# Lesson 3: Forests Are Always Changing

## NUTSHELL

***In this classroom lesson, students simulate forest succession and disturbances by role-playing different species of trees. Using mathematics calculations, students discover how forests are renewable resources if harvested and replanted.***

## ENDURING UNDERSTANDINGS

- Forests are renewable resources. They can be used and regenerated at regular intervals.
- Ecosystems are continuously undergoing natural change. This natural change occurs through such processes as long-term evolution or through relatively short-term processes such as succession, in which one plant community gradually supplants another.
- Ecosystems are dynamic and altered by natural or human disturbance. Disturbance plays an ongoing role in ecosystem structure and function.

## ESSENTIAL QUESTIONS

- In what ways to forests change?
- How does the speed of change in forests influence their ability to be a renewable resource?

## OBJECTIVES

Upon completion of this lesson, students will be able to:

- Describe how forest ecosystems are constantly changing through succession.
- Explain how disturbances contribute to succession.
- Define the term “renewable resource” and relate how forests are renewable resources.

## SUBJECT AREAS

Arts, Mathematics, Science

## LESSON/ACTIVITY TIME

***Total Lesson Time:*** 85 minutes

- Introduction.....5 minutes
- Activity 1 .....40 minutes
- Activity 2 .....20 minutes
- Conclusion.....20 minutes

## STANDARDS CONNECTIONS

Standards for this lesson can be viewed online at the LEAF website ***(www.leafprogram.org)***.

## BACKGROUND INFORMATION

Ecosystems are dynamic: They do not remain the same. All ecosystems are constantly going through a process called **succession**. There are two types of succession that can occur — primary succession and secondary succession. Primary succession is the development of a community on land that has never had plants growing on it before. Examples of such areas include rock slides, soil left behind by glaciers, or a cooled lava flow. Secondary succession is the development of communities in an area where the vegetation has been removed or destroyed. Examples of such areas are abandoned farmlands, burned land, cut forests, or forests that have been destroyed by wind.

Succession involves a predictable series of steps. Early successional stages usually contain small plants and shrubs that can survive under the conditions that exist on a site. In Wisconsin, the first tree species that grow in a disturbed area are often aspen and birch. These trees are fast growing and love sunlight. These sun-loving

## VOCABULARY TERMS

**Disturbance:** An event that disrupts the succession of a forest (e.g., fire, harvest, wind, flood).

**Renewable Resource:** A resource that has the ability to regenerate, grow back, or produce more.

**Shade-intolerant:** Describes a plant's ability to compete for survival under direct sunlight conditions.

**Shade-tolerant:** Describes a plant's ability to compete for survival under shaded conditions.

**Succession:** The gradual changing of an area from one community to another.

**Sustainable Management:** Maintenance of forests to meet current and future ecological, economic, and social needs.

## MATERIALS LIST

### For Each Student

- One species card made from Student Page ***1, Species Cards***
- Copy of Student Pages ***2A-B, Forests Are Renewable***

### For the Class

- 10 carpet squares
- Marker board
- Disturbance Cards cut from Teacher Pages ***2A-B, Disturbance Cards***
- Pair of dice

### For the Teacher

- Teacher Key ***1, Succession Role-play Key***

trees are often called **shade-intolerant** because they cannot live in shade. Sun-loving species are usually not very long-lived. As they reach the end of their lives and go into decline, **shade-tolerant** trees that have been growing underneath them take over. Shade-tolerant trees can survive without much sun, so they can live underneath more mature trees. Eventually, the ecosystem arrives at a point called climax when the site is dominated by long-lived, highly competitive species. Trees that can be part of a climax forest in Wisconsin are maples, white pine, and basswood.

The soil, moisture, and temperature conditions determine what the climax species will be on any given site. Although forests are always moving toward the steady climax state, they rarely achieve it. Even though we mention specific species in the steps of succession, it s really the whole community that is going through the process.

## Forest Disturbance

Succession follows a relatively predictable pattern unless there is **disturbance**. A disturbance interrupts the stages of succession and causes the forest to go back to an earlier stage. Disturbances can be large, such as a fire, harvest, or trees blown down from a windstorm. Disturbances can also be small, like a few trees killed by insects or one large tree blown down in the wind. No matter the size of the disturbance, the makeup of the forest changes. According to the USDA Forest Service, disturbances, particularly fire, were common in eastern deciduous forests in presettlement times.

In some locations, succession to sugar maple-American basswood stands may have taken as long as 650 years. Without disturbances, maple-basswood stands could have grown in as little as 400 years.

## Forests Are Renewable Resources

**Renewable resources** are resources that can be regenerated in a relatively short period of time. Forests have the ability to renew themselves. This is important to people because forests provide a number of services for us. They clean our air and water, provide shade and aesthetic benefits, provide lumber and paper, and even provide us with food and medicine. If forests were not renewable, they would not be able to continue to provide these benefits for people.

All ecosystems can renew themselves. The limiting factor is the amount of time it takes them to do so and the abiotic resources available to them. For instance, vehicle tracks across tundra will be visible for decades. Tundra plants grow very slowly because of the cold temperatures and lack of available water most of the year. It takes them time to recover. On the other hand, vehicle tracks through grassland will likely be visible only for a matter of weeks or months. Grassland plants grow more quickly and live with different abiotic conditions.

The forests of Wisconsin are temperate forests. Temperate forests contain trees that go into a dormant state every fall. Because these trees shed their leaves and the leaves decompose, the soil in a temperate forest contains many nutrients. On the other hand, trees in a tropical rainforest do not lose their leaves annually. That means that most of the nutrients in a rainforest are in the plants, not the soil. Even though there is ample rain and temperature is favorable, these forests do not regenerate from cutting as well as temperate forests do. Temperate forests can be cut and begin to grow new trees within years, without any planting by humans. With planting, forest renewal time lessens.

# PROCEDURE

## Introduction - Schedules

Ask students if they follow a schedule at school. *(Yes.)* Ask if it is always the same. *(No.)* Ask how their schedule changes. *(They might have a field trip, a vacation, a special program in a different room, etc.)* Explain that just like their classroom is always changing, forests are always changing too.

## Activity 1 - Succession Role-play

1. Put out 10 carpet squares spaced about three feet apart for students to stand on.

2. Explain that students will act out the roles of different species of trees in a forest. The activity represents a process called succession that takes place over a long period of time. Define and discuss succession. *(Succession is the gradual changing of an area from one community to another. Succession is always occurring whether we can see it or not. Succession is inevitable.)* Explain the difference between primary and secondary succession. *(Primary succession occurs on soil that hasn't had plants on it before, such as a rock slide. Secondary succession occurs on soil where plants have been destroyed or removed, such as after a fire.)*

3. Tell students that some of the trees they will act out are shade-tolerant and some are shade-intolerant. Define and discuss shade-tolerant and shade-intolerant. (A shade-intolerant plant is able to compete for survival under direct sunlight conditions. A shade-tolerant plant is able to compete for survival under shaded conditions. The tolerance of a plant determines how well it can compete under certain conditions to survive.)

4. Hand out one Species Card made from Student Page ***1, Species Cards,*** to each student. There will be several students with each tree species. Discuss the information on the cards. *(Cards list tree name, typical age, maximum age, how fast they grow, and their shade tolerance. Trees don't all live to their maximum age all the time. Some of their species will probably begin to die earlier.)*

5. Explain the rules of the game.
   a. Tell students they will be "growing" on the carpet squares you have set out. Students will use the information on their *Species Cards* to decide when conditions are right for each species of tree to enter the game. When they enter the game, they must find an available carpet square to grow on. If none is available, they may not enter at that time.
   b. In order to illustrate the differences in species, have students stand according to their shade tolerance.
      - Shade-intolerant trees should stand with their arms at their sides.
      - Moderately tolerant trees should stand with their hands on their hips.
      - Shade-tolerant trees should stand with their arms over their head.
   c. Tell students that you will roll a die to decide how many years will pass each round. Multiply the number rolled by 10 to get the number of years. (A roll of six would equal 60 years.) **NOTE:** If time is an issue, you may use a pair of dice, but that will cause time to go by very quickly for some species.
   d. Each time the die is rolled, write down the year and record what happens (what trees come in and what trees go out) on a timeline on the board. (See example on Teacher Key ***1, Succession Role-play Key***.) **NOTE:** If possible, leave space for a second timeline below the first.
   e. After each roll, help students decide what should happen next. (Use Teacher Key ***1, Succession Role-play Key***, to help you guide the game. It lists an approximate year, the conditions that exist, and the species that should enter or exit). Tell them you will ask questions about the conditions and maximum ages of their species (written on the *Species Cards*) to help them decide which trees should enter and which should exit. For example, ask these questions for the 40-year point:
      - How much shade is there on the forest floor now? *(Some, but since all of the spaces aren't filled, there is still some sun.)*
      - Are there any trees that prefer some sun but not too much or too little? *(White pine, red oak)* The white pine and red oak may only fill the spaces where there are no aspen or birch.

6. Begin the game by describing the imaginary site they, as trees, will be growing on. The soil is good, with enough nutrients and can hold enough water for most trees to do well. It is in the early stages of secondary succession. There was a fire a year ago that destroyed all the vegetation that used to grow there. The conditions now favor shade-intolerant species (those that need a lot of sun to grow) that can grow quickly to fill the space. **NOTE:** The students with aspen and birch cards will enter the game. There will not be enough to fill all the spaces, but the empty spaces will remain until later.

7. Continue with the steps of the game listed above.

8. When you have reached the 450-year point, ask students if the species that make up the forest will change after this. *(No.)* Ask why. *(The conditions are shady. The only trees that can grow there are shade-tolerant and will be the only young trees ready to grow after old trees die.)* Ask how long the forest will look like this. *(Forever.)* Ask if that's what all forests in Wisconsin look like. *(No.)* Ask students if they know why. Accept their suggestions and then explain that it is because of disturbance.

9. Define and discuss disturbance. *(A disturbance is an event that disrupts the succession of a forest [e.g., fire, harvest, wind, flood]. Disturbances set a forest back to an earlier successional stage.)*

10. Prepare to play the game again, and explain changes to the rules for the second game.
    a. This time, you will introduce disturbances during the game.
    b. Students each need to keep track of how old they are while they are growing. This is because some disturbances affect trees only if they are certain ages. (If needed, they may keep track of their age on a piece of paper.)
    c. Draw another timeline on the board, keeping the first one if possible. On this timeline, write when species come and go and what disturbances occurred when.
    d. The roll of the die times 10 will still represent the number of years passed.

> "A people without the knowledge of their past history, origin and culture is like a tree without roots."
>
> ♣ *Marcus Garvey* ♣

11. Begin the game as before. During this game, draw a Disturbance Card from Teacher Pages **2A-B, *Disturbance Cards***, every other time you roll the die. Read the description of the disturbance on the card aloud. Tell students what the disturbance means to each species. If the disturbance had no effect on a species of tree, those students remain in the game. If the disturbance killed the tree, those students should leave the game. A disturbance that weakens trees might not kill a young tree, but would probably kill a tree near its maximum age.

12. Continue until several hundred years have passed. You will likely not reach a point where there are only maple and basswood.

13. At the end, discuss natural and human disturbances. *(Natural disturbances such as wind, fire, and disease interrupt succession. Human disturbances such as harvest also interrupt succession.)* Discuss the effect that the size of a disturbance has on a forest. *(A small disturbance, such as a few trees dying from disease, will not change the succession of the entire forest, but will impact the system. A large disturbance, such as a tornado, will impact the succession of the whole forest.)* Discuss timeframe. *(Succession takes place over hundreds of years. It is sometimes hard for us to realize that the process is still going on when we don't see significant change in our lifetime. The forest is always changing; it won't be the same in 100 years whether there is human disturbance or not.)* Emphasize the point that change through succession is inevitable; trees can't live forever. Disturbance will also usually interrupt succession, so the stable climax forest is unlikely.

## Activity 2 - Forests Are Renewable

1. Remind students that in Activity 1 they learned forests are constantly changing. Forests grow and change even when there is a disturbance that removes some or all of the trees. Review what different disturbances can affect the forest. *(Wind blowing trees down, fire burning, people harvesting trees to use.)*

2. Introduce the term "renewable resource" to students. Ask if anyone can define it. Write the definition on the board. *(A resource that has the ability to regenerate, grow back, or produce more.)* Tell students that forests are renewable resources.

3. Hand out Student Pages ***2A-B, Forests Are Renewable***. Tell students to read the questions and fill in the answers based on the information on the sheet. If needed, explain that an acre is a unit of measure for land. It is about the size of a football field.

4. Once all students have filled in their answers, discuss them. Correct answers are listed below:
   a. How many acres of red pine plantation are there? ..... 6
   b. How many acres have you cut? ..... 1
   c. How old are the oldest trees? ..... 80
   d. How old are the youngest trees? ..... 10
   e. How many acres of 100-year-old trees are there? ..... 2
   f. How old are the trees planted in year 10? ..... 40
   g. How old are the oldest trees? ..... 50
   h. Can you continue to cut one acre of trees every 10 years? ..... Yes
   How long can you do this? ..... Forever

5. As a group (or as individuals) have the students figure out how many acres you would cut every 10 years if you were managing 60 acres (6 acres) and 120 acres (12 acres). Explain that the number of acres you can harvest sustainably depends on how many acres you are managing. Ask if the forest would be sustainable if you cut all the trees at once. *(Yes, if you have 60 years that you can wait until the trees are ready to cut again.)*

## Conclusion - Changing Forest Drawing

Have students draw a changing forest. Set up the drawing like a comic strip so that different parts of forest succession are in different frames. (There should be at least six frames.) Ask them to write below each frame a description of the things that are happening in the forest. When everyone has drawn the changes in their forest, discuss what they drew. Be sure to point out the forests that had disturbances and those that didn't. Ask students if it would be more likely to have a forest with or without disturbances. *(With.)*

## CAREERS

The career profile in this lesson is about Kyoko Scanlon, Forest Pest Specialist, Wisconsin DNR and is found on page 59. Use this profile to enhance the lesson and/or use it with the special careers lesson on page 148.

## SUMMATIVE ASSESSMENT

Assign students to research an ecosystem other than the temperate forest. (Wetlands, prairie, pond.) Ask them to write a report on the role change plays in that ecosystem and what sorts of disturbances affect it.

## SOURCES

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"I'm just delighted to be living, to be able to have a simple conversation, to feel a ray of sunlight on my skin and listen to the breeze move through the leaves of a tree."

*Ryuichi Sakamoto*

## NOTES

# Career Profile

## Kyoko Scanlon, Forest Pest Specialist

This is Kyoko Scanlon. Kyoko is a Forest Pest Specialist with the Wisconsin Department of Natural Resources. She determines what forest pests may be causing problems in a specific forest. She gives advice to foresters and landowners about how to deal with the pests. Forest pest problems could be insects, diseases, or extreme weather such as storms and drought. Kyoko works with foresters, landowners, arborists, loggers, Christmas tree growers, maple syrup producers, and homeowners to help with pest problems.

Kyoko has a master's degree in forestry with an emphasis in forest pathology (the study of diseases). She has had training in pesticide application and has conducted experiments to learn more about forest pests.

Kyoko's favorite part of her job is that she gets to work outside. She also likes talking to people, and this job gives her plenty of opportunities to meet a variety of people.

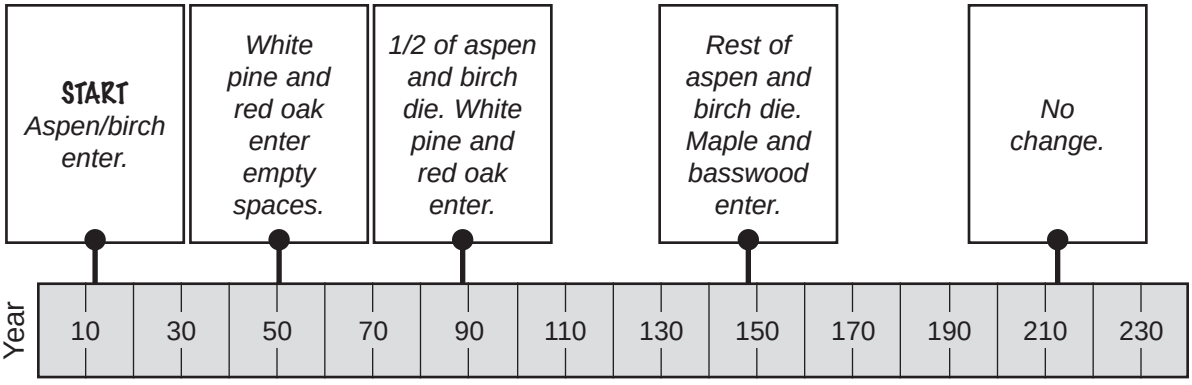
If you would like a job like Kyoko's, she has some advice: "I recommend that you get out of a classroom (after school is done, of course) and go out in a forest when you have time. It's fun to learn about insects, fungi, and bacteria, as well as trees, flowers, birds, and mammals. Every creature has a role in the forest ecosystem — good, bad, or neutral — depending on your perspective."


***This machine helps Kyoko decide if a tree is hollow and should be cut down.***

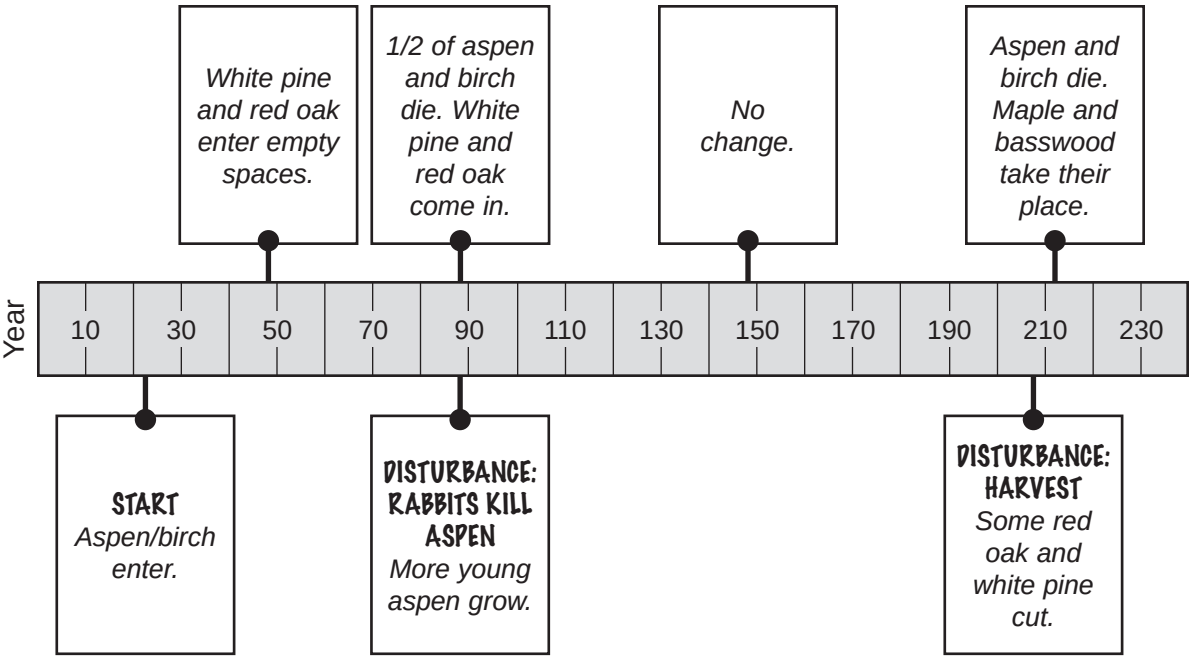
# SUCCESSION ROLE-PLAY KEY

| Approximate Year | Conditions | Who Comes/Goes |
|---|---|---|
| 0 | Sunny | Aspen and birch enter. |
| 40 | Moderately shady | White pine and red oak enter the open spaces. |
| 80 | Moderately shady | Aspen and birch health declining; 1/2 of them die. White pine and red oak replace them. |
| 140 | Shady | The rest of the aspen and birch die. Maple and basswood take their place. |
| 350 | Shady | White pine and red oak die. Maple and basswood take their place. |
| 450 | Shady | Original maple and basswood die. More maple and basswood replace them. |

**Round 1: Example Timeline**




**Round 2: Example Timeline**



# DISTURBANCE CARDS

## FIRE

***A medium-size fire burns through the forest.***

- **Basswood:** Older trees (greater than 50 years) survive; younger trees are killed.
- **Northern red oak**: Older trees (greater than 50 years) survive; younger trees are killed but may re-sprout.
- **Paper birch:** Bark very flammable; killed.
- **Sugar maple:** Thin bark; killed.
- **Trembling aspen:** Bark very thin; killed.
- **White pine:** Older trees (greater than 50 years) survive; young trees are killed.

## WINDSTORM

***A storm with high winds passes through the forest.***

- **Basswood:** Not affected.
- **Northern red oak:** Not affected.
- **Paper birch:** Many trees badly damaged or blown down.
- **Sugar maple:** Many trees badly damaged or blown down.
- **Trembling aspen:** Many trees badly damaged or blown down.
- **White pine:** Not affected.

## HARVEST

***Trees are harvested using different techniques.***

- **Basswood:** A few trees are chosen by a forester to be cut; trees 80 years and older are cut.
- **Northern red oak:** A few trees are chosen by a forester to be cut; trees 80 years and older are cut.
- **Paper birch:** Trees 35 years and older are cut.
- **Sugar maple:** A few trees are chosen by a forester to be cut; trees 80 years and older are cut.
- **Trembling aspen:** Clearcut to encourage more aspen; trees 25 years and older are cut.
- **White pine:** Some trees cut one year; the rest cut five years later to encourage more white pine (trees 90 years and older).

## DEER POPULATION INCREASE

***Increased numbers of deer impact some trees because deer eat young trees.***

- **Basswood:** Preferred tree; young trees (less than five years old) are killed.
- **Northern red oak:** New growth on young trees may be eaten (damaged) but not killed.
- **Paper birch:** Young trees (less than five years old) are killed and new growth is slowed.
- **Sugar maple:** Damaged but not killed.
- **Trembling aspen:** Young trees (less than five years old) are killed and new growth is slowed.
- **White pine:** New growth on young trees may be eaten (damaged) but not killed.

# DISTURBANCE CARDS

## RABBIT POPULATION INCREASE

***Trees are damaged from rabbits eating bark and young branches.***

- **Basswood:** Young trees (less than five years old) are killed.
- **Northern red oak:** New growth (bark and stem) on young trees may be eaten.
- **Paper birch:** Young trees (less than five years old) are killed.
- **Sugar maple:** New growth (bark and stem) on young trees may be eaten.
- **Trembling aspen:** Killed.
- **White pine:** New growth (bark and stem) on young trees may be eaten

## GYPSY MOTH

***Insects eat all of the leaves off trees.***

- **Basswood:** Favored tree; killed.
- **Northern red oak:** Killed if leaves are eaten more than once.
- **Paper birch:** Not killed; more likely to have other things kill it after leaves are gone.
- **Sugar maple:** Moderately palatable; only minor damage.
- **Trembling aspen:** Favored tree; killed.
- **White pine:** Moderately palatable; only minor damage.

## OAK WILT

***A disease spreads through roots or from beetles entering the forest.***

- **Basswood:** Not affected.
- **Northern red oak:** Very susceptible; all are killed.
- **Paper birch:** Not affected.
- **Sugar maple:** Not affected.
- **Trembling aspen:** Not affected.
- **White pine:** Not affected.

## FLOODING

***It's a very rainy, wet year — there are small floods all spring and summer.***

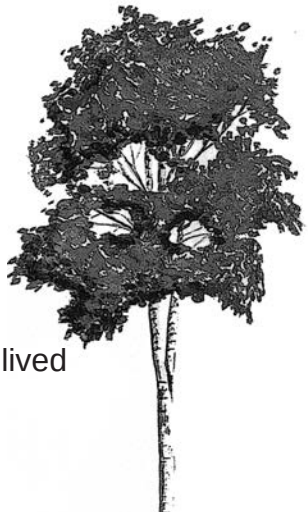
- **Basswood:** Tolerates short-term flooding during the growing season; survives.
- **Northern red oak:** Doesn't tolerate short-term flooding during the growing season; killed.
- **Paper birch:** Doesn't tolerate short-term flooding during the growing season; killed.
- **Sugar maple:** Tolerates short-term flooding during the growing season; survives.
- **Trembling aspen:** Doesn't tolerate wet roots; killed.
- **White pine:** Doesn't tolerate short-term flooding during the growing season; killed.

# SPECIES CARDS

## ASPEN

- Shade-intolerant
- Typical Age: 60 in Wisconsin
- Maximum Age: 150 (but not in Wisconsin)
- Fast-growing, relatively short-lived

## PAPER BIRCH



- Shade-intolerant
- Typical Age: 80
- Maximum Age: 140
- Fast-growing, short-lived

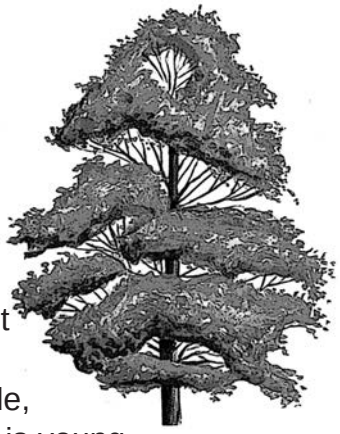
## WHITE PINE

- Moderately shade-tolerant
- Typical Age: 200 (without disturbance)
- Maximum Age: 450
- More tolerant than paper birch and aspen but less than sugar maple

## NORTHERN RED OAK

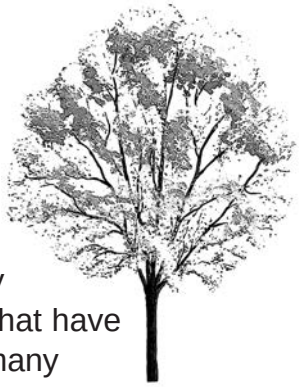
- Moderately shade-tolerant
- Typical Age: 180
- Maximum age: 300
- More tolerant than paper birch and aspen but less than sugar maple

## BASSWOOD



- Shade-tolerant
- Typical Age: 120
- Maximum Age: 250
- Very shade-tolerant and will grow in considerable shade, especially when it is young

## SUGAR MAPLE



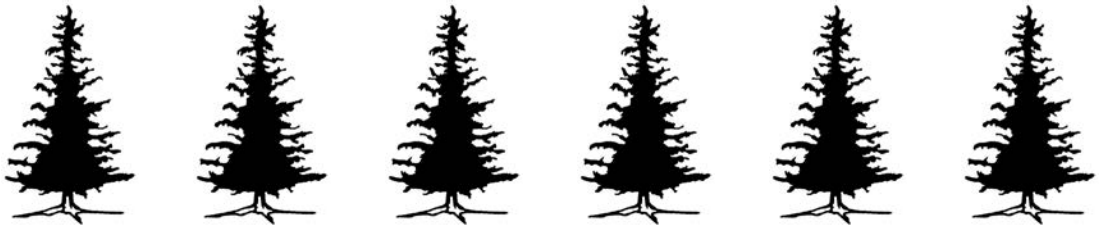
- Shade-tolerant
- Typical Age: 180
- Maximum Age: 350
- Will prosper in heavy shade; young trees that have grown in shade for many years will still grow tall and be dominant when the shade is removed

# FORESTS ARE RENEWABLE

## Each Tree = 1 Acre of Red Pine Plantation • Cutting Rate = 1 Acre Every 10 Years (Every Acre Harvested Is Replanted)

**YEAR 0**

a. How many acres of red pine plantation are there?



| AGE | 60 | 60 | 60 | 60 | 60 | 60 |
|---|---|---|---|---|---|---|

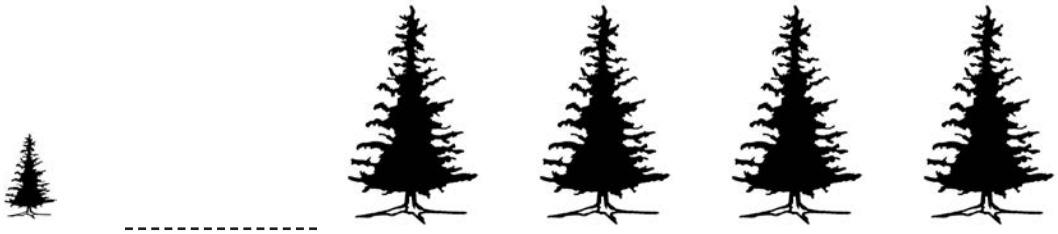
**YEAR 10**

b. How many acres have you cut?

| AGE | 0 | 70 | 70 | 70 | 70 | 70 |
|---|---|---|---|---|---|---|

**YEAR 20**

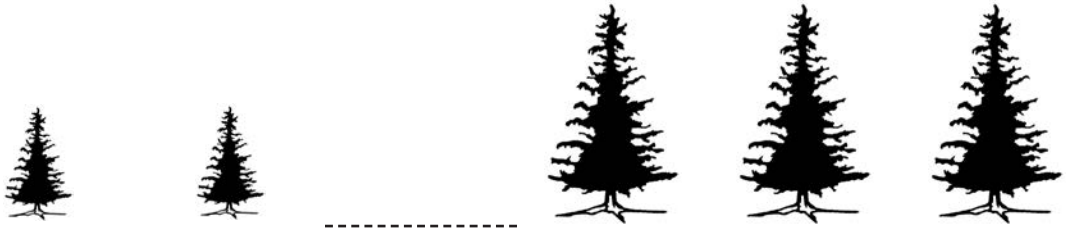
c. How old are the oldest trees?



| AGE | 10 | 0 | ? | ? | ? | ? |
|---|---|---|---|---|---|---|

**YEAR 30**

d. How old are the youngest trees?



| AGE | 20 | ? | 0 | 90 | 90 | 90 |
|---|---|---|---|---|---|---|

# FORESTS ARE RENEWABLE

## Each Tree = 1 Acre of Red Pine Plantation • Cutting Rate = 1 Acre Every 10 Years (Every Acre Harvested Is Replanted)

**YEAR 40**

e. How many acres of 100-year-old trees are there?

| AGE | 30 | 20 | 10 | 0 | 100 | 100 |
|---|---|---|---|---|---|---|

**YEAR 50**

f. How old are the trees planted in year 10?

| AGE | ? | 30 | 20 | 10 | 0 | 110 |
|---|---|---|---|---|---|---|

**YEAR 60**

g. How old are the oldest trees?

| AGE | ? | 40 | 30 | 20 | 10 | 0 |
|---|---|---|---|---|---|---|

**YEAR 70**

h. Can you continue to cut one acre of trees every 10 years? How long can you do this?

| AGE | 60 | 50 | 40 | 30 | 20 | 10 |
|---|---|---|---|---|---|---|