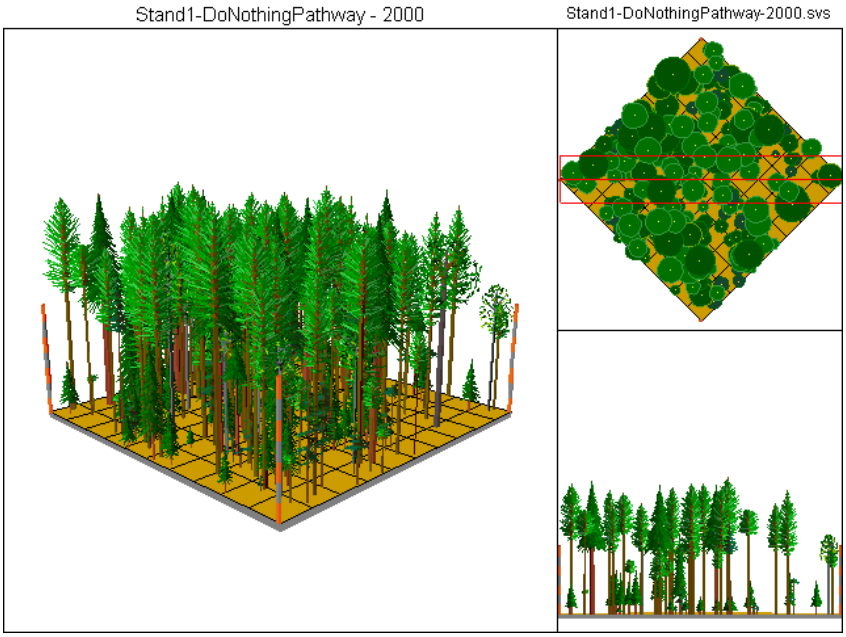
After you have entered all the data you will then open up LMS. Click "Open Portfolio" and open your inventory data. You should see a screen that looks something like the first image on this page.



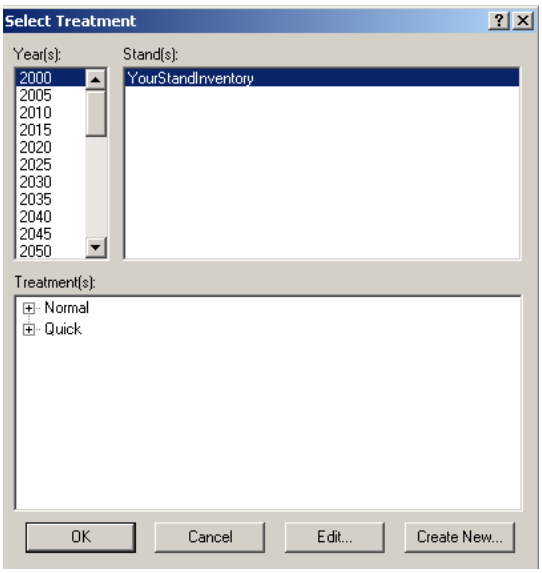
1. First, project the stand:

Right click on the stand and click "Project Stand". A new window will open up that says stand projection. On the Drop Down Menu entitled "To," select 2050 (or 50 years from the first year of the portfolio data) and then hit OK.

2. Now, visualize the stand:
Back on the first screen you will see a plus sign just to the left of the text reading the name of your stand. If you right click on this plus sign you will see a drop down menu of all the years as in this image. You can now **right click on any year and click visualize stand**. This will give you a screen similar to this one. Simply select the year you want to see and select OK. You will get a visual image of what your stand looks like, such as the one below. You can repeat this for any year you are interested in looking at. Close each image after you are done viewing it and do not adjust any of the options at the top of the image screen as this may affect your ability to continue viewing your stand.



3. Treat the stand:
Simply return to the home LMS page and **right click on one of the years listed. Click "Treat Stand."** You will see an image like this one. **Click the plus sign next to Normal and select one of the silvicultural treatments or natural disasters** (such as SHELTERWOOD, WILDFIRE, CLEARCUT). Make sure you have also selected a year. **Then click OK**. If you return to the first LMS page and click the plus sign next to the year you have treated the stand you will see that treatment is listed. Now simply right click on the stand and click visualize stand again. Now you will see how this stand looks after your treatment. If you want to see how the stand looks many years after your treatment, right click on the last year listed and click "Project Stand" as you did previously and project the stand to whatever year you wish (do not project more than 50 years as it will take a long time). You can then visualize any year to which you have projected the stand.



4. Save the results:
Under the dropdown menu, "Projection," select Scenario/Save Log as Scenario. Name your scenario and save it in the folder for your portfolio. Later you can run this scenario (Projection/Scenario/Run, then browse to find the scenario) to review the results of the management pathway.
NOTE: record keeping can be vital to a scientific investigation. It is highly recommended that you keep a list of scenario file names that you can reference, perhaps including a brief description of the treatments in the scenario. Later you will learn how to view graphic results of each scenario. You may wish to save these (usually spreadsheets) and keep track of them as well. It is also

recommended that you save files associated with a given portfolio in the folder for that portfolio within LMSfolio2 on your computer's c drive.

5. Try a different treatment:
If you want to start from scratch and try new treatments on your stand, **click Tools from the main screen and click Flush Entire Cache**. This will erase all treatments and let you start again. Follow the directions above to try another treatment.

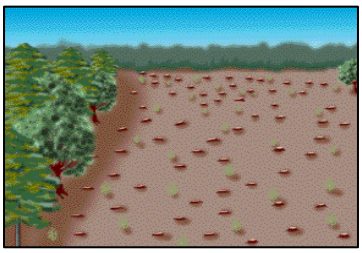
How did your forest change over 50 years? How did your treatments change your forest?

QUESTIONS: LESSON 3

7. Can you match each of the following pictures of a type of silvicultural treatment with its proper name? Draw a line connecting each picture with its proper name. Underneath the name write a brief description of that type of forest treatment

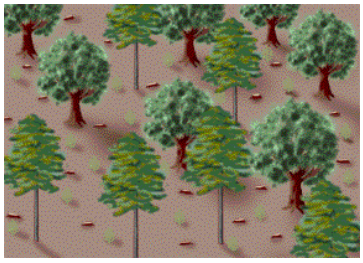
SEED TREE

A Seed Tree Cut is when you cut down most of the trees in a stand but you leave a few of the largest behind to provide the seeds to make new young trees, but not so many as to create much shade. You may later return and cut the remaining seed trees after young trees have sprouted



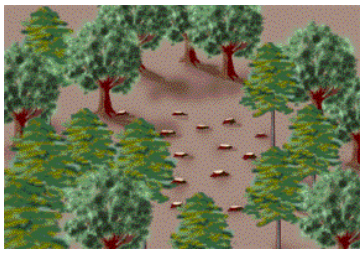
SINGLE TREE SELECTION

In Single Tree Selection you remove scattered trees throughout a forest. This allows species of all ages to survive in a stand. It favors shade tolerant species.



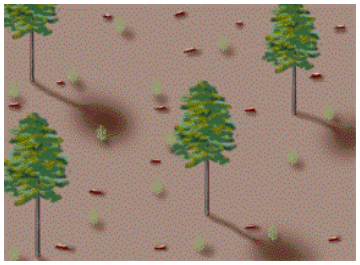
GROUP TREE SELECTION

In Group Tree Selection you remove a small group of trees in a forest stand. Like a single tree selection, this allows trees of all ages to exist in a stand, but it does not favor shade tolerant species as much.



SHELTERWOOD

A shelterwood cut is actually a series of cuts. In the first cut you remove the smaller trees, leaving enough to provide shade. This helps shade-loving species of trees grow. Once these young trees have grown up a bit you come back and cut off the trees you left behind before to give the young trees more light so that they will grow straight and quickly.



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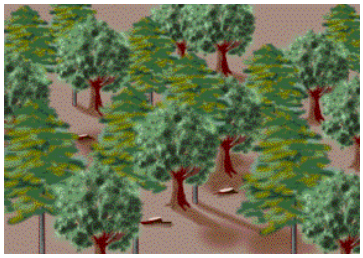

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   Silviculture is the science and practice of managing a forest.

9. What is "ecology"?
   Ecology is the study of living organisms and the way they interact with their environment

10. What is a "prescribed burn" and what is its purpose?
    A prescribed burn is a fire set intentionally by foresters; these burns are designed to burn understory vegetation both to prevent wildfires and to maintain fire adapted forest structures such as savannahs.

11. Describe another silvicultural treatment not mentioned above.
    Pruning – removing lower limbs from a tree to keep it growing straight, quickly, and without knots;
    cleaning – removing understory vegetation to keep it from competing with the trees; planting – planting new trees after a cut to help the forest regrow with a good species mixture.

12. What is a forest inventory?
    A forest inventory is a collection of data gathered from a forest, including basic information on the height, species, and volume of all or some of the trees. Inventories are covered in depth in the first part of this chapter, but are critical during the management of the forest.

Younger student adaptation:
The entry of data into a computer program may be a good way for students to learn mastery of keyboarding. However, the computer modeling process will not likely make sense to younger students, as it involves numerous abstractions. Additionally, younger students will not have enough data to create their own inventory. However, if you have a robust enough dataset, enter the data for students to use in the next section.

Chapter 3, Part 3: Implementing Inventory

Prep Time: 1 hour
Introduction: 20 – 30 minutes
Field: several hours; longer if desired; after practice, students may be as fast as 5 minutes/tree

Location: outside (introduction may be done in classroom)
Indoor Alternative? Not possible; alternate inventories can be used in lieu of this activity's results

Materials needed:
- Tree images/field guide or dichotomous key/leaf samples
- Clinometer (one per group) or biltmore stick
- DBH tape (one per group; if students can calculate diameter of a circle, a regular tape measure may be used)
- Field inventory forms
- Clipboards (one per group)

Materials recommended:
- Pocket knife (to examine under bark for identification)
- Measuring tape

Objectives:
- Be able to use forest measurement tools
- Be able to measure tree height and diameter (DBH)
- Understand and apply basic inventory procedure

National Science Standards:
- Content Standard E: understandings about science and technology (no perfect solution exists)

In this lesson students learn how to conduct a forest inventory by taking measurements in the field. This data could be entered into a computer modeling system (Landscape Management Systems) and converted into an actual model of a forest.

If it is not possible for students to conduct a complete inventory as suggested in this exercise, they can still teach the students the skills that would be used to conduct an inventory on a few practice trees near the school. Then the students can use a sample forest inventory (included with this course on the LMS CD) to do some initial modeling.

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Preparation:

Go to field site and mark trees for students to inventory.

The area to be inventoried does not need to be very large, though having more trees in the inventory will yield more impressive output in any subsequent modeling.

NOTE: in general, it is simplest to select an area that is relatively flat and with trees that are spaced relatively far apart (so there are no visual obstructions from 66 feet away). It is also simplest to inventory trees along a straight line (a transect). Visiting the field site is strongly recommended before you take your class out.

The number of trees students will be able to inventory during a given period of time will depend greatly on student ability, size of trees (bigger trees take longer because students can not reach all the way around them), and the difficulty of the terrain.

Measure any onsite (school) "trees" for the practice portion.

See below for practice instructions.

Prepare inventory forms for the number of sites you have selected.

Sample forms are at the end of this chapter.

Additional forms can be accessed via:

Open LMS Inventory Wizard.

Click on "Getting Started," then on "Field Inventory Forms."

The plot data form can be used with any stand. You will also want to collect information on a Stand Data Form to gather background information about the stand.

Click on "Growth Model Selection Guide" on the "Getting Started" page of the Inventory Wizard to determine which model you should use. The stand data forms are specific to the model you use.

Use a separate data form for each separate subplot. It is recommended that you delineate 2-3 subplots for each plot (plot is synonymous with stand for these purposes).

Introduction:

Present Lesson 3 Power Point to students to introduce the concept of an inventory.

This presentation introduces the concept of a forest inventory to students, including the tools involved, basic math computations, and basic methods for accuracy.

If necessary, construct measuring instruments.

Making the tools can be instructive for students, as well.

Measuring instruments can be purchased through a forestry supply company.

Practice taking inventory measurements

Students can practice measuring height at school using objects other than trees. In fact, it is best to practice measuring things that are of known heights. You may want to have students practice measuring the height to the top of a building, an antenna or tower in the area, or other vertical object. DBH can be practiced on things other than trees as well – for example, if your school has columns on its façade, these could be measured. The object simply need be at least 5 feet tall and columnar in shape.

Inventory forms can be printed out from

Conduct the inventory!

The exercise can be conducted in large or small groups (it is helpful to have at least 3 people in each group). At least one student in each group should be assigned the job of data recorder, while another student works with the clinometer and another with the dbh tape. You may want students to switch roles throughout the exercise so that all students get practice with all parts of the exercise.

Several pieces of equipment will be needed in order to perform this inventory. Some of these tools (such as the clinometer and the Biltmore stick) can be made if they are not readily available (instructions on how to do this are also included with this course). Each group will need a complete set of equipment.

Input inventory data into the LMS Inventory Wizard.

Once entered into the Inventory Wizard, students will have a portfolio that they can use in LMS.

What are you doing?
In this lesson you are going to learn how to use a clinometer and a dbh tape to measure the height and width of trees. You will then use these tools to conduct an inventory of a forest. When you return to school, you will enter this data into a computer-modeling program. The computer will give you a visualization of what your forest looks like now. You can practice applying any of the forest management tools you learned in this lesson and can see how your forest will change over the next 50 years depending on how you treat it.

Why are you doing this?
This will teach you what you need to know to figure out how to manage a forest. You will learn about how trees and forests are described and classified by doing it yourself.

What will you need?
A DBH tape, a long measuring tape OR two pieces of measured twine (one 4.5 feet long and one 66 feet long), a Biltmore stick, a calculator and a clinometer.

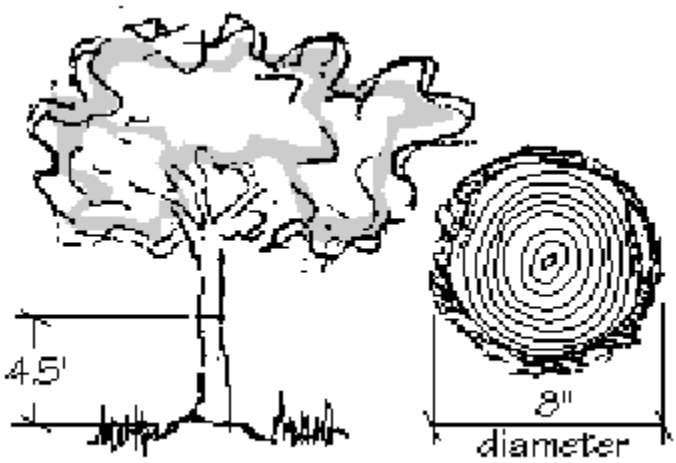
NOTE: DIAGRAMS AND SKETCHES AT RIGHT WILL BE REPLACED – DON'T HAVE SOURCE INFORMATION FOR THESE.

How are you going to do it?
First you need to conduct the inventory. An inventory gives you the basic information about all the trees in a forest. There are four pieces of information you are going to collect for this inventory: for each tree, you'll record the following:

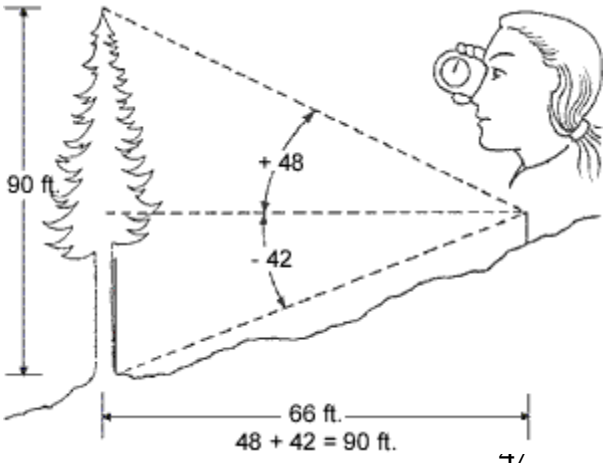
1. the height of the tree,
2. the diameter of the tree at breast height (called DBH), and
3. the species of the tree.

For the forest as a whole, you'll measure

4. the number of trees per acre (TPA).



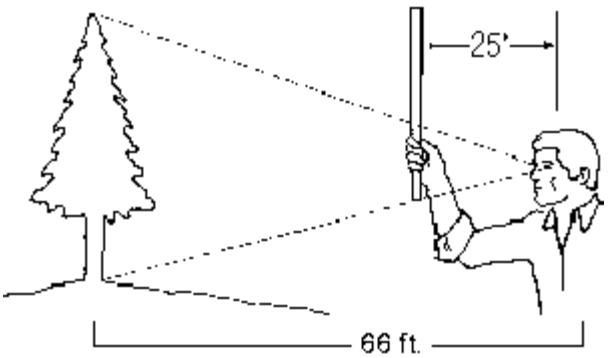
1. Measuring Height
To measure the height of the tree you need to use either a clinometer or a Biltmore stick (whichever your teacher gives you). To use a clinometer you need to walk 66 feet from the tree you are going to measure (measure this with a measuring tape or a 66 ft piece of twine). Looking through your right eye, aim the top of the clinometer at the tree. Then, with your left eye read the number off the topographic scale of your clinometer.
*NOTE: These are general instructions for the most common clinometers; each manufacturer's equipment



is slightly different. Please follow the instructions that accompany the equipment you are using.

If you have a Biltmore stick you will still need to walk 66 feet from the tree (use your measuring tape or twine). Hold the stick straight out 25 inches in front of your face*, facing the tree. Position the stick so that the bottom of the stick lines up in your field of vision with the bottom of the tree. Read the number off the stick where you see the top of the tree reaching.

*This is rather uncomfortable for students less than 5 feet tall (your arms may not reach). If your arms won't reach, ask a fellow student to hold the Biltmore stick for you, at the proper distance from your eyes.



2. Measuring DBH

To measure DBH you first have to measure 4.5 feet up the tree (this is about the level of most early foresters' chests – you may need to measure at your nose level or even higher). Then wrap your tape around the tree at this location. Read the number on the tape where it touches the beginning of the tape. This will give you the diameter of the tree trunk. If the DBH of the tree is less than 2 inches, ignore this tree. Don't record the DBH data, and don't conduct the other measurements. Just go on to the next tree.

Note: A tree's trunk is approximately round, so you can estimate the diameter by using basic geometry. If you don't have a DBH tape, measure around the trunk with a standard tape measure. This is the circumference of the circle. To get the diameter, divide the circumference by 3.14 (called pi, or π, in math). Look at a few trees – they're not perfect circles. So this measurement is not a perfect measure, but a good estimate.

3. Identifying Species

If you completed the tree identification exercises in this workbook, you should be prepared to identify the tree species in your forest. Use the key provided in Chapter 1 to help you as needed. But don't worry too much about getting the species exactly right. Make your best guess and then move on.

4. Determining TPA

The last piece of information you need about your stand is the number of trees per acre. The way to do this is to estimate: figure out the size of the area you have sampled and the number of trees within that space, then construct a ratio to compare that information to one acre.

Divide the number of trees you have, by the size of your sample area (in square feet), and then multiply this number by 43,560 (1 acre has 43,560 square feet). This will give you the number of trees per acre.

Trees counted/area of sample plot = trees in one acre/one acre

Or

Trees counted/(width x length in feet of sample area) = trees in one acre/43,560 ft^2

If you don't know the size of your sample area you can determine the number of trees per acre slightly differently. Take a 10-foot long piece of twine and have one person hold one end in place. Have a second person walk the other end out to its full length. The second person should walk a circle around the first person, holding the end of the twine (the second person will probably have to walk back and forth to avoid trees). You should count all the trees that fall into that circle. Since this circle has a radius of 10 ft it has an area of 314 feet. So, just multiply the number of trees you find in that circle by 138.7 (that is, 43,560 / 314).

Write down the data from your trees on a data sheet. There are sample data sheets available on the course website.

Back in the classroom, enter your data into the LMS Inventory Wizard. This will enable you to examine the stands in LMS.

QUESTIONS: CHAPTER 3, PART I

1. Think about it: why do we measure all trees at 4.5 feet (DBH)? Why not let everyone measure at the height most comfortable for them?

It is important than measurements be consistent. Trees are not perfect columns – they are wider at their bases than most of the trunk, then taper off at the top. The height at which a tree's diameter becomes relatively normal for most of its trunk varies based on the overall height of the tree. Most reach this point before 4.5 feet from the ground. Foresters could have a different height for each species of tree, but this would be hard to remember. The most expensive part of forestry is the labor. If a forester had to look up the proper height for each species, (s)he would be much slower in the field than if (s)he could just use one standard height for all trees. Using a uniform height for all trees also eliminates the potential for errors. Plus, the forester can gauge how high DBH is (most do this by noting how high on his/her body this level is) and doesn't need to get out a tape measure at each tree.

2. Organize your data by making graphs of the following:

a. trees per acre in each subplot
b. total number of trees by species
c. trees in groups of DBH – 5 inch diameter classes (this means all trees with DBH 0 – 5", 5-10", 10 -15", etc.)
d. trees in groups of 10 foot height classes

This can be done in Excel.

Answers will vary based on data. You may also wish to ask students to perform additional analyses.

3. Look at your data. Write a few paragraphs describing the forest based on this information (i.e. where are most of the trees? Do certain areas have bigger or smaller trees?). Why do you think the forest is like this?

Students should examine the relative heights, DBH and densities of the various plots and subplots. They might also note the relative abundance of various species and in which plots they are located.

Younger student adaptation:

Measure the dbh and height of a few trees per student, rather than the entire forest. For comparison purposes, ask students to measure each other (dbh can be done by measuring around the student with his/her arms at her sides) at their shoulders. Height of students will not work well with a Biltmore stick because of their small stature. To compare student height to the height of some trees, try one of the following:

When one student backs 66' from the base of the tree to measure its height, ask other students to lay down in a straight line, head-to-toe, between the measurer and the tree. How many students long is 66 feet?

Measure a tree, then mark the equivalent distance on the ground. Ask students to lay down head-to-toe along the distance. How many students tall is the tree?

Younger students will most likely not conduct a full-fledged inventory of the forest. However, they can work in groups to create qualitative descriptions of an area of the forest or a stand. Some suggested questions include:

- Is there a full or partial canopy? (does much sunlight reach the forest floor?)

- Are the trees in this area taller than others you've seen throughout the forest, the same size, or shorter? In height, or around their diameter (dbh), or both?
- Describe the ground – is it flat or hilly? Are there lots of leaves and twigs, or can you see the dirt? Is it easy or hard to walk around this area?
- Are there many plants or baby trees (seedlings) on the forest floor?
- Are the trees far apart from each other? How far?

Sample Plot Data Form

Plot Data Form for use with all growth models

Stand: _____ Plot Number: _____(see note below)

Plot Type: (circle one)
Main Plot
Subplot Type 1
Subplot Type 2
Subplot Type 3
Subplot Type 4

Sampling Type:
Variable: Basal Area Factor (BAF) = _____ (a more complex model; measures smaller trees closer to a fixed point and larger trees in a wider area)
Fixed: Plot size = _____ acres (all trees inside a set plot, usually a rectangle)
Transect: Length = _____ feet (this is recommended for students)

Species	**DBH** (nearest 1/10")	**Status** (live, snag, downed log)	**Count**	**Height/ Length** (ft)	**% Live Crown**	**Decay class 1-5** (snags/downed)	**Age**

Note: When numbering plots, use a decimal system to discriminate between plot types. For example,
your first main plot would be numbered 1.0. If additional subplots are nested at that same location, they
would be numbered 1.1, 1.2, 1.3, and 1.4 depending on the number of nested subplot types.

Sample Stand Form

Stand Data Form for use with the Western Sierra Nevada Variant of the FVS Growth Model (FVS, WS)

Required Data

Stand Name:_____ Inventory Year: _____
Stand Acreage: _____ (to the nearest 1/10th acre)

Recommended Data

Location: _____ Stand Site Index: _____
(your nearest national forest—see attached list) (Dunning's site class (0-5) or 50-year index)
Elevation (feet): _____ Mean Slope (percent): _____

Optional Data

Stand Age: ___ Mean Aspect (0-360º): _____ Latitud e (nearest degree): _____
Additional Site Index(es):
(see attached list for recognized species)

_____
_____
_____

Chapter 4: Putting It All to Work

Time: *10 minutes intro; 45 minutes to one hour per scenario*
Preparation: Familiarize yourself with LMS and its functions; practice a scenario (2 – 3 hours)
Introduction: familiarize students with LMS and its basic functions (approximately 1 hour)
Activity: approximately 2-3 hours, best done in several shorter episodes.

Location: indoors

Materials needed:
- Computers (1 per group)
- LMS (on CD provided)

Recommended:
- *data from inventory*

Objective:
- Understand what a model is
- Compare models to determine the most appropriate management pathway

National Science Education Standards:

This lesson teaches students how to use a modeling tool to achieve specific goals on a particular piece of land. While the students may work alone, or in one large group, this lesson is ideally designed for students working in small groups. Each student or group of students will be given a "scenario" as a land manager. The students will need to read their scenario and brainstorm about possible management strategies to meet the goals of their landowner. They will need to look at the initial inventories of their stands in order to make these decisions, and may also need to draw on some of the supplementary material available. They will then use the "Applied LMS" tool to test out their management strategies on their piece of land. This tool will allow them to visually and graphically see the effect of their management strategies. They will need to draw their own conclusions about the effectiveness of these strategies and may need to try again if they are to obtain successful results.

Depending on the age and capabilities of the students, you may wish to have each group give a short presentation of what they did, why they did it, what the results were, and an evaluation of how closely results met the landowners' needs. Each scenario ends with a list of questions to facilitate the students' analysis of their modeling work. The first scenario is the easiest and the scenarios become progressively more difficult.

Preparation:

Review scenarios that students will be modeling.

The various scenarios utilize data in the portfolios provided on the course CD/WEBSITE? The portfolios students created through their inventory most likely do not contain as much data as these sets, which encompass an entire forest, so are not as useful for testing various management pathways.

Assign scenarios to students or groups. Working in groups can be

helpful so students can share ideas among the group.

Select questions for students to complete.

The scenarios are followed by detailed sets of questions that can guide students through the analysis of the forest to develop a management strategy. You might wish to give students only a select set of these questions to encourage them to use their decision making skills.

Introduction:

Present Lesson 4 Power Point to students to introduce the concept of an inventory.

This presentation introduces the concepts of using LMS for the development of a management scheme and guides them through the process of decision making.

Orient students to use of LMS.

WILL INSERT BASIC INSTRUCTIONS WHEN FINAL VERSION OF LMS TO USE IS READY.

Let students experiment!

Encourage students to try a wide variety of silvicultural pathways and to be creative in their management ideas.

What are you doing?
In this lesson you are going to be put in charge of a piece of land where the landowners have a specific goal for their forest. Using what you read about the land and the landowners' goals, what you have learned about forests and forest management, and the information provided about the forest you are managing, you are going to decide how to manage this forest.

Why are you doing it?
As you know, forests can provide different environmental services. Environmental services are services that the natural world provides humans - such as forests providing places for wildlife to live, or protection for water. One of the primary reasons to manage forests is to be able to provide these different environmental services as well as other values such as money and wood. You are using LMS to help you crunch some numbers that would be very time-consuming to do by hand.

How are you going to do it?
You will use LMS to create models of how the forest will look in many years if managed a certain way (pathway). You will examine the results of each model (different management pathway) to determine whether it achieves the landowners' goal for their forest. Once you have examined several different models, you will determine which is the best for the landowners to use on their property.

First, you will look at the inventory sheets you have been provided with to understand what your forest is like. You should brainstorm with your group about what you need to do and how you should do it. When you open up LMS, you will open your "PORTFOLIO" and you will see a list of all the stands in your forest and if you click on a stand all the different pathways you could choose for each stand. If you right click on a particular stand/pathway combination you will see exactly what that pathway would include. Click on the year that you are interested in and you will see a visualization of that stand. You can also look at some data and graphs to understand better what is happening to the forest. When you are looking at a visualization, simply click graphs and this will give you information as a graphical image of how the stand has changed over the years.

For each stand you will pick a pathway. Look at the visual and graphical images for the pathway you are interested in. Check out the consequences table after you have inspected the visual and graphical information. Try to understand exactly what happened and how your treatments changed the forest. Think about what pathway is best for each stand. You should try several times, with different combinations of pathways, to see which scenario yields the best results. For each stand you will need to pick one pathway that you think best meets the needs of your landowner. Answer the questions at the end of this lesson.

Some basic LMS commands

If you want to:	do this:
See the stand visually	right click on stand year, then select "visualize stand"
See graphs about the stand	right click on stand and year, then select "Tables"
Project stand into future	right click on stand and year, then select "Project Stand." Use the drop down bars to select the years for the projection.
Treat stand	right click on stand and year, then select "Quick Treatment" or "Treat stand". Select the desired treatment.

Remember: LMS can not really see into the future. Using assumptions based on many years of many observations by many students and scientists, LMS was created to predict what you could reasonably expect to see if you used the pathways you entered into the model. It's not 100% perfect. Models like LMS that try to predict results (outcomes) are tested by predicting and then comparing the model's scenario against what really happens. So keep an eye on your forest after you implement the management plan!

Extension: Group discussion or essay question - what could happen to make reality different than the prediction from LMS?

The data for each scenario is available on the COURSE CD.

SCENARIO 1: SOUTHERN PINES and WOODPECKER PARADISE

You have just been hired to manage the Great Pines forest in North Carolina. The forest is owned by the "Feathered Friends Conservation Crew" and they want you to help them get more of the threatened red cockaded woodpecker in their forest. The bird is a native resident to southern pine forests and there used to be a large numbers of these birds in the Great Pines forest, but in the last 20 years the bird has almost disappeared.

To help you out the "Feathered Friends" group has told you a bit about what they know about the red cockaded woodpeckers. These birds like savannah type forest structures. They need to lay their eggs in holes they peck out of trees. They will only nest in old, large trees with diameters of over 10 inches and ages over 60 years. They make their nests 30 to 50 feet up on the tree, and prefer to have their nests in living long leaf pine trees. The nests take a long time to build, but the birds will use them again and again, year after year. They don't like to have "hardwood" trees – such as oaks, maples, and ashes – in their forest.

As you do a little research about the forest you find that conditions have changed substantially in the last 20 years. A golf course and a number of private homes were built surrounding the Great Pine forest about 25 years ago. After all these homes were constructed, the fire department felt that they needed to stop all the fires in the area. They simply couldn't afford to risk letting a wildfire run rampant and burn down people's homes. Since the forest used to burn very frequently this is a big change for the forest!

Look at your forest inventory. What kinds of trees are in the forest now? What do you think the woodpecker likes about the forest as it is now? What do you need to change to get the forest to be a good home for woodpeckers? How can you manage the forest to get it that way? How are you going to keep it that way?

Look at the potential pathways to manage the forest and pick the best one. Then, run this scenario in LMS and see what happens. How is your forest changing over the next 5 years? Over the next 20 and 50 years? Do you have more woodpeckers? What type of structure is your forest in?

EXTENSION: are the management pathways that are best for the woodpeckers good strategies for this sort of area (Remember that the fire department stopped doing controlled burns)? Would you want this sort of management strategy implemented in your neighborhood?

What happened to the other animals? If "Feathered Friends" tells you that they like all types of feathered animals, not just woodpeckers, what are you going to do? How does this change your management decisions? What sort of research would you need to do before determining a new management pathway?

Some guiding questions:

1. Who is the decision maker?
2. What are the major objective(s) for this piece of land? (okay to be general here)
3. Now turn one of your goals into measurable criteria.
    a. What information do you need to make this decision?
    b. Which charts, tables or graphs from LMS will give you this information?
    c. Mark the places on the charts, tables and graphs that meet your objectives.
4. Choose 3 alternative pathways to try in the forest to meet the goal from question 3.
5. Analyze the pathways' effects on the forest.
    a. Examine the charts, tables and graphs (chosen in 3b) to see how each pathway changes the forest.
    b. Compare the results of each pathway to your objectives.
    c. Which pathway gets you closest?
6. Do you think one pathway would meet all of your objectives? Or any objectives other than the one you chose in question 3?

Table	Information Given
Economatics	Cash Flow, Revenue
Inventory	TPA, DBH, Height, height crown ratio, etc.
Carbon Sequestration	Amount of carbon stored in trees, dead trees, snags, logs, soil, litterfall, stems and crown; also amount carbon saved versus using other materials
Species Mix	TPA and basal area by species
Summary	TPA, basal area, Reineke stand diversity index, average height,

SCENARIO 2: HAPPY HUNTING in TENNESSEE

The "Happy Hunters" hunting group has just purchased a large forest in the Smokey Mountains of Tennessee and has decided to hire YOU to manage their forest. This group really likes to hunt, and is interested in hunting many different species including bobwhite quail, deer, and wild turkeys. The only problem is that the hunting in their forest right now isn't so hot and they don't know why. It is a beautiful old forest, with lots of big trees.

Here is a little bit about what they know about the different animals they are interested in:

- Bobwhite quail need both open fields and young forests (they would prefer to have an average 'basal area' of trees of between 40 and 60 feet per acre). They won't venture out into large open areas because it puts these large birds at too much risk of being attacked upon by coyotes or other predators. But they also can't find the seeds they need to eat in closed forests. So they like to have access to both young forests for cover and open fields to find their food.
- White-tailed deer have two different needs as well. They need a lot of cover to protect them from the heat in the summer, the cold in the winter, and the hunters in the fall. Because they need cover in the winter, they do better if the trees that provide them cover don't lose their

leaves – like pine or hemlock. The cover also works better if it is dense and not too high – so dense forests tend to serve their needs better. Deer can eat a wide variety of foods, but not evergreen needles – so the same trees that make good cover for them, don't make good food. They like grasses and lichens, and young 'hardwood' trees (such as oaks, maples, and ashes).

- Like bobwhite quail, wild turkeys also like small open areas for feeding. It also helps if there are a lot of oak trees around to provide the acorns they like to eat. They also like to spend a lot of their time in large open pine plantations.

Wow. With so many different animals to manage for, it's probably too complicated to try and manage for each separate species. A better strategy may be to think carefully about which types of habitats you need, and how much of those habitats you need. How are you going to manage for that mix of habitats? How are you going to keep it that way?

Look at your forest inventory. What kinds of trees are in the forest now? What sort of structures exist now? What can you do to create homes for all these animals? How are you going to make sure that you always have enough homes for these animals?

Look at the potential pathways to manage the forest and pick the best one. Then, run this scenario in LMS and see what happens. How is your forest changing over the next 5 years? Over the next 20 and 50 years? What type of structure is your forest in? How is it changing? Why do you think you will have more animals for the "Happy Hunters"?

Some guiding questions:

7. Who is the decision maker?
8. What are the major objective(s) for this piece of land? (okay to be general here)
9. Now turn one of your goals into measurable criteria.
    a. What information do you need to make this decision?
    b. Which charts, tables or graphs from LMS will give you this information?
    c. Mark the places on the charts, tables and graphs that meet your objectives.
10. Choose 3 alternative pathways to try in the forest to meet the goal from question 3.
11. Analyze the pathways' effects on the forest.
    a. Examine the charts, tables and graphs (chosen in 3b) to see how each pathway changes the forest.
    b. Compare the results of each pathway to your objectives.
    c. Which pathway gets you closest?
12. Do you think one pathway would meet all of your objectives? Or any objectives other than the one you chose in question 3?

SCENARIO 3: MONEY MATTERS at the SCHOOL FOREST

Your school wants to start a great new sports program but it's going to cost some serious money. First they need to buy an athletic field and athletic equipment. That's going to cost a lot of money for just the first five years of the program. They also want to hire two new teachers to coach all the new teams, so they will need an ongoing steady supply of income for the future. Finally, they expect that equipment will need replacing or modifying every 15 years – so they need a little extra money to cover those costs.

Unfortunately the school is on a very tight budget. However, they did receive a forest as a gift from the family of one very happy student. Now the school is hiring YOU to manage that forest to make them all the money they need to start the new sports program.

Look at your forest inventory. What kinds of trees are in the forest now? What can you do to get some money immediately? What will the forest be like after that treatment? How can you manage the forest to get all the money you need for the 50 years?

Look at the potential pathways to manage the forest and pick the best one to meet your financial goals. Then, run this scenario in LMS and see what happens. How is your forest changing over the next 5 years? Over the next 20 and 50 years? Have you made enough money to cover the initial costs? Is your forest still in good enough shape to keep providing the income you need in the future?

Some guiding questions:

13. Who is the decision maker?
14. What are the major objective(s) for this piece of land? (okay to be general here)
15. Now turn one of your goals into measurable criteria.
    a. What information do you need to make this decision?
    b. Which charts, tables or graphs from LMS will give you this information?
    c. Mark the places on the charts, tables and graphs that meet your objectives.
16. Choose 3 alternative pathways to try in the forest to meet the goal from question 3.
17. Analyze the pathways' effects on the forest.
    a. Examine the charts, tables and graphs (chosen in 3b) to see how each pathway changes the forest.
    b. Compare the results of each pathway to your objectives.
    c. Which pathway gets you closest?
18. Do you think one pathway would meet all of your objectives? Or any objectives other than the one you chose in question 3?

SCENARIO 4: WATER, WIND and FIRE!

In the city of "Wet-N-Windy" Florida, the local water company owns a large forest around the lake that the city's water comes from. The forest has a very important role in keeping their water clean, clear and constant. When it rains the forest absorbs a lot of the water and keep the lake from getting too full, overflowing, and losing water. The water is released slowly so that the water does eventually make it to the lake. The slower release of water also means that the water doesn't carry a lot of mud into the stream making it dirty. The trees also pull many of the dirty chemicals out of the water so it doesn't reach the city's water supply.

The water company wants to be very careful that nothing happens to their forest. If they didn't have all those trees around that lake they would have to install an EXTREMELY expensive mechanical water cleaning system to get the water as clean as the trees get it. So they are hiring YOU to manage their forest to keep their forests and their water safe. They also want you to make some money from the forest by cutting it and harvesting the timber; but their first concern is the water!

Wet-N-Windy Florida is, maybe not surprisingly, often very wet and windy. At the end of the summer, hurricanes often hit this area of Florida and can cause very heavy winds and rain. The water company wants to make sure their forest is not at high risk of getting blown over in a windstorm. Forests that are at high risk of being blown down are very dense forest, with lots of young thin trees. Forests that have been thinned too heavily (leaving a few trees exposed to all the wind) and forests right next to clearcuts are especially at risk of blow down. The water company also wants to slow the water from running into the lake as much as possible, so that the lake doesn't overflow and so that the water doesn't bring in lots of dirt and make the water mucky. The important thing here is just to make sure all the land is forested!

Finally the water company wants to protect the forest from fire. Very dense forests and forests with lots of dead trees are at risk of fires. A big fire would be just as bad for the water company as a big blow down.

Look at your forest inventory. What kinds of trees are in the forest now? Is your forest at high risk from wind or fire? What can you do to reduce that risk? How can you manage the forest to keep the water clean, protect from wind and fire, and make the water company some money from timber on the side?

Look at the potential pathways to manage the forest and pick the best one to meet your goals for forest health and money. Then run this scenario in LMS and see what happens. How is your forest changing over the next 5 years? Over the next 20 and 50 years? Is your forest pretty safe from wind and fire? What type of structures do you have in your forest? Did you make some money, too?

Some guiding questions:

19. Who is the decision maker?
20. What are the major objective(s) for this piece of land? (okay to be general here)
21. Now turn one of your goals into measurable criteria.
    a. What information do you need to make this decision?
    b. Which charts, tables or graphs from LMS will give you this information?
    c. Mark the places on the charts, tables and graphs that meet your objectives.
22. Choose 3 alternative pathways to try in the forest to meet the goal from question 3.
23. Analyze the pathways' effects on the forest.
    a. Examine the charts, tables and graphs (chosen in 3b) to see how each pathway changes the forest.

b. Compare the results of each pathway to your objectives.
c. Which pathway gets you closest?

24. Do you think one pathway would meet all of your objectives? Or any objectives other than the one you chose in question 3?

SCENARIO 5: Personal Portfolio Pathways

For this scenario, you will use the portfolio that your class created through your inventory exercises.

First, do some research into local issues related to forestry:

- What are the primary markets for timber?
- Are any endangered species known to live in the region? In what sort of habitat?
- What values do people want from your local forests? (examples are recreation, timber, carbon sequestration, habitat for wildlife, water filtration)

Once you have conducted research, create your own "client" – write a description of a landowner you might find in your region. Be sure to specify their goals for management of their land.
Given the goals of your client, develop a management pathway, testing multiple scenarios before choosing the best one. Will this plan satisfy the client over the next 5 years? The next 20 and 50 years?

QUESTIONS: LESSON 4

1. What type of forest structures were in your forest when you got it?
   ANSWERS TO ALL QUESTIONS WILL VARY BASED ON WHICH PORTFOLIO STUDENTS USE.

2. What kind of forest structures did you need in your forest for your landowner?

Savannah for the woodpeckers. Owls needed dense forests.

3. What types of treatments did you implement to change your starting forest structures into the forest structures you wanted?

Thin & Burn is generally the most effective offered to create savannahs

4. How did you succeed or fail in meeting your goals and why?