CONCEPTS

1. Sustainable harvesting is a logging method used by foresters to ensure a continuous and constant supply of lumber throughout time.
2. The type of management used on a forested land depends on the goals of the landowner, the investors, the local community, and the public.
3. Forest resources can be managed for multiple uses.
4. Conflicts may arise when managing a forest for multiple uses.
5. Compromise and cooperation are important when management plans encounter conflict.

OBJECTIVES

Students will be able to:
1. Identify and compare the uses of clearcutting, shelterwood cutting, and selection cutting in forest management.
2. Define sustainable harvest.
3. Use the dot-grid method to calculate the areas of different forest types on a map.
4. Design a forest management plan using management guidelines to meet objectives.
5. Compromise with other students to create a management plan.
6. Describe several sources of conflict in forest management.

TEACHING SITE

Indoor classroom with large desk/table space.

MATERIALS

Day 1 - Forest Area - calculators, rulers, transparent dot grids for students, **Forest Area Worksheets** for students. Harvesting Methods – all 5 **Harvesting Methods Overheads**. Sustainable Harvest – **Sustainable Harvest Worksheet 1 and 2** as worksheets for students and as overhead transparencies.
Day 2 - Forest Management Simulation – calculators, rulers, red/green/blue/brown colored pencils, transparent dot grid handouts, **Shady River State Forest Map handout, Worksheets 1-2** as handouts and teacher copy for reference, **Management Objectives for wildlife and recreation and forestry** as handouts, **Best Management Practices and Rules for Map Drawing** as handout.
Day 3 - Decision and Discussion – calculators, **Worksheet 3, Who owns Wisconsin's Forests Pie Chart** as an overhead transparency.

Lesson Time

3 50-minute class periods

NUTSHELL

In this lesson students will learn forest management concepts and practices and use these techniques to create forest management plans that satisfy certain objectives. While creating the management plan the students will see how conflict can arise when trying to meet differing management goals. The completion of these management plans, along with a guided discussion, will introduce the concepts of multiple-use management and sustainable forestry.

TEACHER PREPARATION

Read background information before each day of class and prepare materials. Familiarize yourself with the worksheets and overheads. It may be helpful to use the dot grid, work through the worksheets, and answer all of the questions that appear in the activities before beginning the lesson.

VOCABULARY

✏ **Acre** – the most common unit of measurement used by foresters in Wisconsin. A football field is about 1.2 acres in size.

✏ **Cutting rate** – the rate of timber harvesting that produces a sustainable harvest.

✏ **Cutting (Harvesting) method** – timber harvesting method used to encourage the re-growth of specific trees (clearcutting, shelterwood cutting, and selection cutting).

✏ **Dot grid** – a grid composed of squares and dots that foresters use to measure area on a map.

✏ **Ecosystem management** – use of ecological concepts to predict the effects of management actions on the ecosystem and to guide management planning and actions over large areas of land and through long periods of time.

✏ **Multiple-use management** – the practice of managing forest resources for a variety of benefits including water quality, timber yield, wildlife habitat, recreation, and wilderness.

🍂 **Sustainable harvest** – forest management practices that ensure the constant and continuous production of forest resources through time.

🍂 **Sustainable forestry** - the practice of managing forest ecosystems to provide ecological, economic, and cultural benefits for present and future generations

See previous lesson for additional terms used in this activity.

BACKGROUND INFORMATION

Sustainable Harvesting
Sustainable harvest is a method of cutting and planting trees which forest managers use to maintain continuous and lasting timber production. Sustainable harvesting also distributes a forester's work, time, and expenses evenly. It may be best to visualize sustainable harvest by example.

Assume that you are harvesting red pine and that red pine must be 60 years of age before it is big enough to harvest. Also assume that you have 120 acres of red pine and all of the red pine that you have is 60 years of age. What is your harvest plan? If you cut all 120 acres right away then you will have to wait 60 years to cut again. You would overwork yourself and your employees and then have an extended 60 year vacation. If you plan on managing the land in perpetuity it would make more sense to evenly distribute the cutting.

If you take the total amount of acres you have and divide it by the number of years that it takes the trees to mature you will come up with the **cutting rate** (120 acres / 60 years = 2 acres per year).

Now visualize the result. If you begin cutting 2 acres per year and planting directly afterwards, by the time you reach the end, the first acres that you cut will once again be 60 years old. You can then continue to harvest. This trend will continue indefinitely,

assuming that the land will continue to produce mature red pine trees in 60 years. The final outcome can be visualized as a continuous cycle of harvesting and planting.
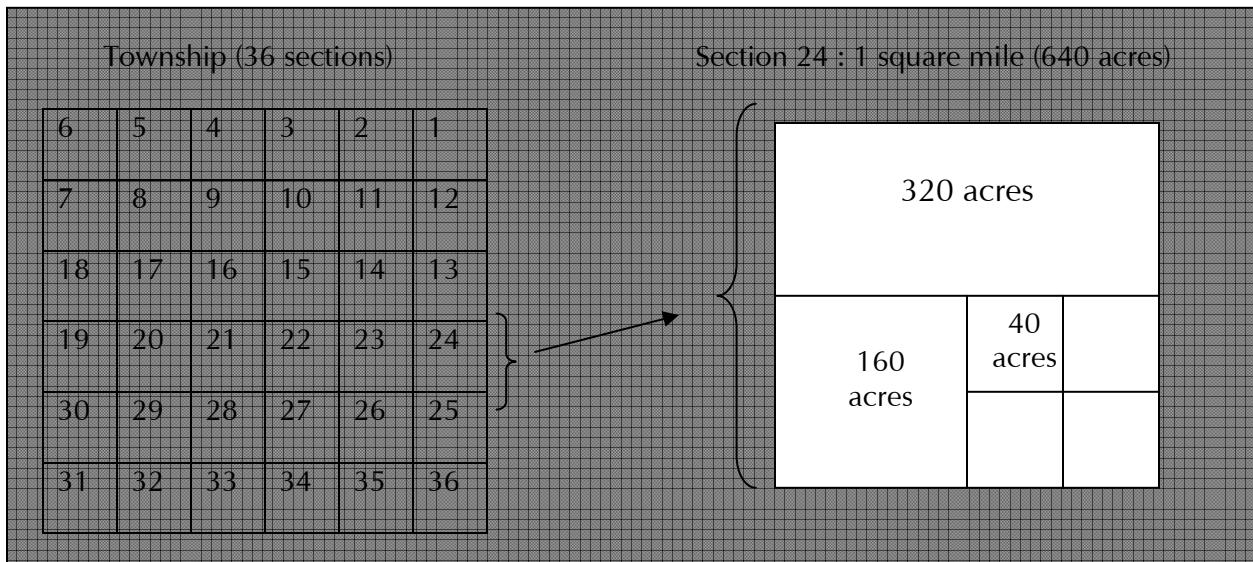
It is important to note though that real forest management is unlikely to ever be this mathematically perfect. Most likely the trees will differ in growth rates throughout a forest and the ages of trees will not be evenly distributed. Disturbances such as insect infestations and wildfires, along with invasive plants, soil erosion, acid rain, and many other factors, continuously disrupt natural forest systems. These disruptions also affect the amount of timber and rates of growth throughout a forest.

Forest Area
Acres are the most common unit of land area used by foresters when mapping forested land in the Wisconsin. One acre is equal to 43,560 square feet. Why such a strange number? When land was first mapped in the United States during our westward expansion, a grid method was used that divided land into townships. These townships were made up of 36 sections. Each section was 1 square mile. The sections (square miles) were then further divided. One square mile equals 640 acres, thus half of a section would be 320 acres. One half of a half section would be 160 acres and so on. As more people acquired land, the land was divided into smaller and smaller parcels.
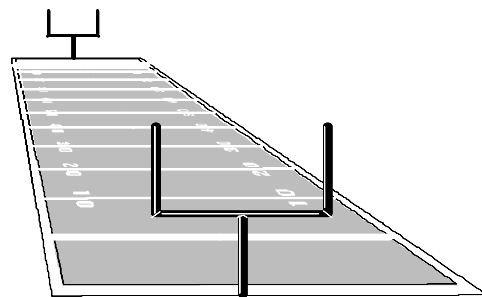
Today it is common for an individual to own a quarter of a quarter section which is 40 acres. The term "the back 40" refers to this system of land distribution. For comparison, **a standard outdoor football field is about 1.2 acres.**

Township (36 sections) | **Section 24 : 1 square mile (640 acres)**

| 6 | 5 | 4 | 3 | 2 | 1 |
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

320 acres

160 acres | 40 acres

When resource managers need to measure land area on maps, it is common to use a dot grid to do so. The dot grid is a relatively quick and easy way to get estimations of land areas. Many types of dot grids are used, each having its own specific scale. The dot grid that we will be using has a scale of 1 dot = 40 acres.

To use the dot grid place the transparent grid over the top of the map. Line up the grid so that the solid lines run vertically and horizontally. Count all of the dots that are inside of the land area in question. Some dots may be right on the line. If this is so, count every other one as in. Take the total number of dots and multiply it by the number of acres the dot represents (40). The answer is the number of acres of land.

For example: The map below on the left represents the forested area in question. If you needed to find the forested area occupied by red pine trees, you would 1) lay the grid over the picture as shown in the picture below on the right 2) count the number of dots inside of the area marked as red pine (if they are on the line count every other one), and 3) multiply the number of dots times 40. Your answer will be the acreage of red pine in the forested area.

(111 dots) x (40 acres per dot) = 4440 acres of red pine
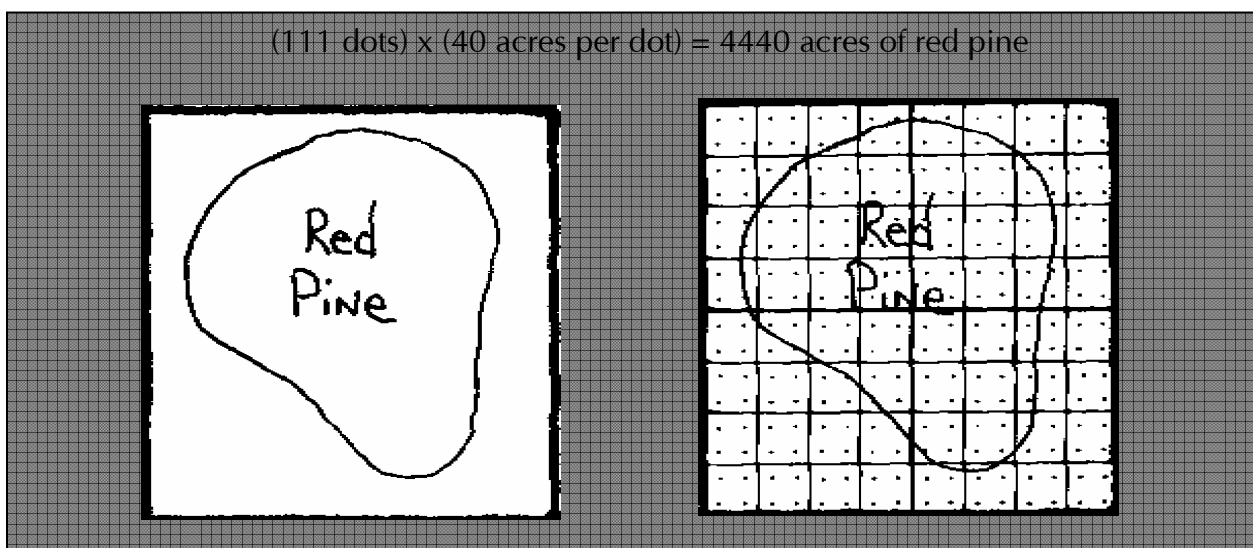
Forest Management

Managing forested areas requires foresight, planning, and the involvement of many people who represent various goals and interests. It is necessary to seek the input of more professionals than just foresters. Wildlife biologists, soil scientists, hydrologists, recreation specialists, and many other professionals work with foresters to create management plans. The local community's needs and public opinion must also be kept in mind as they may be the landowners, users, or funding sources. Their combined efforts in creating a management plan is crucial to quality forest management.

The purpose of a management plan is to identify the goals and objectives of the landowner, determine how these goals will be achieved, achieve the goals in accordance with the best management strategies available, and monitor the effectiveness of the management plan. The management goals and objectives are determined by the landowner's values. When the landowner is a public agency, such as state government, the values considered are those of the community as interpreted by government officials. There are two major forest management theories that dictate current and future forestry practices: sustainable forestry and ecosystem management.

Sustainable forestry involves the sustainable production of timber (as discussed earlier) along with the continuous production of many other benefits from a forest. According to Wisconsin State Legislature, sustainable forestry is "the practice of managing constantly changing forest ecosystems to provide ecological, economic, social, and cultural benefits for present and future generations."

Ecosystem management is a new concept in forestry and its applied definition remains broad and unspecified. Ecosystem management encourages foresters to move away from thinking of forests as just tree components and towards treating them as integrated and complex systems of water, air, soil, plant, and animal interactions. Much data and understanding is still required to properly manage ecosystems, but the understanding that many ecosystem characteristics are related is well established. For example, Mike Dombeck, the chief of the U.S. Forest Service, strongly emphasizes the importance of healthy forests and good forest management as a key in maintaining healthy watersheds. Healthy watersheds provide us with clean water, wildlife habitat, land security, and many other benefits.

The development of management plans that use ecosystem management principles is very difficult and requires the coordination of many different citizen and state groups. According to the Wisconsin DNR, the understanding of scientific facts together with open-minded discussion among citizens with differing perspectives will be required to develop policies that consider ecological principles, economics and human values.

ACTIVITIES OVERVIEW

Students will participate in a simulation activity which will demonstrate the complexities of forest management. On day one, the entire class (the new group of employees for the DNR Forestry Division) will participate in a DNR training session. In this session, the students will learn how to use a dot grid to measure land area from a map, the methods of tree harvesting, and the science of sustainable harvest.

On day 2, the class will be divided into groups of 2-4 students. Each group will receive the forest cover map of the Shady River State Forest and be introduced to the maps details and the history of the land. They will use this map along with a data table to determine the value of standing timber within the state forest. The students will then be given the compiled list of management objectives (forestry, parks and recreation, and wildlife) and a list of Best Management Practices

that they must follow. Students will work within their group to form a management plan that meets or exceeds their objectives and the Best Management Practices assigned to them. After the maps are completed, students will determine how much money they make each year from forestry in the State Forest and how much standing timber is available to be harvested.

On the third and final day, the groups will present the maps to the rest of the class. These final maps will be overviewed by the teacher (State Forester) and the class (DNR staff) in order to determine if the Best Management Practices and objectives were met. The final maps will then be voted on by the class to select the best management plan. Students will then be introduced to the concept of sustainable forestry and begin to analyze how forests are managed throughout Wisconsin. They will assess the economic cost of multiple-use management and the ways this cost can be measured. Finally, the students will take a peek at who owns and manages Wisconsin's forested lands.

ACTIVITY I- THE TRAINING SESSION

At the beginning of class let the students know that each and every one of their applications for employment has been accepted by the Wisconsin Department of Natural Resources Bureau of Forestry. Let them know that a very large piece of land has just been donated to the state of Wisconsin as a State Forest and that their involvement is necessary in its management. Congratulate them and tell them that today is the first day of training for this project. After training is finished today, the following two days will be spent working on the project at hand. Let the class know that they will need the skills learned today in order to complete the project successfully.

I. Forest Area (15 minutes)

Distribute the **Forest Area Worksheet** to the class. Have the class turn the worksheet over face down. Ask them what shape the paper is. *A rectangle.* Ask them to use a ruler to figure out how long and how wide the paper is in inches. *11 inches x 8.5 inches.* Tell them that if they multiply the length of the paper times the width of the paper, the answer will be the area, or the amount of space on top of their desk that the paper covers (write all of the answers on the board as you go through the questions). Have them do the math. *11 inches x 8.5 inches = 93.5 square inches.* Ask them what units follow the number 93.5. *Square inches.* Tell them that when doing math with units like inches or centimeters they must keep track of the numbers and the units. For example, (11 x 8.5) = 93.5 and (inches x inches) = square inches, the complete answer = 93.5 square inches or inches squared. Have them measure the same piece of paper using centimeters and get the answer. *If your students are still having trouble, have them divide the paper into 8.5 equal columns and 11 equal rows. Have them count the boxes, adding the ½ boxes together (93.5) and measure the height and width of a box (1 inch by 1 inch). Tell them these boxes are all 1 square inch of area or 1 inch x 1 inch.*

Ask the class how many inches are in a foot. *12.* Ask them how many square inches are in a square foot. *12 inches x 12 inches = 144 square inches.* Ask them how many square inches are in a football field. *Who knows!!* Tell them that the number would be huge. Ask them if they can think of a way of making the number smaller. *Use bigger units.* Tell the class that foresters often map very large areas of land. Ask the class if anyone know what units of area foresters use to map land. *Acres.* Tell the class that there are 43,560 square feet of area in just 1 acre. That's pretty big. Tell them that an NFL football field is just about 1.2 acres in size.
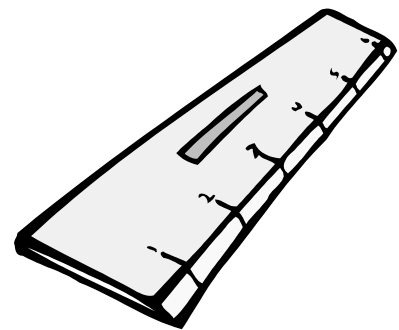
Have the students flip over the worksheet. Ask them to figure out the area of shape #1. *It isn't as easy as measuring the length and width and multiplying it.* Tell them that forests, lakes, and other features on the land take many different shapes and are difficult to measure with a ruler. Tell them that foresters and many other professionals use a dot grid to measure shapes like these. Hand out the **Transparent Dot Grids** to the students.

The dot grids should be cut into strips 12 boxes long x 8 boxes wide and one should be given to each student (this size will be big enough to use easily and small enough to save on the number of transparencies used – 1 transparency makes 2 strips). You may also save additional transparencies by grouping or pairing students for this activity.

Ask the students to pretend that the shapes are features on the land (lakes, buildings, islands, swimming pools etc.) and that they are looking at a map. Ask them how they might figure out the area of the shape on the land? *They can find the area of the shape with the dot grid.* Tell the students to place the transparent dot grid on shape #1. Tell them to line the dot grid so that it is laying long-ways up and down over the shape and is parallel to the edges of the paper. Have the students count the number of dots that are inside of the shape. If a dot is right on the edge of the shape, count every other one.
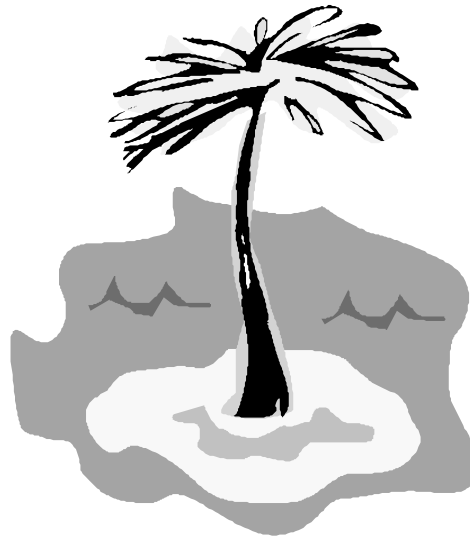
Once they have the number of dots inside the shape, have them write that number down. Tell the class that each dot is equal to 40 acres of land. Have them multiply the number of dots times 40 acres. The answer is the area of the shape in acres. Write the calculation on the board: (# of dots) x (40) = acres of land area. Have students complete the worksheet in this manner. After completion, either collect the dot grids or tell students to save them because they will be using them for their project tomorrow.

Ask the students why foresters would need to know the area of forested land. Brainstorm the reasons. Ask them to think back on what they have learned about forests. Ask them if all forests have the same structure and tree composition. Tell the class that a forested area can differ greatly from place to place. One forested area may have swamps, lakes, valleys, hilltops, cliffs, rivers, etc. and the forest cover will differ from place to place. Foresters map the areas of different forest types across the landscape. These different cover types have different trees, different structures, different disturbances, and require different management methods.

2. Harvesting Methods (10 minutes)

Harvesting methods are forest management practices used when cutting down trees to sell as products. The purpose of harvesting methods is to take economically valuable trees from the forest in a way that ensures that the forest will grow more of the same economically valuable trees in the future. Ask the class if they can think of any trees that have been or currently are economically valuable in Wisconsin. *White pine – ship masts, homes, etc.; aspen – paper products; oak – furniture; fir and spruce – Christmas trees.* Use the **Forest Harvest Overheads 1-4** to illustrate the 3 major types of harvesting methods used in Wisconsin: selection cutting, shelterwoood cutting, and clearcutting.

During **selection cutting**, single trees are selected and removed from the tree stand leaving small, widely spaced holes in the upper canopy. This allows small patches of light to reach the forest floor. **Shelterwood cutting** removes large groups of trees from the forest but leaves some shade and shelter for young trees. This method allows large amounts of light to reach the forest floor. **Clearcutting** removes all of the trees from the forest. This method leaves little to no shelter for young trees and brings sunlight to the entire forest floor.

Have the class think back to the competition and the different trees in the competition. Ask the class if they can remember which tree species they were and if they were tolerant to shade, fire, wind, etc. Ask the class to remember how the forest changed through time because of disturbances and how their trees reacted to the disturbances. Tell the class that harvesting methods are very similar to natural disturbances within the forest. They remove certain trees from the forest and make it easier for some trees to grow and harder for other trees to grow. The difference is that harvesting methods take the economically valuable trees and encourage the same trees to re-establish themselves in the forest. Ask students how they think that harvesting methods might differ for different tree species (you may use the competition trees as examples). *Trees that need shade must be grown under a canopy, and trees that need sunlight must be grown in the open. Many trees grow more slowly than others and take longer to mature. Different trees are used for different products and these products require the trees to be a certain size. For example: red pine trees and utility poles for power lines ,and historically, white pine trees for ship masts.*

Put the **Harvesting Methods Sheet** on the overhead and use it to illustrate the harvesting methods required for certain trees found in Wisconsin. Tell the class to write the trees and the management practices used for each in their log books because they will be using them for the next class.

Tell the class that the characteristics of the trees also determine the products that we can make from them. *Long straight trees can be used for utility poles, log cabins, etc., while fast growing trees with soft, clean wood can be used for paper production. Trees with strong, flexible wood are used for many building purposes. One example is the use of white cedar wood for the construction of canoes (cedar-strip canoes). Many trees also produce resins used in paints and finishes, while other trees produces syrups used for candy, soft drinks, and other foods. Trees can also provide habitat for commercially valuable animals and plants like honey bees and shiitake mushrooms.*

Ask the class if they think that the demand for products from all of the different tree species in the forest is the same. *No, different trees are used for different products and each of these products have different costs. The wood of many trees is very valuable for expensive furniture, stocks for guns, and carvings. The wood from trees such as black walnut, black cherry, and sugar maple are worth more money than white birch or jack pine wood.* Ask the class if they think that the amount of money that a tree is worth can influence the type of harvesting method that landowners use. *Yes it does.* Finally, introduce the class to the 4 factors that influence the harvesting methods that

are used within forests. Write these on the board and have the students copy them into their logbooks.

Four Factors that Influence Harvesting Methods
1) The forest type (structure and composition)
2) The characteristics of the trees within the forest type
3) The quality and quantity of different trees within the forest type
4) The products that the landowner wishes to produce and continue to produce

3. Sustainable Harvest (25 minutes)

Ask the class if they know what the word "sustainable" means. Discuss the answers. Ask for a volunteer to help you illustrate the definition. Have the student run in place as fast as they can. Ask the class how long they think the student can continue to run that fast. *Not long.* Explain to the class that the rate or speed that the student was running was very fast and it requires a lot of energy to run that fast. Tell them that the human body could not continue to supply enough energy to keep up that pace for a very long time.

Now ask the student to walk slowly in place. Ask the class how long they think the student could keep that up. *A long time.* Could the student keep up the pace all day long? *No -- hunger, exhaustion, boredom.* Tell the students that a sustainable pace would be a pace that could be kept up for the entire time the student was awake. Relate the idea of pace to the class by discussing marathon runners, swimmers, etc.

Tell the class that when harvesting trees from the forest, foresters try to cut down trees at a pace that will allow them to cut trees from the same piece of land throughout the future. Ask the class how this is possible. *By planting trees after cutting them down and only cutting trees down as fast, or slower, than the trees can grow.* Write the following problem on the board.

Suppose you have 4 hickory trees in your backyard. You use the wood from these trees to smoke, cure, and grill meat. The first of the trees is 10 years old, the second is 20 years old, the third is 30 years old and the fourth is 40 years old. To produce good fire logs the trees must be 40 years old. A 40 year old tree will produce 200 fire logs when you cut it down. You plant a new tree every time you cut one down.

Have students copy the problem into their log books. Draw the trees in proportional sizes on the board, put the ages underneath them, and ask the following questions:

Will the trees remain this age forever? *No.* Why? *Because trees grow and age just like people do.* How old does a tree have to be before you can cut it down for firewood? *40 years old.* After you cut the 40 year old tree down, how long will it be until you can cut firewood again? *10 years.* Why? *Because, by that time, the 30 year old tree will be old enough to cut down.* How many fire logs will you have for those 10 years? *200.* Why? *Because each 40 year old tree produces 200 fire logs and it will be ten years before you cut down another tree.* If you have 200 logs and they have to last you 10 years, how many can you use each year? *200 logs / 10 years = 20 logs per year.* If you plant a new tree every time you cut one down for firewood, how long can you continue to use 20 fire logs a year? *forever.* Why? Use the tree pictures you have drawn on the board to show that if you continue to plant trees after you cut them, you will always have a 40 year old tree every ten years.

Once the class can do the calculations (# of logs from each tree harvest / # of years between harvests = log use per year) and they are introduced to the 'forever' in sustainable harvesting, ask them the following questions:

What would happen if you didn't plant trees after you cut them down? *You would run out of wood in 40 years.* What happens if you use more than 20 logs a year for firewood? *You wouldn't have enough firewood, you would have to cut your trees down too early, you would have to buy firewood from somewhere else.* If you use more than 20 logs per year or neglect to replant your trees after cutting them down, would it be sustainable? *No.*

Tell the class that it is time to apply what they have just learned. Put the **Sustainable Harvest Worksheet 1** on the overhead projector, but only let the very top of the sheet show and cover everything below the row of trees and ages labeled 'Original Tree Stand'. Cover the cutting rate with a pen. Tell the class that the stand consists of 6 acres of red pine trees and that all of the trees are 60 years of age. Tell them that these red pine trees are ready for harvesting at 60 years of age and that they can be harvested at any time beyond that age. Tell them that the landowner plans to use these trees for lumber and to heat his home. Have them brainstorm the best ways of harvesting the trees. Possible answers may be*: Cut them all down because they are all old enough. Let them grow bigger because then you'll have more firewood and construction wood. Don't cut them down at all. Cut 0.1 acres every year or 1 acre every ten years.*

Tell the class that the best way to manage this stand would be to 1) evenly distribute your work and expenses, 2) maintain a constant supply of wood each year, and 3) maintain the same supply of wood throughout the future. Assess the answers from the brainstorm with these criteria.

If no student answers correctly, then ask the class if they have enough information to figure out the pace or rate that they should cut the trees down. *They do have enough information.* The **cutting rate** = (the # of acres of red pine trees) / (# of years it takes for red pine trees to be ready for harvest) or (6 acres / 60 years = 0.1 acres per year). Hand out **Sustainable Harvest worksheets 1 and 2** and reveal the overhead worksheet. This worksheet will illustrate the result of cutting 1 acre every ten years. Go through both worksheets with the class and write the answer to each question (1-7) directly onto the overhead as the class answers them. Have the students write the answers on their worksheets. Correct answers are: 1) 1 acre, 2) 80 years old, 3) 10 years old, 4) 2 acres, 5) 110 years old, 6) 50 years old, 7) yes and forever.

After the students fully grasp the concept of sustainable harvesting, ask if they think that red pine trees grow at the same rate in all types of forests. *No, forests differ in the amounts of nutrients that are in the soil, the degree of competition from other trees, weather patterns, moisture, etc. All of these factors affect the rate at which trees grow.* Ask the class what they think would happen if the red pine trees in the last exercise only took 50 years to mature? *You could cut the tree down faster (6 acres / 50 years = .12 acres per year).* What if they took 70 years? *You would cut at a slower rate (6 acres / 70 years = .0857 acres per year).*

Ask the class what other things might cause trees to grow faster or slower? *Adding fertilizer (faster), soil erosion (slower).* What could happen if harvesting trees was causing soil erosion? *The more trees you harvest, the more soil you would lose. As the soil is lost so are the nutrients that trees need to grow. The trees would grow at slower and slower rates. Ultimately, you would have to cut at slower and slower rates to keep a sustainable pace.* What other natural events might cause problems with future harvests? *Disturbances (fire, insect infestation, floods, acid rain, etc.).* What other events might increase the speed that you cut down trees? *The demand for wood from consumers. Increases and decreases in wood prices. Financial needs of the landowner.* Brainstorm how the demand for wood and the speed at which you cut down trees are related. How is this influenced by all of the other natural factors that affect the way trees grow?
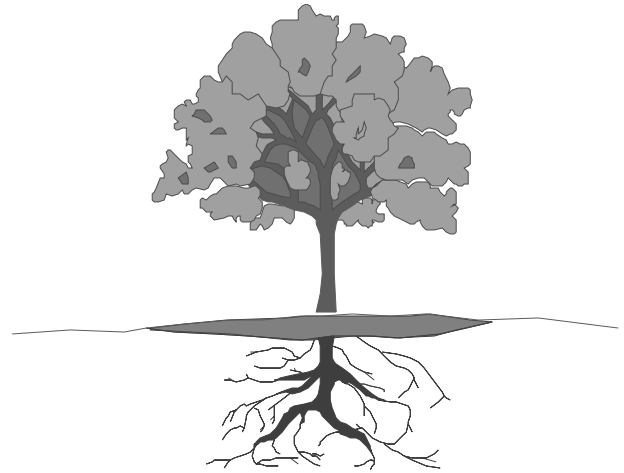
ACTIVITY 2 – FOREST MANAGEMENT SIMULATION

DAY 1 – THE MANAGEMENT PLAN (50 MINUTES)

1. Briefly review the subjects that the students learned in the training session. Ask students if they remember how to measure forest area and if they remember the harvesting methods commonly used in Wisconsin. Once students are comfortable with the information, divide the class into groups of 2-4. Explain to the class that each of the groups will each work on the project separately. Explain the project to the class.

"In the early 1800s a lumber baron named Folsom bought a very large piece of land in the Northwoods and began his logging operation. The huge pines and dense hardwoods made him a fortune. He soon realized that the forests of the North were almost gone. He stopped his logging and saved what he had left. Many people thought that he was quite foolish for leaving the land unlogged, but he was rich and had many friends and didn't much care. The land has been passed through two generations of Folsoms. Just last month the last Folsom passed away. Within his will was the deed to the land signed over to the state of Wisconsin to be used as a State Forest. You are here today to form a management plan for this land, the Shady River State Forest."

2. Hand out the **Shady River State Forest Map** to each group. Have the groups identify all of the major features on the map: legend, roads, rivers, lakes, forest types, and property boundaries. Explain the different forest types to the class.

1) **Old Growth White Pine** – a mixed coniferous and deciduous stand dominated by very large and very old white pine trees.
2) **Bottomland Hardwoods** - found on lower ground that stays moist throughout the growing season. These stands are made up of mostly deciduous trees like maple, birch, aspen, and ash. These forests are usually not very productive and trees do not grow to great heights or in great numbers, but some trees have a very high quality wood such as black ash.
3) **Northern Hardwoods** – deciduous and mixed forests found in great abundance throughout northern Wisconsin. Maple, oak, elm, hickory, and birch grow in great quantities. Mature northern hardwood stands are usually dominated by large and valuable sugar maple trees.
4) **White Cedar Swamps** – lowland, wet, coniferous forest dominated by slow growing, but valuable white cedar trees.
5) **Aspen Lowland** – young, early-successional forest made up of dense stands of aspen trees. These forests are sometimes called 'dog-hair stands' because they are as thick as the hair on a dog's back.
6) **Red Pine Plantation** – a replanted forest made up of straight rows of even-aged red pine trees. Plantations contain large amounts of tall, straight, valuable trees.

3. After you have reviewed the map, hand out **Worksheet 1**. Have students calculate the total timber value of the State Forest as shown on the worksheet. Explain to the class that this the economic value of the trees today. Ask them what would happen to this value as the forest (trees) grows older. *Trees would get bigger, more wood, more money.* Brainstorm the possible ways that the trees could be harvested referring to the sustainable harvest activity. After discussing the economic value of the forest, ask the class if they think that a state forest should be managed for more than just wood products. Try to form a list of things that happen today in Wisconsin's State Forests. *Hiking, biking, camping, hunting, fishing, skiing, etc.*

4. Tell the groups that they must manage the forest for more than just timber and hand each group the **List of Management Objectives** (forestry, wildlife, and recreation). Browse through each objective set starting with wildlife and ending with forestry. Point out the objectives from each set and explain them. Tell the groups that by following all of the objectives, they will create a management plan that fulfills all of the DNR requirements.

5. Remind the class that many management practices can be harmful to the environment. Ask the groups if they can remember anything from our logging history that caused environmental damage. *Slash from logging caused devastating fires, logging caused soil erosion, many forests were permanently changed, many animals and plants became extinct or endangered, etc.* Ask the groups what might happen if they were to drive logging trucks across the swamp on their map. *Soil and trees would be damaged and they might lose a few trucks.* Tell the students that foresters must also follow Best Management Practices in order to protect the quality of water and the future potential of the forest to grow trees. Hand out the **Best Management Practices for Shady River State Forest**. Review all of the practices that must be followed.

6. Make sure that each group has at least 1 red pencil , 1 green pencil, 1 brown pencil, and 1 blue pencil along with at least 1 dot grid, 1 ruler, and 1 calculator. Tell the groups that they

must cooperate to complete the map. Tell them that all of the restricted areas should be marked in blue, wildlife habitats should be outlined on the map with red pencil, all of the recreations requirements should be marked in brown, and all of the land being logged for forestry should be outlined in green. The areas used for forestry and the wildlife habitats they choose must be calculated using the dot grid (1 dot : 40 acres). The length of trails and other lines can be determined with their rulers (1 mile : 3 cm or 1 cm : 1/3 mile). *All of this information is listed on the Rules for Drawing the Management Map Handout that you have given the groups.*

! Be sure to have extra copies of the maps and of the calculation worksheet in case students make mistakes.

Day 2 – Decision and Discussion (40 minutes)

1. After all plans are finished hand the groups **Worksheet 2**. Have them use the areas that they have left for forestry to find the answers to the worksheet. After completing **Worksheet 2**, students will have calculated the amount of money made form forestry each year in the State Forest. This dollar amount is calculated by using the areas left for forestry, a sustainable cutting rate, and the appropriate harvest method. This yearly income will be used as one way that students can judge the value of the management plan.

2. After the map and worksheet are finished, post them for the entire class to see. It is possible that some groups will not finish the maps. Tell the class that managing forests for many uses is not easy and sometimes impossible. Have an elected student from each group present their plan to the class including the dollar value from **Worksheet 2**. After the presentations, ask the students which plan they think is best. Lead a discussion on the strengths and weaknesses of each plan using the Best Management Practices, management objectives, and the annual profit made from the forestry practices as your guidelines. Have the students think about what arguments surfaced and what tough decisions were made in their groups. Ask the class to help you identify the sources of conflict. Have the students use a ranking system to vote on the best plan.

Here is an example of how the ranking system works for choosing a plan (next page). Of the six plans, each student ranks their choices from 1 to 6, with 6 being their top choice. The plan that receives the highest score is the best: in this case #6.

	Ellen	Nick	Sterling	Rachel	Anne	Totals
Plan #1	3	6	1	5	2	17
Plan #2	2	5	3	1	4	15
Plan #3	1	3	5	2	6	17
Plan #4	4	4	2	6	3	19
Plan #5	6	1	6	3	1	17
Plan #6	5	2	4	4	5	20

3. After the best plan is chosen, congratulate all of the groups for their work. Ask the class what they think the difference between sustainable harvesting and sustainable forestry is. Tell them to think about all of the things that they have managed for in the Shady River State Forest. After their ideas are exhausted tell them that sustainable forestry not only provides a continuous supply of lumber throughout the future but also supplies the many other qualities of a forest such as recreation, education, wildlife habitat, and environmental protection.

4. Have the students look at **Worksheet 1.** Ask the class how much the timber was worth then, before we managed the forest. *About 2 billion dollars.* Ask the class if the wildlife and recreation requirements along with the Best Management Practices have changed the amount of timber available for harvesting. *It has, many areas are now protected and reserved.* Brainstorm the ways that they can determine the new market value of standing timber after the management plan. Hand out **Worksheet 3**. Have students use the areas left for forestry in their management maps to complete the table (these can be taken directly from **Worksheet 2**). Use this total value and the value calculated before management to find the economic cost of the management plan.

> Value of timber before management (Worksheet 1) – Value of timber after management (Worksheet 3)
> = **Economic Cost of Management**

! Tell the class that this is one of the ways that the economic cost of managing for purposes other than forestry can be calculated.

Conclusion (10 minutes)

Lead a discussion on the weaknesses of this method for determining the cost of managing for multiple uses. Explain that no other values are taken in to account (recreational, educational, ecological, egocentric, and aesthetic). The park will also continue to make money from its recreational facilities. Ask the students to brainstorm all of the other values that their management plan has provided. Ask the class if they think that managing forests in this way is beneficial to people in the state. Ask the groups if they think that all forest management is done in this way. *No.* Why? *Because many different people own the land and these people have different objectives.* Who else owns land besides the state? *Industries, counties, the national government, private landowners, Native American tribes.* Put the **Who Owns Wisconsin's Forest Pie Chart** on the overhead. Explain the chart to the students.

With the chart on the overhead, explain to the class that State Forests, National Forests, and much of the county-owned land is managed much the same as the project they have just completed. These lands are managed for multiple uses and for the use of the general public. These managed lands also use Best Management Practices. The other landowners manage land with their specific goals and interests in mind. These specific goals differ between landowners and can include many different land uses. Have the class figure out the percent of forested land that is managed in this fashion. *71%.* Have the students brainstorm ways that individuals, industries, and corporations might manage their forests differently than the way that they have managed their forest.

STUDENT LOG BOOK

Have students write a summary of the sources of conflict that arose when forming their management plan. Have the students relate some of these conflicts to conflicts that exist in their hometown or somewhere in Wisconsin. Encourage students to ask their parents, relatives, friends, etc. about these real-life conflicts.

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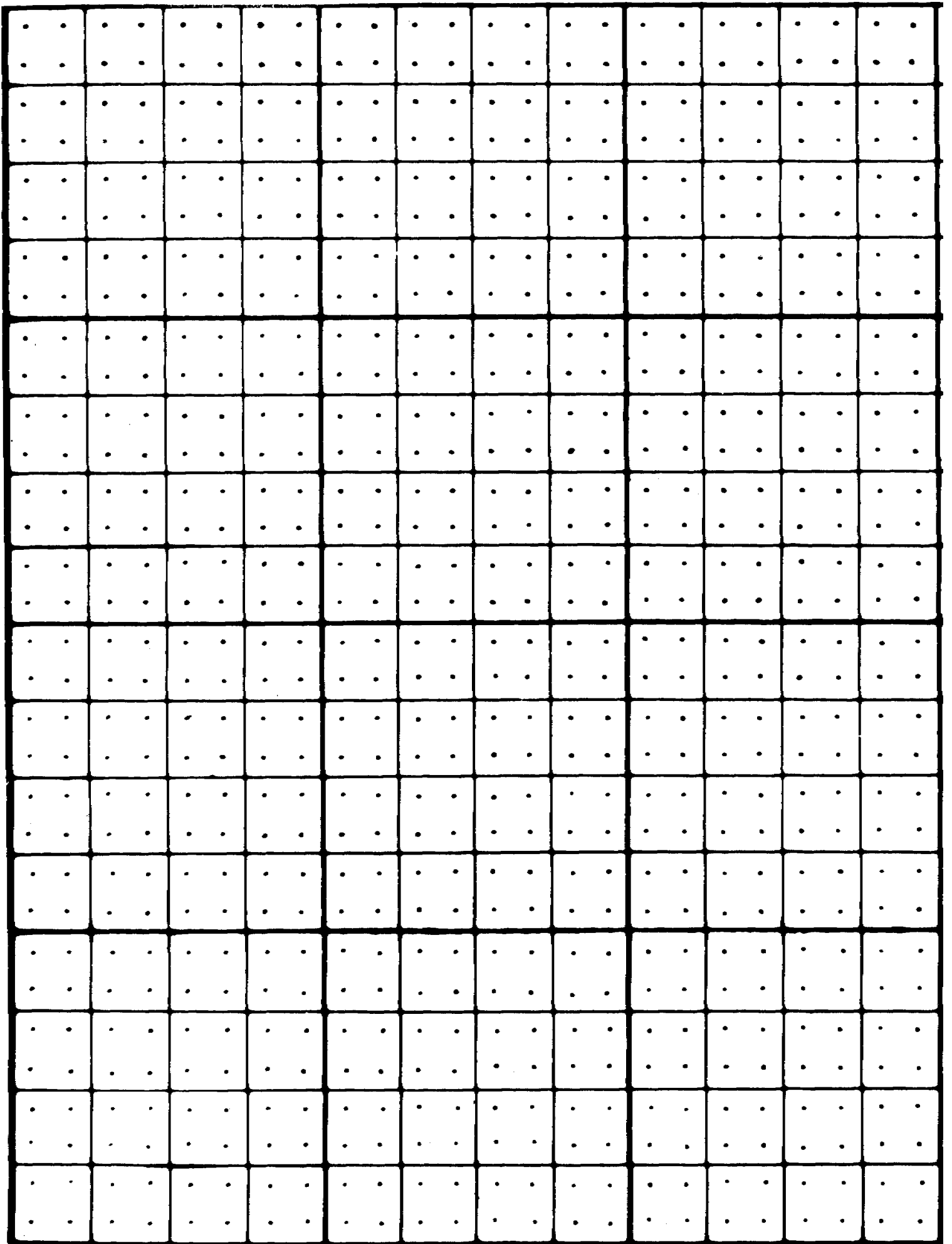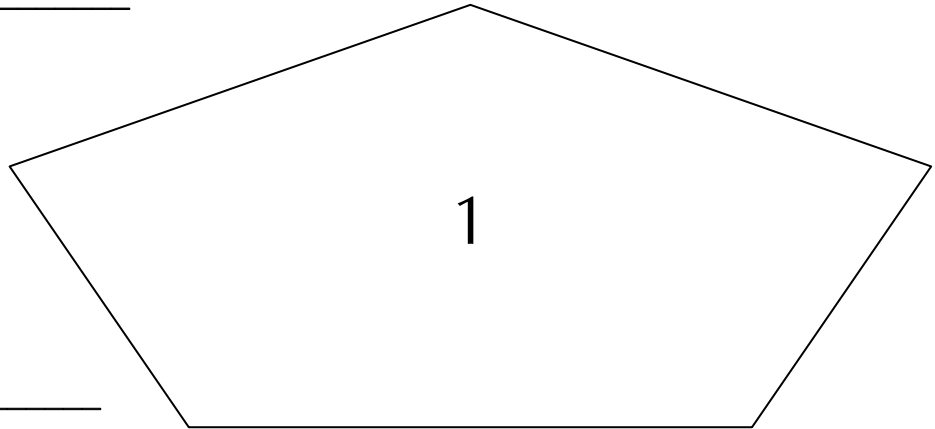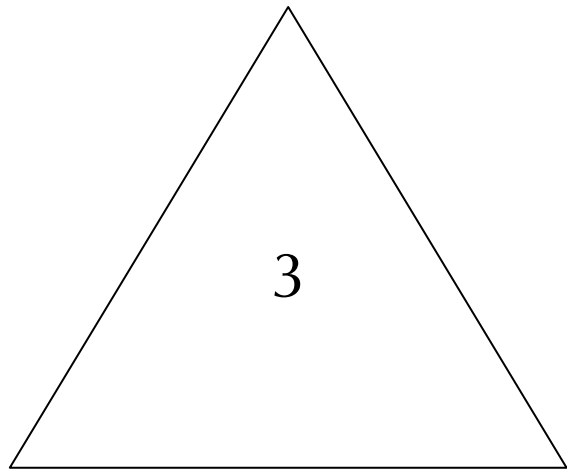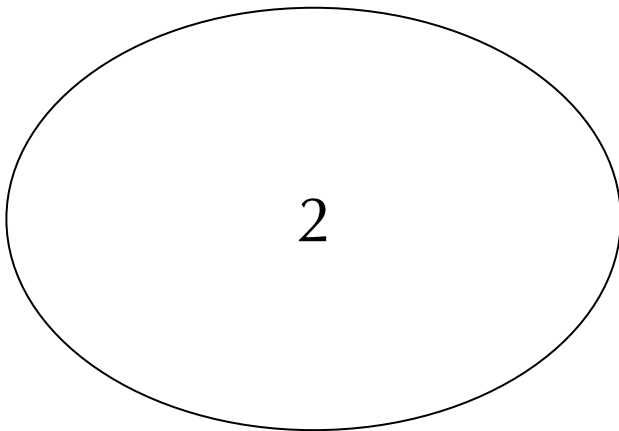
Forest Area Worksheet

(Use your dot grid to determine the area inside of the shapes below)

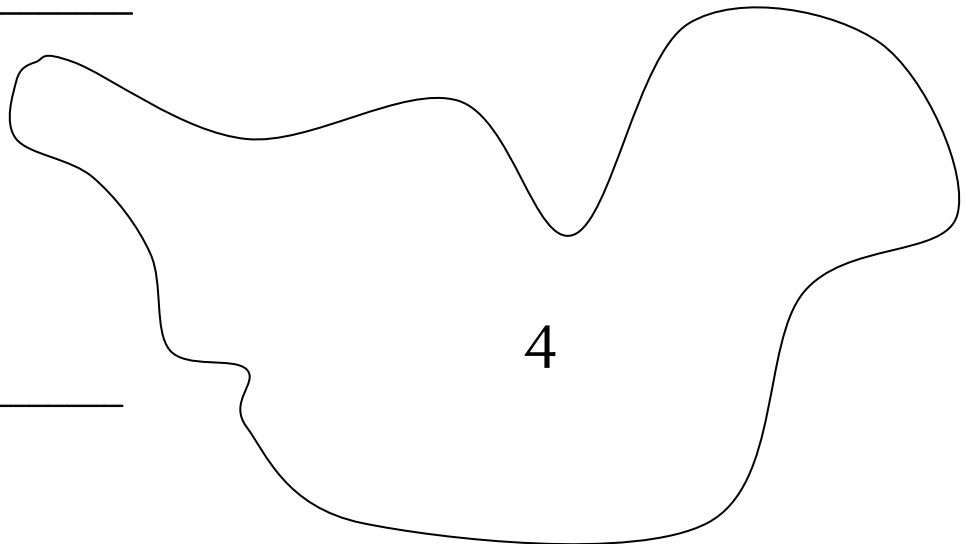1 dot : 40 acres

Area 1 _____

1

Area 2 _____
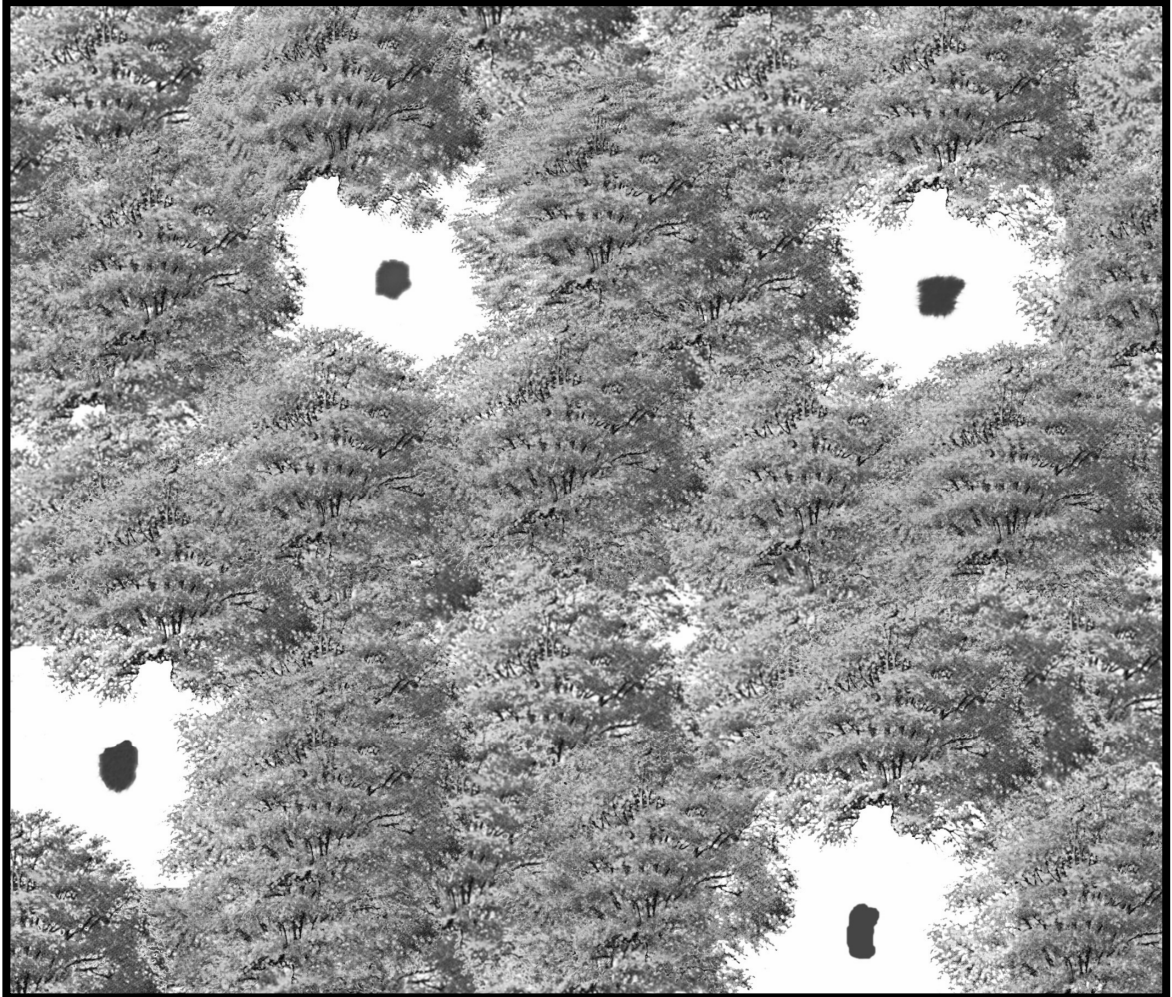
2

3

Area 3 _____

Area 4 _____

4

FORESTED LAND
Before Harvesting
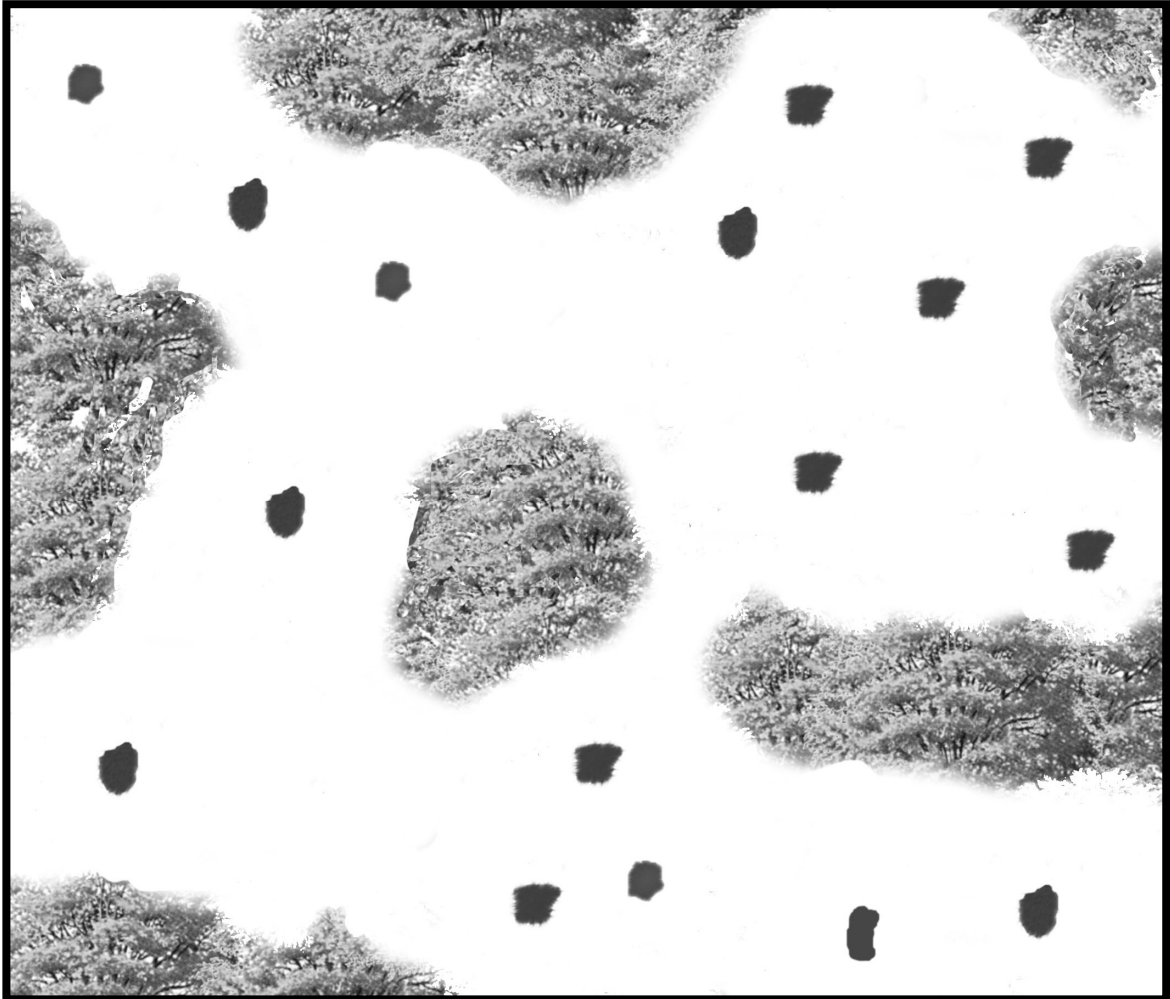## (Harvesting Methods Overhead #1)

SELECTION CUT
(Harvesting Methods Overhead #2)

- Removes select trees
- Creates small, scattered gaps in the canopy
- Brings patches of light to forest floor
- Used to encourage the establishment and growth of shade tolerant trees
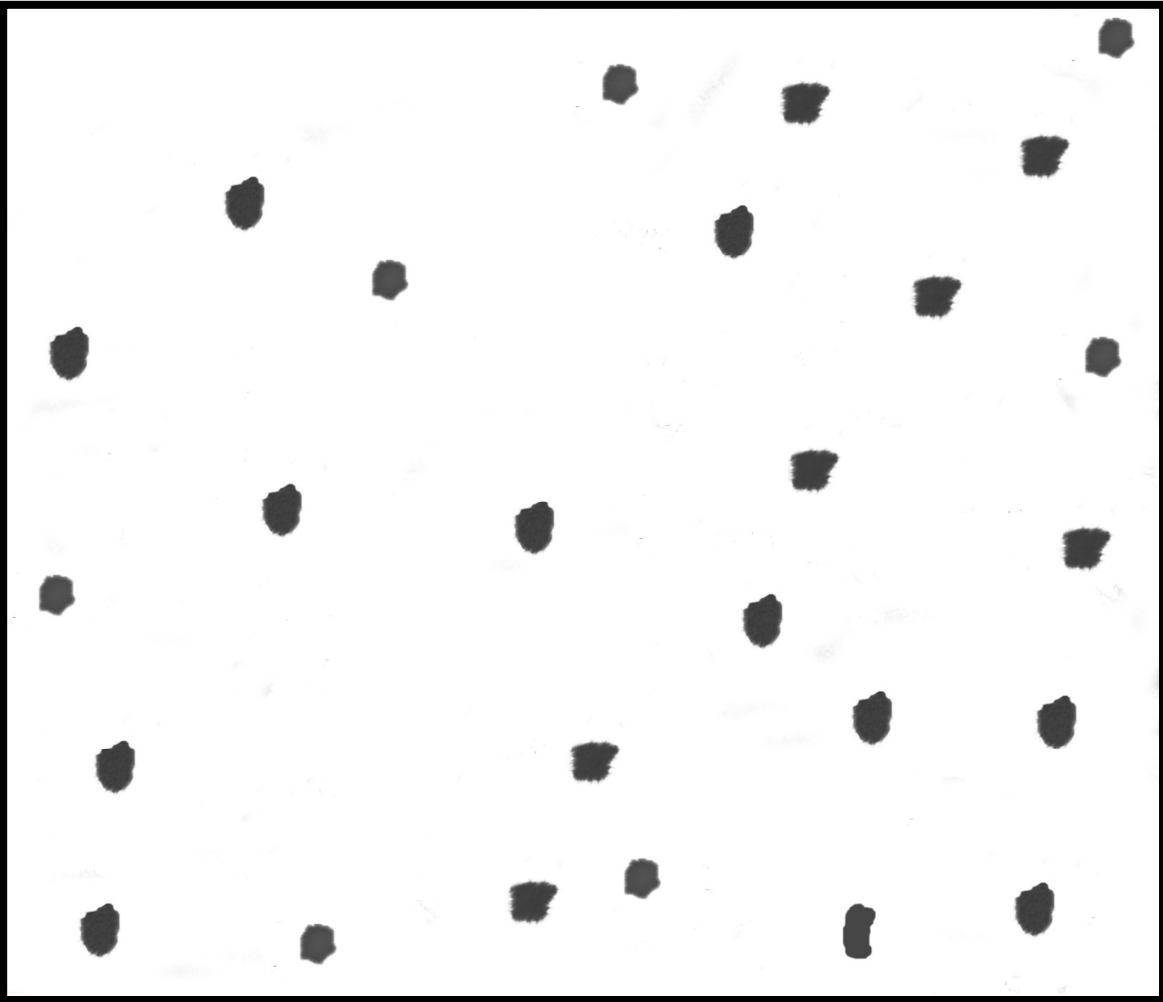
Shelterwood Cut

(Harvesting Methods Overhead #3)

- Removes larger groups of trees
- Creates large gaps in the canopy
- Leaves only small portions of shade on the forest floor
- Used to cause growth in suppressed trees and provide shade for the re-growth of shade tolerant trees
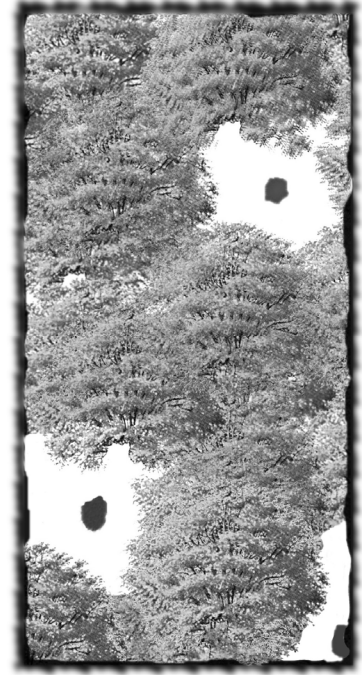
Clearcut
(Harvesting Methods Overhead #4)

- Removes all trees in one cut
- Brings sunlight to the entire forest floor
- Used to promote the growth of trees intolerant of shade

Timber Management Practices
(Harvesting Methods Overhead #5)

| CLEARCUT	SHELTERWOOD	SELECTION
Shade Intolerant Trees	*Partially Shade Tolerant Trees*	*Shade Tolerant Trees*
Aspen	Oak	Black Ash
Birch	White Cedar	Basswood
Tamarack	White Spruce	Hemlock
Jack Pine	Hickory	Sugar Maple
Red Pine		Balsam Fir
Black Spruce		

Sustainable Harvest Worksheet I

Each tree = 1 acre of red pine plantation
Total acres of red pine plantation = 6
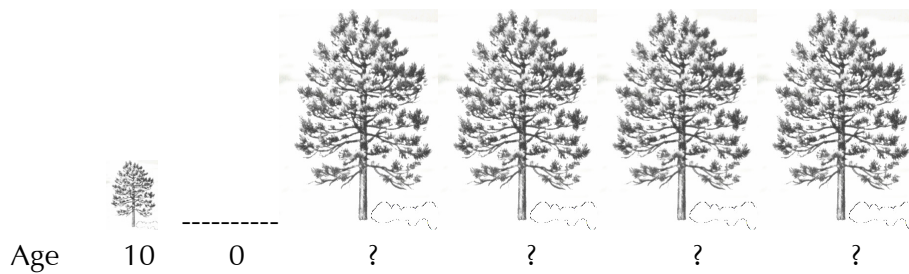Cutting rate = 0.1 acres per year *or* 1 acre every ten years

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Original Tree Stand.

| Age | 60 | 60 | 60 | 60 | 60 | 60 |

---
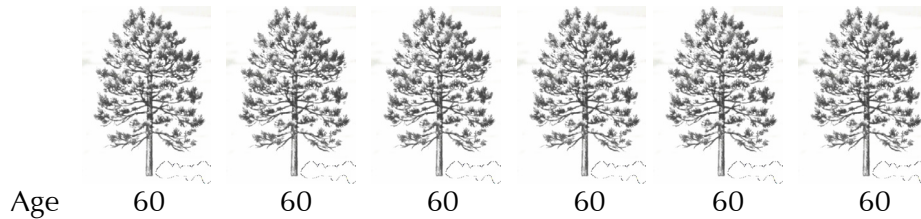
1) You have been cutting for 10 years. How many acres have you cut?

| Age | 0 | 70 | 70 | 70 | 70 | 70 |

---
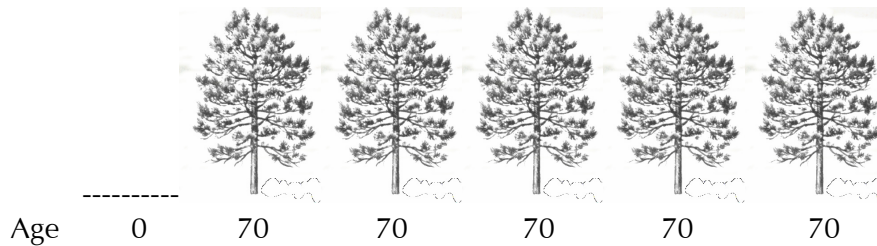
2) You have been cutting for 20 years. How old are your oldest trees?

| Age | 10 | 0 | ? | ? | ? | ? |

---

3) You have been cutting for 30 years. How old are your youngest trees?

| Age | 20 | ? | 0 | 90 | 90 | 90 |

150
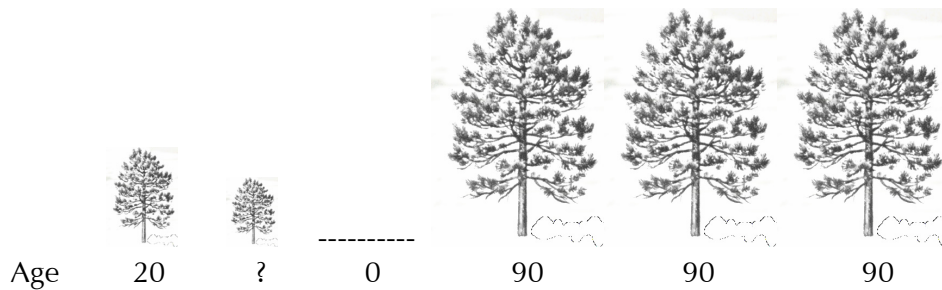
4) You have been cutting for 40 years. How many acres of 100 year old trees are there?

Age	30	20	10	0	100	100
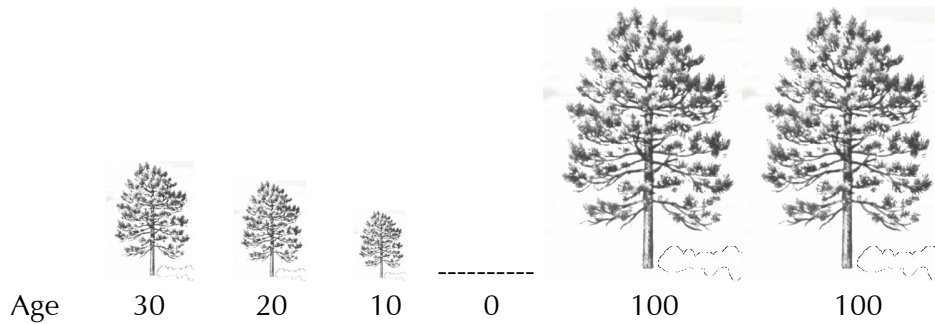
5) You have been cutting for 50 years. What is the oldest that any of the trees will be?

Age	40	30	20	10	0	?
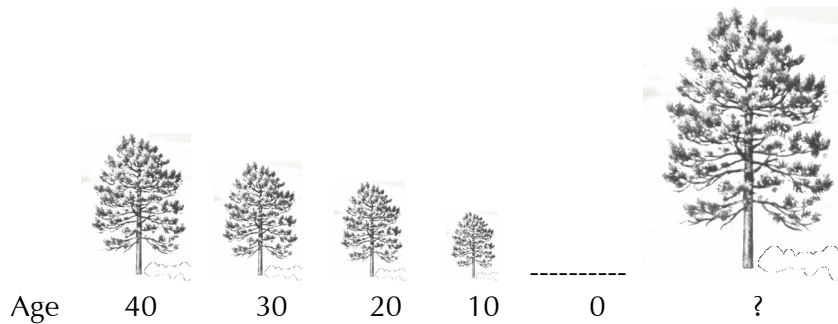
6) You have been cutting for 60 years. How old are your oldest trees?

Age	?	40	30	20	10	0
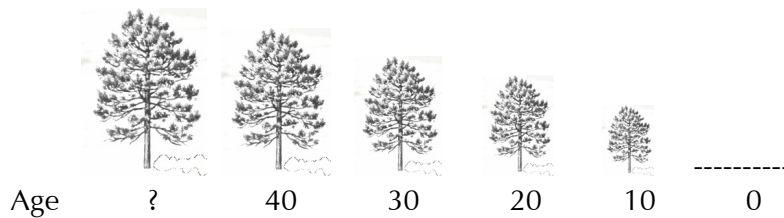
7) Your Forested Land After 70 Years of Ownership. Can you continue to cut 1 acre of trees every 10 years? How long can you do this?

Age	60	50	40	30	20	10
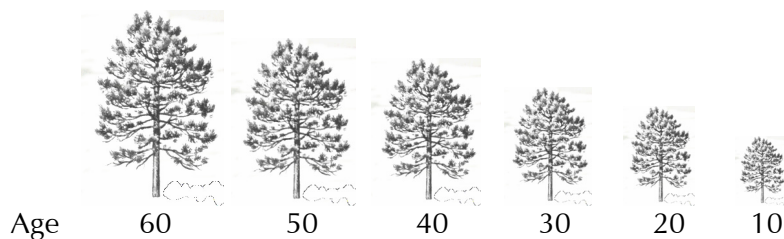
Dollar Value of Timber in Shady River State Forest Before Management
(TEACHER COPY)

Forest Type	Number of logs per acre (hundreds)	(x)	Price per log (hundreds of $)	(x)	Acres	(=)	Total for each forest type
Old Growth (White Pine)	5	(x)	$4	(x)	7,360	(=)	$1,472,000,000
Northern Hardwoods (Mature Sugar Maple)	3	(x)	$2.50	(x)	8,240	(=)	$618,000,000
Mature Red Pine Plantation	5.5	(x)	$1	(x)	3,040	(=)	$167,200,000
Bottomland Hardwoods (Black Ash)	1	(x)	$1.50	(x)	8,360	(=)	$125,400,000

Forest Type	Number of poles per acre (hundreds)	(x)	Price per pole (hundreds of $)	(x)	Acres	(=)	Total for each forest type
White Cedar Swamp (White Cedar)	3	(x)	$1	(x)	2,920	(=)	$87,600,000
Aspen Lowland (Aspen)	6	(x)	$0.30	(x)	4,000	(=)	$72,000,000

Total Dollar Value (add all totals together) = | $2,542,200,000

Dollar Value of Timber in Shady River State Forest Before Management
(Worksheet 1)

Forest Type	Number of logs per acre (hundreds)	(x)	Price per log (hundreds of $)	(x)	Acres	(=)	Total for each forest type
Old Growth (White Pine)	5	(x)	$4	(x)	7,360	(=)	0,000
Northern Hardwoods (Mature Sugar Maple)	3	(x)	$2.50	(x)	8,240	(=)	0,000
Mature Red Pine Plantation	5.5	(x)	$1	(x)	use the dot grid to find the answer	(=)	0,000
Bottomland Hardwoods (Black Ash)	1	(x)	$1.50	(x)	8,360	(=)	0,000
Forest Type	Number of poles per acre (hundreds)	(x)	Price per pole (hundreds of $)	(x)	Acres	(=)	Total for each forest type
White Cedar Swamp (White Cedar)	3	(x)	$1	(x)	2,920	(=)	0,000
Aspen Lowland (Aspen)	6	(x)	$0.30	(x)	4,000	(=)	0,000

Total Dollar Value (add all totals together) =

0,000

153

Money Made Each Year from Forestry in the Shady River State Forest
(Worksheet 2)

Forest Type	Cutting Method	Cutting Rate (logs per year)	(x)	Price per log	(x)	Acres of land for forestry	(=)	Money made each year from forestry
Old Growth (White Pine)	Selection Cut	30	(x)	$500	(x)		(=)	
Northern Hardwoods (Mature Sugar Maple)	Selection Cut	20	(x)	$300	(x)		(=)	
Mature Red Pine Plantation	Clearcut	45	(x)	$150	(x)		(=)	
Bottomland Hardwoods (Black Ash)	Selection Cut	12	(x)	$200	(x)		(=)	
Forest Type	Cutting Method	Cutting Rate (poles per year)	(x)	Price per pole	(x)	Acres of land for forestry	(=)	Money made each year from forestry
White Cedar Swamp (White Cedar)	Shelterwood Cut	50	(x)	$150	(x)		(=)	
Aspen Lowland (Aspen)	Clearcut	100	(x)	$30	(x)		(=)	

Total Dollars Made Each Year From Forestry (add all totals together) **=**

154

Dollar Value of Timber in Shady River State Forest After Management
(Worksheet 3)

Forest Type	Number of logs per acre (hundreds)	(x)	Price per log (hundreds of $)	(x)	Acres used for forestry	(=)	Total for each forest type
Old Growth (White Pine)	5	(x)	$4	(x)		(=)	0,000
Northern Hardwoods (Mature Sugar Maple)	3	(x)	$2.50	(x)		(=)	0,000
Mature Red Pine Plantation	5.5	(x)	$1	(x)		(=)	0,000
Bottomland Hardwoods (Black Ash)	1	(x)	$1.50	(x)		(=)	0,000
Forest Type	Number of poles per acre (hundreds)	(x)	Price per pole (hundreds of $)	(x)	Acres used for forestry	(=)	Total for each forest type
White Cedar Swamp (White Cedar)	3	(x)	$1	(x)		(=)	0,000
Aspen Lowland (Aspen)	6	(x)	$0.30	(x)		(=)	0,000

Total Dollars Made Each Year From Forestry (add all totals together) =

0,000

155

Best Management Practices
for Shady River State Forest

1) Temporary logging roads must be constructed to all logging sites from highways, county roads, or other logging roads.

2) Logging roads cannot be constructed through white cedar swamps.

3) No logging practices are allowed within 1/3 mile of any water (mark these restricted areas on your map with blue).

4) Logging operations, including logging roads, may not occur within 1/3 mile of park trails, campgrounds, or public facilities.

5) Forests are to be actively managed to maintain timber wolf, fisher, and neotropical bird habitat.

6) The entire state forest is to be managed to fulfill the recreation requirements supplied.

Rules for Drawing the Management Map

1) Use red to mark wildlife requirements, brown to mark recreation requirements, green to mark lands to be logged, and blue to mark restricted areas near water.

2) 3 centimeters : 1mile

3) 1 dot on the dot grid : 40 acres

4) To make the management easier: Mark the restricted areas in blue first. Mark the habitats for wildlife in red second. Mark the recreation facilities in brown third. Mark the areas for logging and the roads to those areas in green last.

GOOD LUCK!!!!!

Wildlife Requirements

The Department of Natural Resources has chosen three major wildlife habitats to manage for in the Shady River State Forest. These habitats are those of the fisher, eastern timber wolf, and neo-tropical birds. The minimum habitat requirements are listed below. These minimum requirements must be met within the State Forest. Any additional habitat that you can provide will greater benefit the populations of these animals and birds.

Fisher Habitat Requirements

The Fisher

The fisher is one of the largest members of the weasel family ranging from 30 to 40 inches in length. They are dark brown to black in color and have a grizzly appearance. The last native Wisconsin fisher was seen in 1921. Fishers have been reintroduced into Wisconsin forests and are viewed as an important part of many forest ecosystems. They feed on porcupines, squirrels, snowshoe hares, deer carcasses, and other small animals along with select plants, berries, and tree seedlings.

Fishers require large areas of undeveloped, mature hardwood forest for habitat. They also depend heavily on snowshoe hares that live primarily in white cedar swamps. The minimum requirements that must be met within the Shady River State Forest are as follows:

1) Fisher habitat must be in Northern Hardwood (Mature Sugar Maple) forest.
2) You must provide 2 areas of at least 1500 acres with no logging operations or logging roads within this forest type.
3) Each of these areas must border White Cedar Swamp.

# Eastern Timber Wolf Requirements

Eastern Timber Wolf

The eastern timber wolf or gray wolf has ranged everywhere in North America except deserts. Wolves were gone from Wisconsin lands after the logging of the 1800s but returned in 1970 after large forested areas were once again in place. They were classified as an endangered species in 1975. In 1999, there were estimated to be 197 wolves in Wisconsin and they have been reclassified from endangered to threatened. The Wisconsin Department of Natural Resources has recently developed a Wolf Management Plan that is now in place throughout Wisconsin.

Wolves require extremely large tracts of land to support them. This habitat is estimated at nearly 200 square miles (128,000 acres). Habitat is provided for wolves by creating corridors in the forest. Corridors are strips of un-logged land that connect different forests. These corridors connect larger areas of wolf habitat. The corridors that connect wolf habitats are very similar to interstate highways. The highways make a path for cars and people that connect from city to city. The corridors make paths for wolves to move from habitat to habitat.

The white-tailed deer is the main prey species for wolves in Wisconsin. Young deciduous forests (aspen lowlands and bottomland hardwoods) supply habitat for the deer and for the wolf itself. The Shady River State Forest is located within a Wolf Management Zone and must meet the minimum habitat requirements for land located within the zone. The following management guidelines apply:

1) A corridor (pathway) must be made for wolves in the State Forest.
2) The corridor must connect any two of the property borders.
3) The corridor must be at least ½ mile wide.
4) The corridor can be made through aspen lowlands, red pine plantations, bottomland hardwoods and white cedar swamps.
5) Logging operations may occur inside of the corridor BUT no logging roads can be made across the corridor.

Neo-tropical Bird Requirements
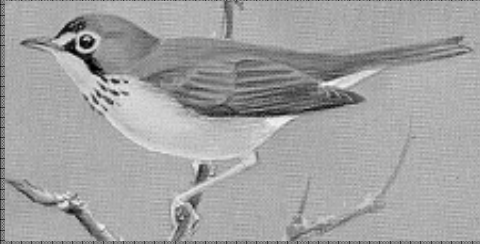
Neotropical birds are birds that live much of their life in South America, Central America, Mexico, or the West Indies. Many of these birds migrate to Wisconsin in the warmer months to raise their young. These birds require only small amounts of land to nest. Usually their nesting range only amounts to around 2 acres. However, neotropical birds will only select to nest in large tracts of undeveloped, old forests . The larger the tract of undeveloped land is, the more likely it is that the birds will choose to nest there.

Much of the neotropical bird habitat in Wisconsin has been developed or is currently under development. It has recently been observed that many areas that used to contain high numbers of neotropical birds now have few of these birds. Many birds still live within the areas, but the species are local species such as the robin, blackbird and starling and are not neotropical species.

The Wisconsin Department of Natural Resources has chosen the Shady River State Forest as management zone for neotropical birds. The minimum requirements are as follows:

1) You must provide at least 2000 acres of old growth white pine forest for neotropical bird habitat.
2) No logging practices or logging roads are allowed in the area.
3) The area selected for neotropical bird habitat must border a water source such as a river or lake.

Recreation Management Objectives

Since this land belongs to the state it must be accessible to and usable by the general public. As recreation managers, you must build adequate facilities for all of the visitors, including those with special needs, such as wheelchair accessibility. You are also required to supply a variety of outdoor activity options for both summer and winter visitors.

The following facilities must be built:

1) A visitor's center and educational exhibits covering at least 80 acres.
   - The area must border a lake and be located in mature or old growth forest. A permanent road must be built to the center and no logging practices or logging roads can happen within 1/3 mile of the area.

2) Fifteen miles of trails for hiking only, and 15 miles of trails only for mountain biking and cross-country skiing must be made into the forest.
   - The trails should go through as many forest types as possible. They can be made side by side. No logging practices can occur within 1/3 mile of these trails. No logging roads may cross these trails.

3) A family campground covering at least 40 acres.
   - The campground must be connected by a permanent road. No logging operation can happen with 1/3 mile of the campground. No logging roads may cross the campground or the campground road.

Forestry Objectives

- After you have marked all of the wildlife requirements and recreation requirements on your map, follow the Best Management Practices and draw roads to any area that can be forested. These roads must start from a road on the property boundary of the map and end in the forest that is to be logged.

- Once the area is connected by a logging road, mark the total area that can be forested in green. Once the areas are marked, use the dot grid to figure out the area of land that can be used for timber production in each forest type.

- Once you have the areas of each forest type, write them in the correct space in the area column of Worksheet 2.

- Use Worksheet 2 to determine how much money you will make from forestry each year. The cutting methods were selected for each forest type to make sure that the valuable trees will continue to grow. The cutting rate was determined to make sure that you cut trees only as fast as they can grow (sustainable harvest). The price was determined by the amount that consumers are willing to pay for the timber.

- The amount of money that you make each year from forestry will be used to judge the quality of your management plan. The more money that you make from forestry, the better you have used the land for the wildlife requirements, recreation requirements, and Best Management Practices.

Who owns Wisconsin's forested land?

- 57%
- 15%
- 9%
- 7%
- 5%
- 4%
- 2%
- 1%
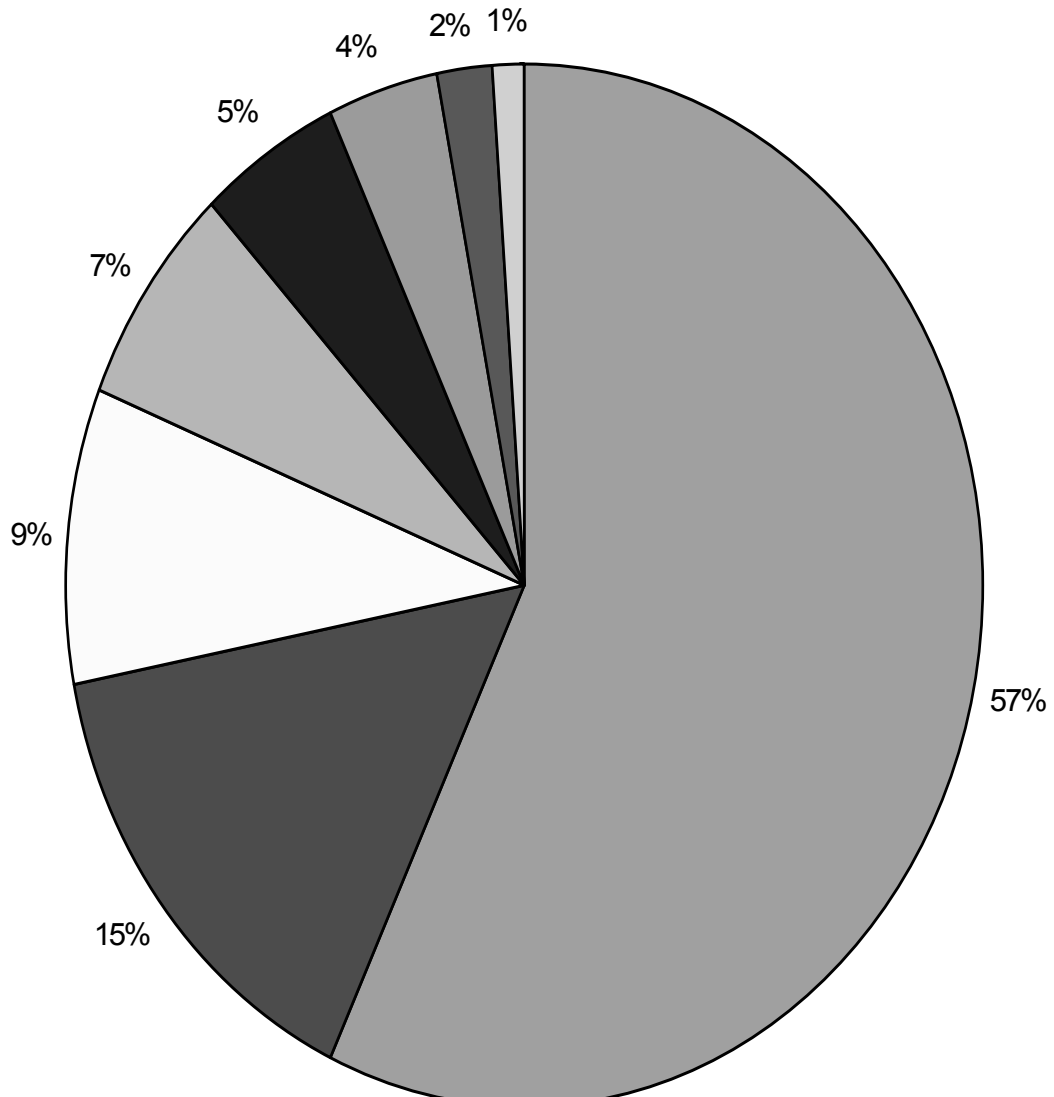
Legend:
- ☐ Private Individual = 57%
- ■ County Owned = 15%
- ☐ National Forest = 9%
- ☐ Forest Industry = 7%
- ■ State Forest = 5%
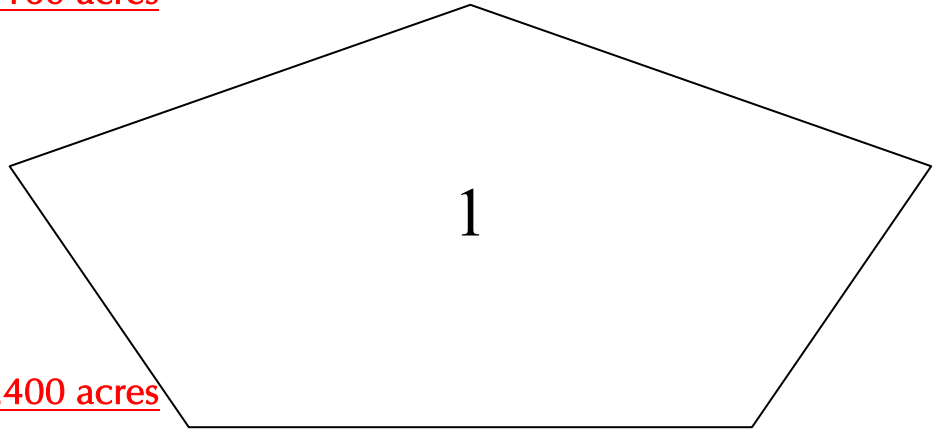- ☐ Private Corporation = 4%
- ■ Tribal Lands = 2%
- ☐ Other = 1%

FOREST AREA WORKSHEET

(Use your dot grid to determine the area inside of the shapes below)
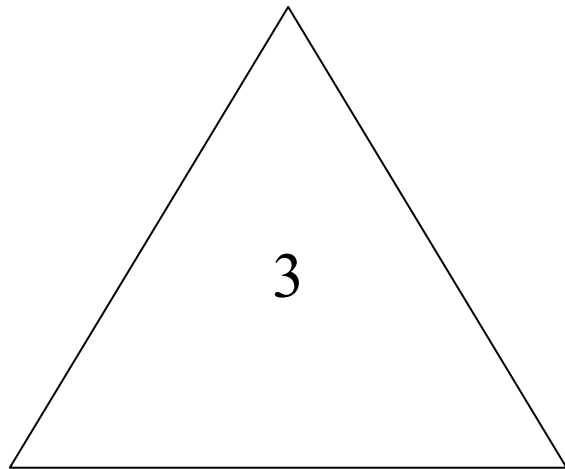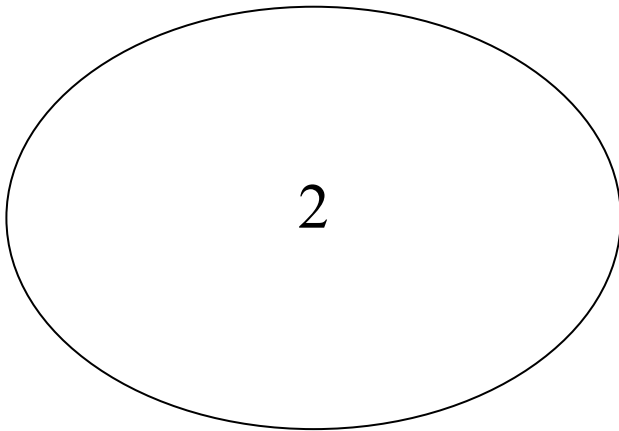
1 dot : 40 acres

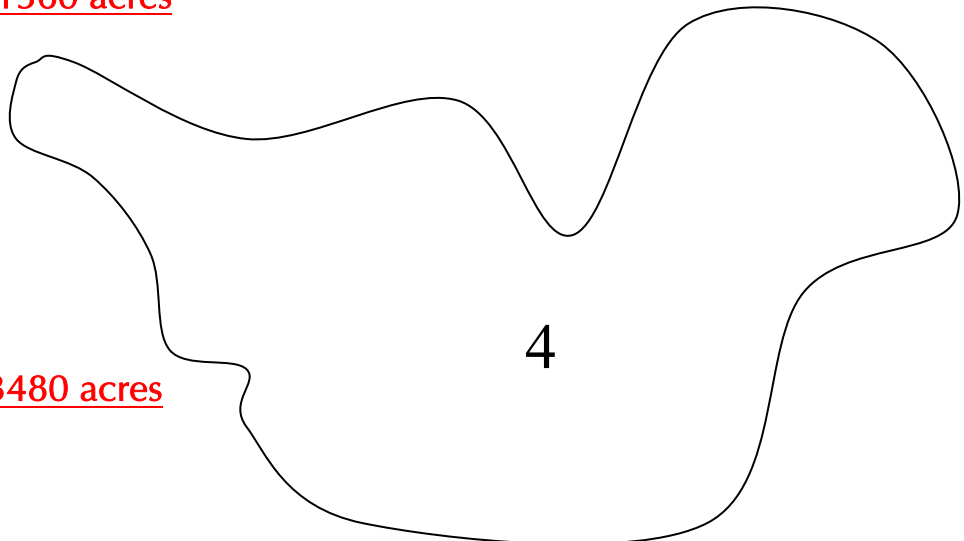***These answers were determined with the dot grid reduced to 93%.

Area 1   approx. 3160 acres

1

Area 2   approx. 2400 acres

2

3

Area 3   approx. 1360 acres

4

Area 4   approx. 3480 acres

Lesson 8

Tip:

For best results on the worksheets and mapping activity, reduce the size of the grid to 93% on a photocopy machine before making additional copies.
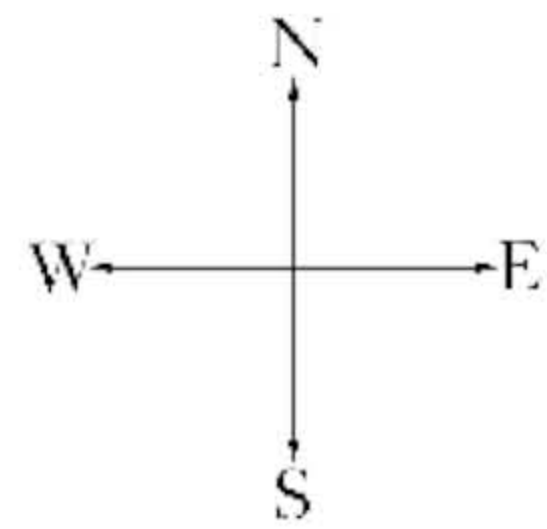
Duplicating Instructions

Print this map on 8.5 X 11 inch paper.

Photocopy map onto 11 X 17 inch paper, enlarge by 136%.
This will ensure the figures for land area match those on the
worksheets in the lesson.

Shady River State Forest
Map of Forest Types

N
W — E
S

Forest Type Descriptions

1) Old Growth White Pine - a mixed coniferous and deciduous forest dominated by large, old White Pine trees.

2) Bottomland Hardwoods - found on low gound that stays moist throughout the growing season. Made up of deciduous trees like maple, birch, aspen, and ash. Trees do not grow to great sizes or in great numbers, but many trees such as Black Ash are very valuable.

3) Northern Hardwoods - deciduous and mixed forest found in great abundance throughout northern Wisconsin. Maple, oak, elm, hickory, and birch may grow in large quantities. Mature forests are usually dominated by large, valuable Sugar Maples.

4) White Cedar Swamps - lowland, wet, coniferous forest dominated by slow growing, but valuable White Cedar trees.

5) Aspen Lowland - young forest made up of dense stands of Big-tooth and Trembling Aspen trees that are highly valued for paper and pulp production.

6) Red Pine Plantation - a replanted forest made up of straight rows of even-aged red pine trees. Plantations contain large amounts of tall, straight, valuable trees.

Privately Owned Property

Aspen Lowland

Old Growth White Pine

Aspen Lowland

Red Pine Plantation

Bottomland Hardwoods

Black Bean Lake

Red Pine Plantation

Red Pine Plantation

White Cedar Swamp

Aspen Lowland

Mature Northern Hardwoods

Bottomland Hardwoods

Mature Northern Hardwoods

Footprint Lake

Old Growth White Pine

Red Pine Plantation

White Cedar Swamp

Map Legend

Forest Type Boundaries

Rivers and Streams

Highways and Roads

3cm : 1 mile or 1cm : 1/3 mile